PP284/2017-1

30 Morley Avenue Wye River and 36 Morley Avenue Wye River

Lot 6 LP 50107 V/F 8521/629, Lot 4 LP50107 V/F 8616/602, Lot 1 LP77174 V/F 8678/476

Construction of a Dwelling, Outbuilding and Associated Works, Removal of Two (2) Trees and Removal of a Carriageway Easement

Rob Kennon Architects

Officer - **Bernadette McGovan**

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

Colac Otway SHIRE

Planning Enquiries
Phone: (03) 5232 9400
Web: www.colacotway.vic.gov.au

Clear Form

Office Use Only

Application No.: Date Lodged: / /

Application for a **Planning Permit**

If you need help to complete this form, read MORE INFORMATION at the end of this form.

Any material submitted with this application, including plans and personal information, will be made available for public viewing, including electronically, and copies may be made for interested parties for the purpose of enabling consideration and review as part of a planning process under the *Planning and Environment Act 1987*. If you have any questions, please contact Council's planning department.

Questions marked with an asterisk (*) must be completed.

If the space provided on the form is insufficient, attach a separate sheet.

Click for further information.

The Land

Address of the land. Complete the Street Address and one of the Formal Land Descriptions.

Street Address *

Unit No.: | St. No.: 30, 32 & 36 | St. Name: Morley Avenue

Suburb/Locality: Wye River | Postcode: 3234

Formal Land Description *
Complete either A or B.

This information can be found on the certificate of title.

If this application relates to more than one address, attach a separate sheet setting out any additional property details.

A Lot No.: 1, 4 & 6 | ○ Lodged Plan ○ Title Plan ◉ Plan of Subdivision | No.: 050107 & 077174

OR

B Crown Allotment No.: | Section No.:

Parish/Township Name:

The Proposal

You must give full details of your proposal and attach the information required to assess the application.
Insufficient or unclear information will delay your application.

For what use, development or other matter do you require a permit? *

Complete demolition of existing house and garage on the site including removal of easement benefitting 32 Morley Ave and construction of a new two storey (half basement) dwelling with detached studio.

Provide additional information about the proposal, including: plans and elevations; any information required by the planning scheme, requested by Council or outlined in a Council planning permit checklist; and if required, a description of the likely effect of the proposal.

Estimated cost of any development for which the permit is required *

Cost $

You may be required to verify this estimate.
Insert '0' if no development is proposed.

Existing Conditions

Describe how the land is used and developed now *

For example, vacant, three dwellings, medical centre with two practitioners, licensed restaurant with 80 seats, grazing.

Single Dwelling

☑ Provide a plan of the existing conditions. Photos are also helpful.

Title Information

Encumbrances on title *

Does the proposal breach, in any way, an encumbrance on title such as a restrictive covenant, section 173 agreement or other obligation such as an easement or building envelope?

- (●) Yes (If 'yes' contact Council for advice on how to proceed before continuing with this application.)
- ( ) No
- ( ) Not applicable (no such encumbrance applies).

☑ Provide a full, current copy of the title for each individual parcel of land forming the subject site.
The title includes: the covering 'register search statement', the title diagram and the associated title documents, known as 'instruments', for example, restrictive covenants.

Applicant and Owner Details

Provide details of the applicant and the owner of the land.

Applicant *

The person who wants the permit.

Name:
Title: Mr | First Name: Jack | Surname: Leishman
Organisation (if applicable): Rob Kennon Architects
Postal Address: | If it is a P.O. Box, enter the details here:
Unit No.: 1/1 | St. No.: 156 | St. Name: George Street
Suburb/Locality: Fitzroy | State: VIC | Postcode: 3065

Please provide at least one contact phone number *

Contact information for applicant OR contact person below
Business phone: 9015 8621 | Email: jack@robkennon.com
Mobile phone: | Fax:

Where the preferred contact person for the application is different from the applicant, provide the details of that person.

Contact person's details*
Same as applicant ☑
Name:
Title: | First Name: | Surname:
Organisation (if applicable):
Postal Address: | If it is a P.O. Box, enter the details here:
Unit No.: | St. No.: | St. Name:
Suburb/Locality: | State: | Postcode:

Owner *

The person or organisation who owns the land

Where the owner is different from the applicant, provide the details of that person or organisation.

Same as applicant ☐
Name:
Title: Mrs | First Name: Sarah Louise | Surname: Carter
Organisation (if applicable):
Postal Address: | If it is a P.O. Box, enter the details here:
Unit No.: | St. No.: 5 | St. Name: Rosslyn Street
Suburb/Locality: Hawthorn East | State: VIC | Postcode: 3123
Owner's Signature (Optional): | Date:
day / month / year

Declaration

This form must be signed by the applicant *

Remember it is against the law to provide false or misleading information, which could result in a heavy fine and cancellation of the permit.

I declare that I am the applicant; and that all the information in this application is true and correct; and the owner (if not myself) has been notified of the permit application.

Signature: [signature]

Date: 02/03/2018
day / month / year

Need help with the Application?

General information about the planning process is available at planning.vic.gov.au

Contact Council's planning department to discuss the specific requirements for this application and obtain a planning permit checklist. Insufficient or unclear information may delay your application.

Has there been a pre-application meeting with a council planning officer?

(●) No ( ) Yes If 'Yes', with whom?:

Date: day / month / year

Checklist

Have you:

- [x] Filled in the form completely?
- [x] Paid or included the application fee?

Most applications require a fee to be paid. Contact Council to determine the appropriate fee.

- [x] Provided all necessary supporting information and documents?
  - [x] A full, current copy of title information for each individual parcel of land forming the subject site.
  - [x] A plan of existing conditions.
  - [x] Plans showing the layout and details of the proposal.
  - [x] Any information required by the planning scheme, requested by council or outlined in a council planning permit checklist.
  - [x] If required, a description of the likely effect of the proposal (for example, traffic, noise, environmental impacts).
- [x] Completed the relevant council planning permit checklist?
- [x] Signed the declaration above?

Lodgement

Lodge the completed and signed form, the fee and all documents with:

Colac Otway Shire
PO Box 283
Colac VIC 3250

2-6 Rae Street
Colac VIC 3250

Contact information

Phone: (03) 5232 9400
Email: inq@colacotway.vic.gov.au

Deliver application in person, by post or by electronic lodgement.

REGISTER SEARCH STATEMENT (Title Search) Transfer of Land Act 1958

VOLUME 08678 FOLIO 476

Security no : 124070485712Y
Produced 21/02/2018 03:21 pm

LAND DESCRIPTION

Lot 1 on Plan of Subdivision 077174.
PARENT TITLE Volume 08362 Folio 715
Created by instrument LP077174 11/07/1967

REGISTERED PROPRIETOR

Estate Fee Simple
Sole Proprietor
SARAH LOUISE CARTER of 5 ROSSLYN STREET HAWTHORN EAST VIC 2123
AQ173748L 23/08/2017

ENCUMBRANCES, CAVEATS AND NOTICES

MORTGAGE AQ173749J 23/08/2017
NATIONAL AUSTRALIA BANK LTD

Any encumbrances created by Section 98 Transfer of Land Act 1958 or Section 24 Subdivision Act 1988 and any other encumbrances shown or entered on the plan or imaged folio set out under DIAGRAM LOCATION below.

DIAGRAM LOCATION

SEE LP077174 FOR FURTHER DETAILS AND BOUNDARIES

ACTIVITY IN THE LAST 125 DAYS

NIL

------------------------END OF REGISTER SEARCH STATEMENT------------------------

Additional information: (not part of the Register Search Statement)

Street Address: 36 MORLEY AVENUE WYE RIVER VIC 3234

ADMINISTRATIVE NOTICES

NIL

eCT Control 16089P NATIONAL AUSTRALIA BANK LIMITED (59)
Effective from
23/08/2017

DOCUMENT END

Imaged Document Cover Sheet

The document following this cover sheet is an imaged document supplied by LANDATA®, Land Use Victoria.

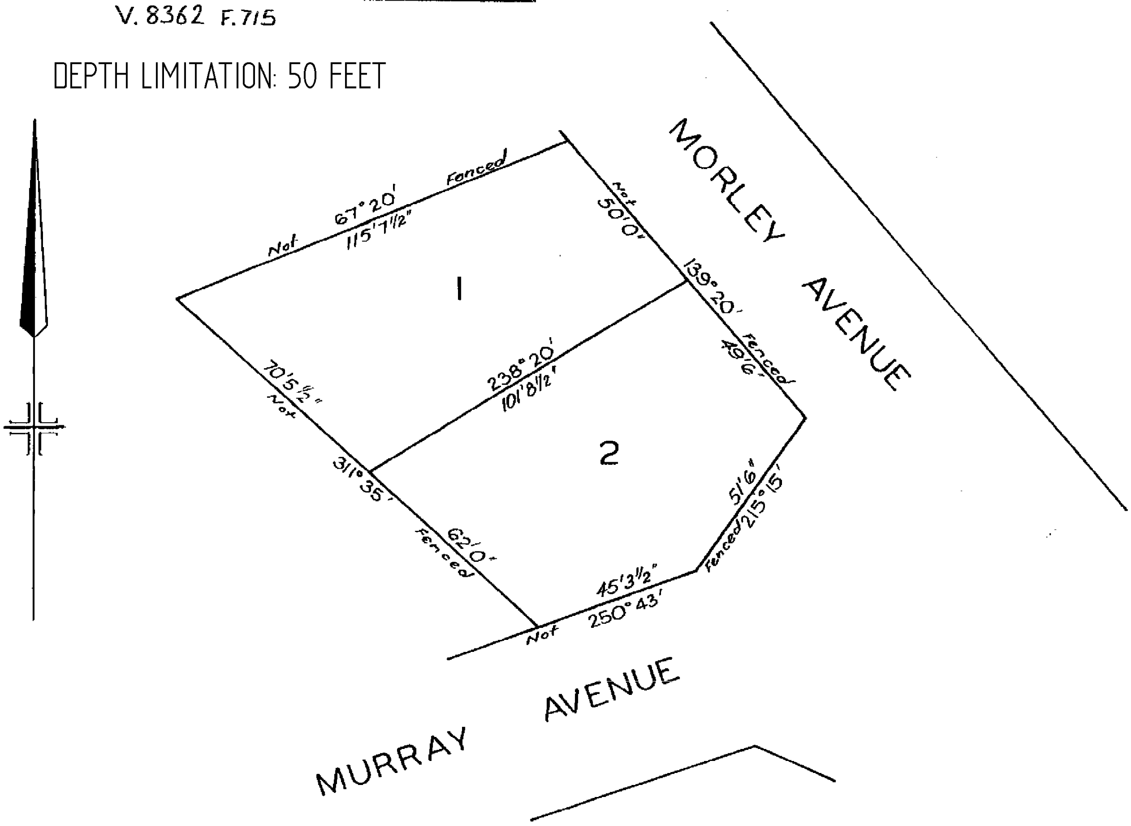
Document Type	**plan**
Document Identification	**LP077174**
Number of Pages (excluding this cover sheet)	**1**
Document Assembled	**22/02/2018 09:33**

LP77174
EDITION 1
APPROVED 22/6/67

PLAN OF SUBDIVISION OF:	APPROPRIATIONS
PART OF CROWN ALLOTMENT 2A	
PARISH: WONGARRA	
COUNTY: POLWARTH	
SCALE OF FEET: 30 15 0 30 60	

V. 8362 F. 715

DEPTH LIMITATION: 50 FEET



D17/101942

REGISTER SEARCH STATEMENT (Title Search) Transfer of Land Act 1958

VOLUME 08521 FOLIO 629

Security no : 124069281076L
Produced 27/11/2017 03:23 pm

LAND DESCRIPTION

Lot 6 on Plan of Subdivision 050107.
PARENT TITLES :
Volume 08362 Folio 708 Volume 08362 Folio 711
Created by instrument B911436 22/04/1964

REGISTERED PROPRIETOR

Estate Fee Simple
Sole Proprietor
SARAH LOUISE CARTER of 5 ROSSLYN STREET HAWTHORN EAST VIC 3123
AQ123733H 08/08/2017

ENCUMBRANCES, CAVEATS AND NOTICES

MORTGAGE AQ457093E 17/11/2017
NATIONAL AUSTRALIA BANK LTD

Any encumbrances created by Section 98 Transfer of Land Act 1958 or Section 24 Subdivision Act 1988 and any other encumbrances shown or entered on the plan or imaged folio set out under DIAGRAM LOCATION below.

DIAGRAM LOCATION

SEE LP050107 FOR FURTHER DETAILS AND BOUNDARIES

ACTIVITY IN THE LAST 125 DAYS

NUMBER		STATUS	DATE
AQ123727C	CONVERT AN ECT TO A PCT	Completed	08/08/2017
AQ123732K	DISCHARGE OF MORTGAGE	Registered	08/08/2017
AQ123733H	TRANSFER	Registered	08/08/2017
AQ457092G (E)	CONV PCT & NOM ECT TO LC	Completed	17/11/2017
AQ457093E (E)	MORTGAGE	Registered	17/11/2017

------------------------END OF REGISTER SEARCH STATEMENT------------------------

Additional information: (not part of the Register Search Statement)

Street Address: 30 MORLEY AVENUE WYE RIVER VIC 3234

ADMINISTRATIVE NOTICES

NIL

eCT Control 16089P NATIONAL AUSTRALIA BANK LIMITED (59)
Effective from
17/11/2017

DOCUMENT END

D17/101942

Imaged Document Cover Sheet

The document following this cover sheet is an imaged document supplied by LANDATA®, Land Use Victoria.

Document Type	plan
Document Identification	LP050107
Number of Pages (excluding this cover sheet)	3
Document Assembled	27/11/2017 15:25

PLAN OF SUBDIVISION OF PART OF CROWN ALLOTMENT 2A PARISH OF WONGARRA COUNTY OF POLWORTH

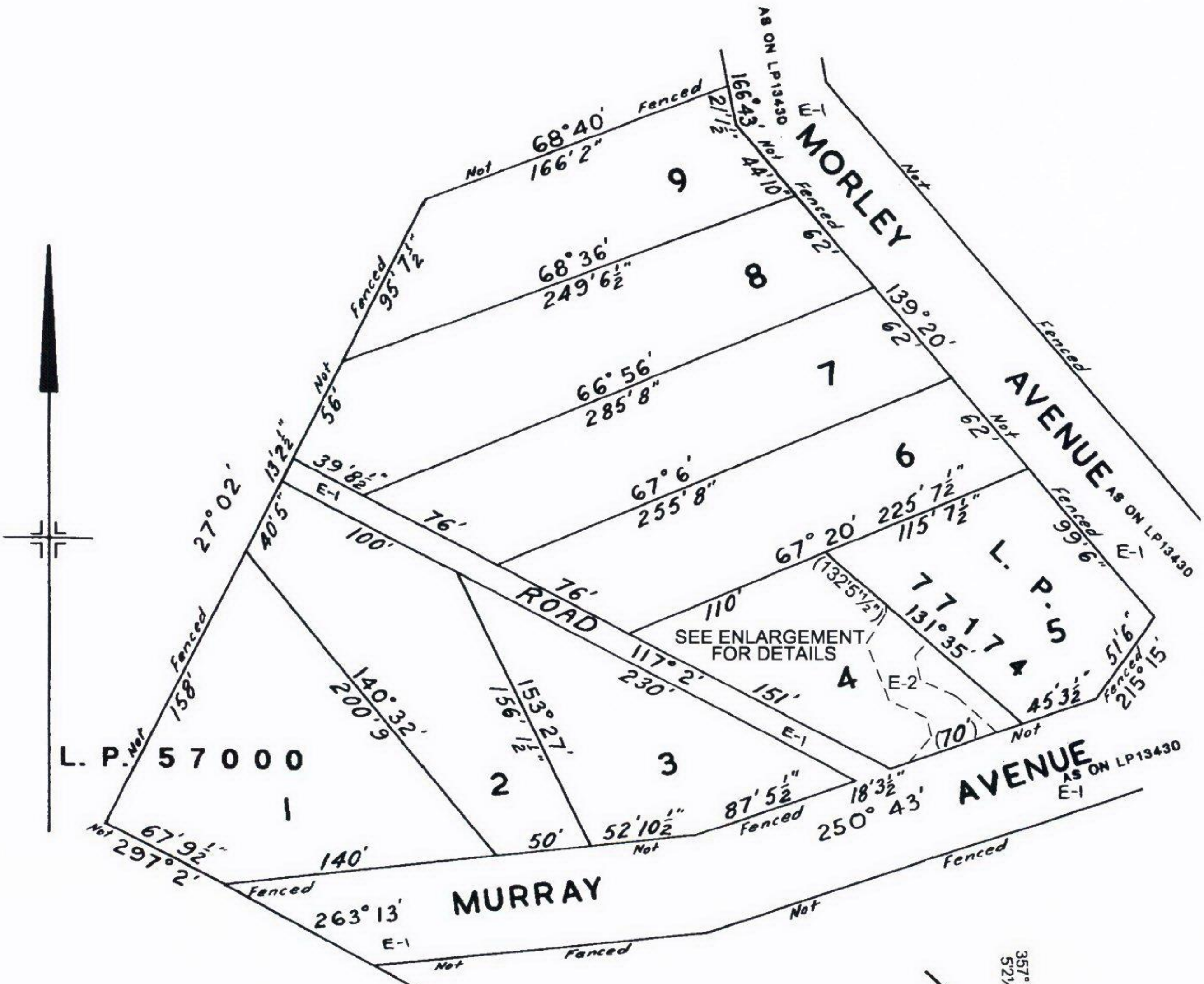
LP 50107
EDITION 2
PLAN MAY BE LODGED 30/ 6 / 59

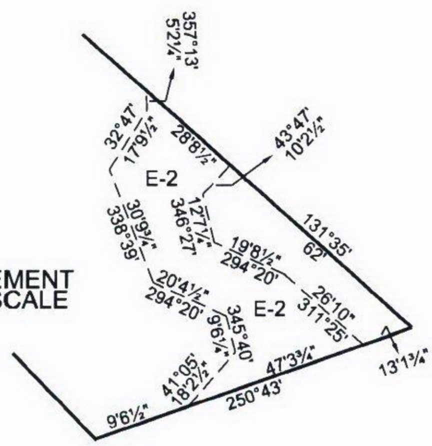
SCALE FEET

COLOUR CONVERSION
E-1 = BROWN

DEPTH LIMITATION: 50 FEET

EASEMENT INFORMATION				
Legend: A - Appurtenant Easement E - Encumbering Easement R- Encumbering Easement (Road)				
Easement Reference	Purpose	Width (Metres)	Origin	Land Benefitted / In Favour Of
E-1	WAY & DRAINAGE	SEE DIAG.	THIS PLAN	LOTS ON THIS PLAN
E-2	CARRIAGEWAY	SEE DIAG.	AM411403K	VOL 08678 FOL 476





ENLARGEMENT NOT TO SCALE

FOR APPROPRIATIONS, ETC, SEE BACK HEREOF

CERTIFICATE OF TITLE V. 6359. F. 661

LODGED BY P. ARUNDELL

DEALING No A 721849. DATE 20.4.59.

DECLARED BY F. D. GARNER. 15.12.58

CONSENT OF COUNCIL SHIRE OF
OTWAY.
18.3.59.

PLAN MAY BE LODGED M.P. 30.6.59

LP 50107
BACK OF SHEET 1

THE LAND COLOURED BROWN
IS APPROPRIATED
OR SET APART FOR
EASEMENTS OF WAY AND
DRAINAGE.

MODIFICATION TABLE

RECORD OF ALL ADDITIONS OR CHANGES TO THE PLAN

PLAN NUMBER

LP050107

WARNING: THE IMAGE OF THIS DOCUMENT OF THE REGISTER HAS BEEN DIGITALLY AMENDED.
NO FURTHER AMENDMENTS ARE TO BE MADE TO THE ORIGINAL DOCUMENT OF THE REGISTER.

AFFECTED LAND/PARCEL	LAND/PARCEL IDENTIFIER CREATED	MODIFICATION	DEALING NUMBER	DATE	EDITION NUMBER	ASSISTANT REGISTRAR OF TITLES
LOT 4	E-1	CREATION OF EASEMENT	AM411403K	13/04/16	2	JBHB

REGISTER SEARCH STATEMENT (Title Search) Transfer of Land Act 1958

VOLUME 08616 FOLIO 602

Security no : 124069281171H
Produced 27/11/2017 03:25 pm

LAND DESCRIPTION

Lot 4 on Plan of Subdivision 050107.
PARENT TITLES :
Volume 08362 Folio 708 Volume 08362 Folio 711
Created by instrument C419602 10/02/1966

REGISTERED PROPRIETOR

Estate Fee Simple
Sole Proprietor
SARAH LOUISE CARTER of 5 ROSSLYN STREET HAWTHORN EAST VIC 2123
AQ173748L 23/08/2017

ENCUMBRANCES, CAVEATS AND NOTICES

MORTGAGE AQ173749J 23/08/2017
NATIONAL AUSTRALIA BANK LTD

Any encumbrances created by Section 98 Transfer of Land Act 1958 or Section 24 Subdivision Act 1988 and any other encumbrances shown or entered on the plan or imaged folio set out under DIAGRAM LOCATION below.

DIAGRAM LOCATION

SEE LP050107 FOR FURTHER DETAILS AND BOUNDARIES

ACTIVITY IN THE LAST 125 DAYS

NUMBER		STATUS	DATE
AQ170811X (E)	NOMINATION OF ECT TO LC	Completed	23/08/2017
AQ173747N (E)	DISCHARGE OF MORTGAGE	Registered	23/08/2017
AQ173748L (E)	TRANSFER	Registered	23/08/2017
AQ173749J (E)	MORTGAGE	Registered	23/08/2017

------------------------END OF REGISTER SEARCH STATEMENT------------------------

Additional information: (not part of the Register Search Statement)

Street Address: 36 MORLEY AVENUE WYE RIVER VIC 3234

ADMINISTRATIVE NOTICES

NIL

eCT Control 16089P NATIONAL AUSTRALIA BANK LIMITED (59)
Effective from
23/08/2017

DOCUMENT END

D17/101942

Imaged Document Cover Sheet

The document following this cover sheet is an imaged document supplied by LANDATA®, Land Use Victoria.

Document Type	**plan**
Document Identification	**LP050107**
Number of Pages (excluding this cover sheet)	**3**
Document Assembled	**27/11/2017 15:27**

PLAN OF SUBDIVISION OF PART OF CROWN ALLOTMENT 2A PARISH OF WONGARRA

COUNTY OF POLWORTH

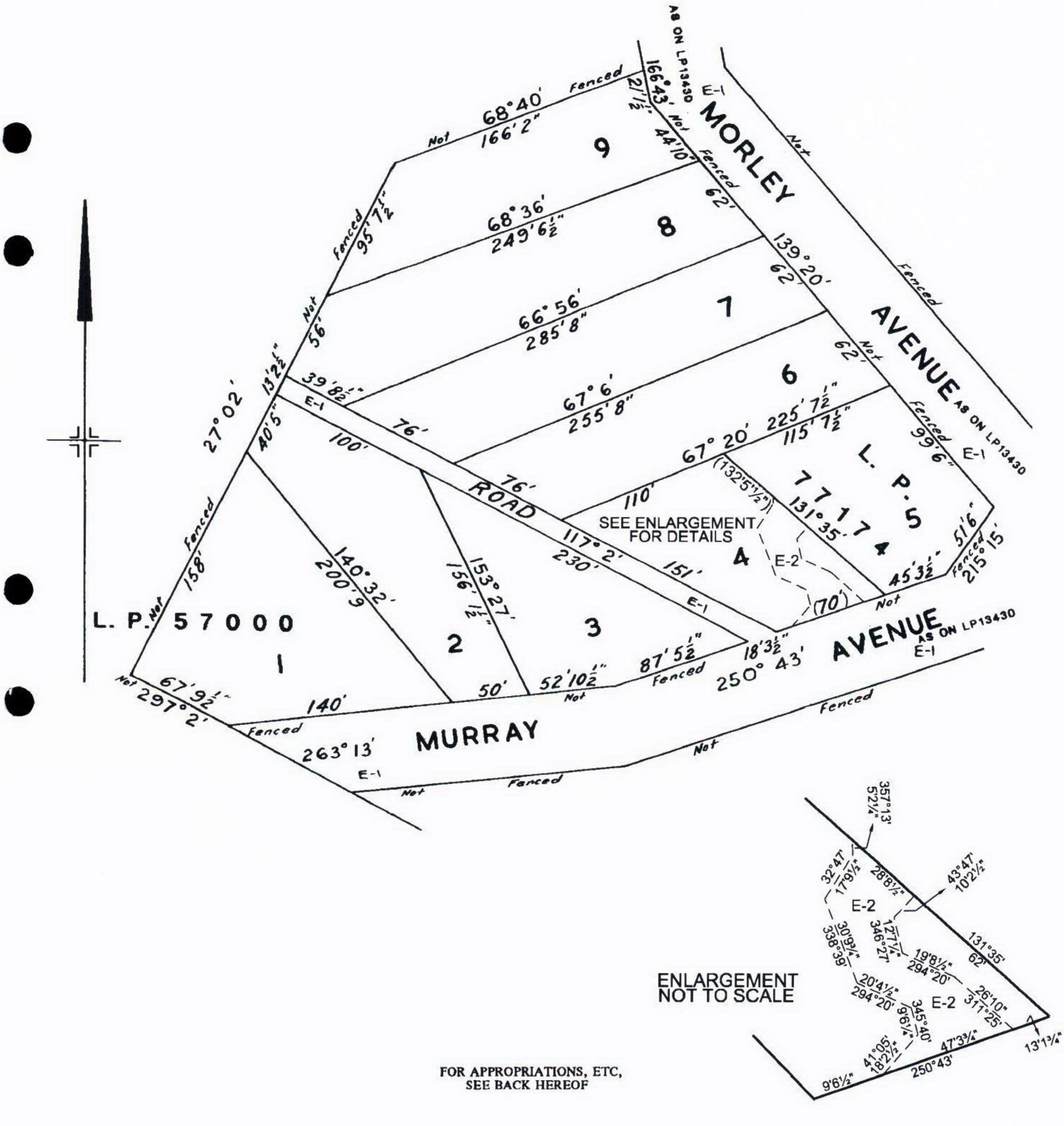
LP 50107
EDITION 2
PLAN MAY BE LODGED 30/6/59

SCALE FEET

COLOUR CONVERSION
E-1 = BROWN

DEPTH LIMITATION: 50 FEET

EASEMENT INFORMATION				
Legend: A - Appurtenant Easement E - Encumbering Easement R- Encumbering Easement (Road)				
Easement Reference	Purpose	Width (Metres)	Origin	Land Benefitted / In Favour Of
E-1	WAY & DRAINAGE	SEE DIAG.	THIS PLAN	LOTS ON THIS PLAN
E-2	CARRIAGEWAY	SEE DIAG.	AM411403K	VOL 08678 FOL 476



FOR APPROPRIATIONS, ETC, SEE BACK HEREOF

CERTIFICATE OF TITLE V. 6359. F. 661

LODGED BY P. ARUNDELL

DEALING No A 721849. DATE 20.4.59

DECLARED BY F. D. GARNER. 15.12.58

CONSENT OF COUNCIL SHIRE OF OTWAY. 18.3.59

PLAN MAY BE LODGED M.P. 30.6.59

LP 50107
BACK OF SHEET 1

THE LAND COLOURED BROWN IS APPROPRIATED OR SET APART FOR EASEMENTS OF WAY AND DRAINAGE.

MODIFICATION TABLE

RECORD OF ALL ADDITIONS OR CHANGES TO THE PLAN

PLAN NUMBER
LP050107

WARNING: THE IMAGE OF THIS DOCUMENT OF THE REGISTER HAS BEEN DIGITALLY AMENDED.
NO FURTHER AMENDMENTS ARE TO BE MADE TO THE ORIGINAL DOCUMENT OF THE REGISTER.

AFFECTED LAND/PARCEL	LAND/PARCEL IDENTIFIER CREATED	MODIFICATION	DEALING NUMBER	DATE	EDITION NUMBER	ASSISTANT REGISTRAR OF TITLES
LOT 4	E-1	CREATION OF EASEMENT	AM411403K	13/04/16	2	JBHB

Studio 1, Level 1
156 George Street
Fitzroy Vic 3065

03 9015 8621
mail@robkennon.com
www.robkennon.com

Rob Kennon
Architects Pty Ltd
ACN 600 023 854
ABN 95 600 023 854

28 Nov 2017

Statutory Planning
Colac Otway Shire
PO Box 283
2-6 Rae Street
COLAC VIC 3250

DESIGN RESPONSE STATEMENT – 30, 32 & 36 MORLEY AVE, WYE RIVER

The proposed demolition and construction at the abovementioned address aims to provide contemporary and innovative architecture whilst adding to the existing diversity of Wye River. It was on this basis and the following written response that the design was developed.
A title consolidation of the 3 lots will be applied shortly.

The proposed development
The proposal involves demolition of the existing dwelling and garage on 30 Morley Ave and the construction of a new contemporary two storey (Half Basement & Ground Level) dwelling with additional single storey studio to the rear of the block.

Demolition works
Demolish the existing timber dwelling and brick garage including all rear outbuildings and non-native landscape elements.

New works
Construct a new double storey dwelling (Half Basement & Ground Floor) and additional single storey studio.
The main dwelling, being a highly considered building will comprise much of the family activity providing up to date amenities.
The studio, while also being a highly considered building, will sit back to the rear of the block in a similar location to that of the demolished garage.

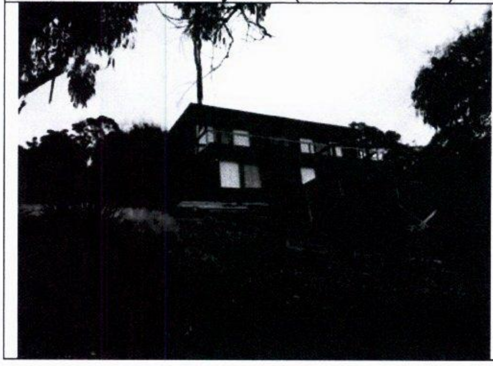
Yours sincerely,

Jack Leishman

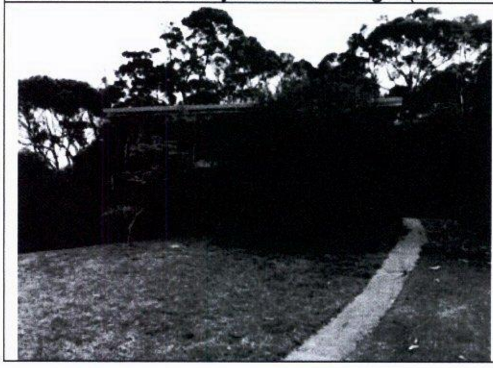
Cc. Client
Encl. As above

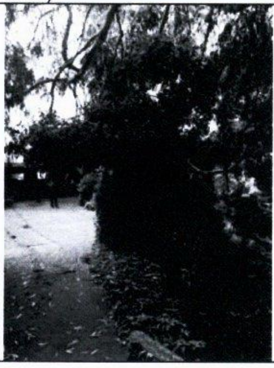
D17/101942

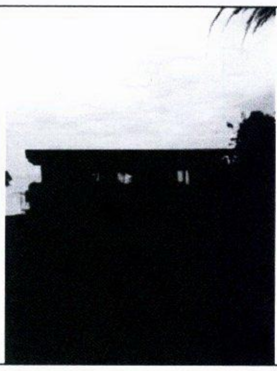
30, 32 & 36 Morley Ave (Front & Rear)



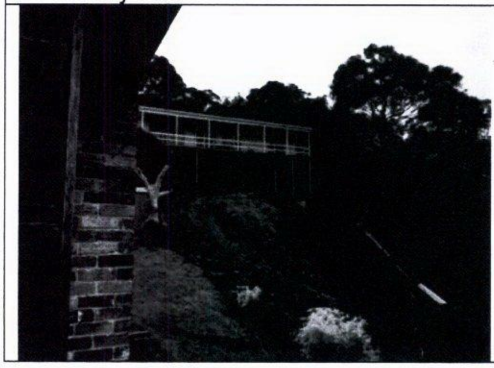
30, 32 & 36 Morley Ave – Garage (Front & Rear)

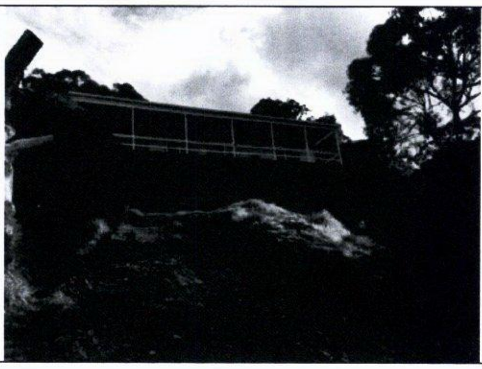




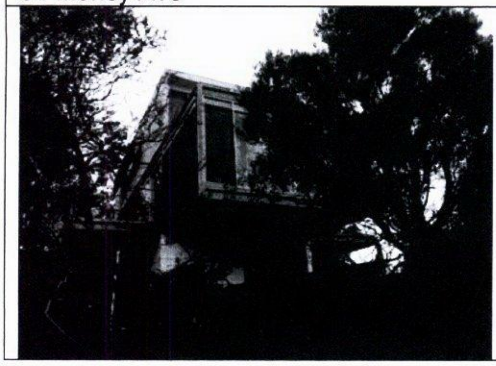


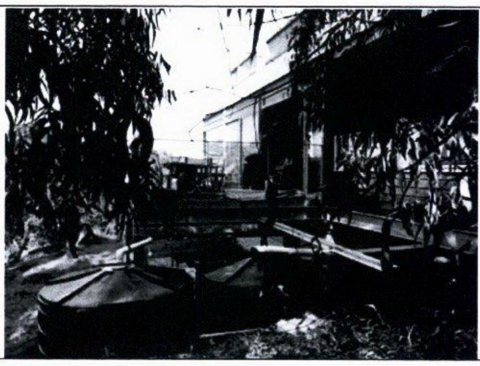
28 Morley Ave





34 Morley Ave





Studio 1, Level 1
156 George Street
Fitzroy Vic 3065

03 9015 8621
mail@robkennon.com
www.robkennon.com

Rob Kennon Architects Pty Ltd
ACN 600 023 854
ABN 95 600 023 854

RESCODE CLAUSE 54 RESPONSE – 30, 32 & 36 MORLEY AVE, ELWOOD

54.01	SATISFIED	NEIGHBOURHOOD AND SITE DESCRIPTION AND DESIGN RESPONSE
54.01 – 1	YES	**Neighbourhood and site description** The property is located in Morley Ave, Wye River. The subject site is typical of the area, being on a steep incline levelling out at the rear. Currently there is a house on the site of number 30 Morley Ave itself has a range of single and double storey dwellings. They vary in style and size from small fibro and timber shacks to larger contemporary holiday homes. Many the houses in close vicinity have multiple storeys with lower basements developed from the natural slope in the land.
54.01 – 2	YES	**Design Response** The proposal seeks to demolish the existing timber building on 30 Morley Ave, consolidate the 3 lots (30, 32 & 36) and build a new contemporary holiday home with separate studio. We will be applying for the title consolidation shortly. The proposed new home will be predominantly on the ground floor with a small semi submerged basement with garage. The proposed studio will be a small self-contained single storey building. The proposed development will be located within the area which the existing demolished home occupied with the studio taking a similar location to the demolished garage.

54.02		NEIGHBOURHOOD CHARACTER AND INFRASTRUCTURE
	YES	Refer 55.01 – 1

54.03 **SITE LAYOUT AND BUILDING MASSING**

54.03 – 1	YES	**Street Setback** The front portion of the proposed residence will be over 15m from the street.
54.03 – 2	YES	**Building Height** The roof of the ground floor at its highest point will be 7.90m above the natural ground level. Below the maximum allowable height of 8m.
54.03 – 3	YES	**Site Coverage** The total site Coverage of the proposal is 16% which is the below the maximum 20% allowable control.
54.03 – 4	YES	**Site Permeability** The site has a permeability of 84% which exceeds the minimum 20% of pervious surfaces required.
54.03 – 5	YES	**Energy efficiency** The proposal is orientated to allow for maximum use of natural light and heat. The operable openings and open plan nature of the design allows for good cross ventilation. Eaves have been designed into the architectural form of the building to ensure adequate shading to living areas. All ceiling and wall insulation will incorporate energy rated reflective foils to maximise the energy efficiency of the house.
54.03 – 6	YES	**Significant trees objective** No significant trees or shrubs will be removed as part of the proposed works.

54.04 **AMENITY IMPACTS**

54.04 – 1	YES	**Side and rear setbacks** All side and rear setbacks meet the objectives set out in the Colac Otway Shire Planning Scheme
54.04 – 2	YES	**Walls on boundaries** There are no new walls on boundary
54.04 – 3	YES	**Daylight to existing windows** The proposal has no impact on existing habitable room windows.
54.04 – 4	YES	**North Facing Windows** There is no additional overshadowing of north facing habitable windows on adjoining properties.

54.04 – 5	NO	**Overshadowing private open space** There is new overshadowing of private open space on 34 Morley Ave. Although the proposal does meet the Rescode setback, new overshadowing of open space according to September 22 occurs at 3pm It is the applicant's opinion that the new overshadowing does not pose any amenity impact to 34 Morley Ave given the shadowing occurs to the vegetated and service area at the rear area of the property. The applicant considers this acceptable.
54.04 – 6	YES	**Overlooking** Windows have also been located to negate any possible overlooking of private open space.

54.05 **ON SITE AMENITY AND FACILITIES**

54.05 – 1	YES	**Daylight to new windows** The design incorporates large operable and fixed glazing to all new habitable areas.
54.05 – 2	YES	**Private open space** The proposal provides ample private open space and exceeds the required secluded private open space as per the schedule.
54.05 – 3	YES	**Solar access to open space** Throughout the duration of the day the proposed private open space will have good access to natural light.

54.06 **DETAILED DESIGN**

54.06 – 1	YES	**Design Detail** The proposed design response has been considered with the immediate context of Wye River in mind. The number of storeys, siting of building and building materials/colours have all been made in a conscious effort to respect the neighbourhood character of the area.
54.06 – 2	YES	**Front fences objective** There is no existing front fence and none is proposed.

Studio 1, Level 1
156 George Street
Fitzroy Vic 3065

03 9015 8621
mail@robkennon.com
www.robkennon.com

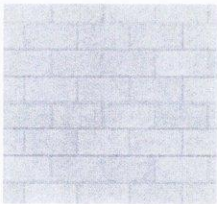
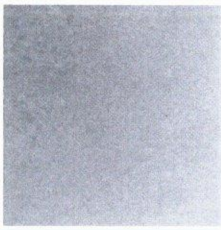
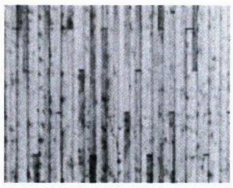
Rob Kennon Architects Pty Ltd
ACN 600 023 854
ABN 95 600 023 854

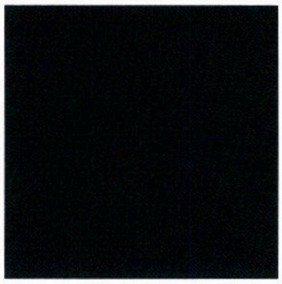
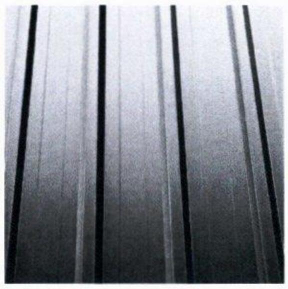
28 Nov 2017

Statutory Planning
Colac Otway Shire
PO Box 283
2-6 Rae Street
COLAC VIC 3250

MATERIALS SCHEDULE – 30, 32 & 36 MORLEY AVE, WYE RIVER

Note: This information is to be read in conjunction with the architectural drawings included in the application.

MATERIAL	DESCRIPTION	SAMPLE
Cladding Material EF01	Masonry – Concrete Blockwork	
Cladding Material EF02	Grey Cladding	
Cladding Material EF03	Timber Cladding	

Cladding Material EF04	Steel Cladding - Black	
Roofing Material RS01	Colourbond metal deck roofing – Woodland Grey	
Roofing Material RS02	Transparent Roofing	

THE END

Studio 1, Level 1
156 George Street
Fitzroy Vic 3065

03 9015 8621
mail@robkennon.com
www.robkennon.com

Rob Kennon Architects Pty Ltd
ACN 600 023 854
ABN 95 600 023 854

RESCODE CLAUSE 54 RESPONSE – 30, 32 & 36 MORLEY AVE, ELWOOD

54.01	SATISFIED	NEIGHBOURHOOD AND SITE DESCRIPTION AND DESIGN RESPONSE
54.01 – 1	YES	**Neighbourhood and site description** The property is located in Morley Ave, Wye River. The subject site is typical of the area, being on a steep incline levelling out at the rear. Currently there is a house on the site of number 30 Morley Ave itself has a range of single and double storey dwellings. They vary in style and size from small fibro and timber shacks to larger contemporary holiday homes. Many the houses in close vicinity have multiple storeys with lower basements developed from the natural slope in the land.
54.01 – 2	YES	**Design Response** The proposal seeks to demolish the existing timber building on 30 Morley Ave, consolidate the 3 lots (30, 32 & 36) and build a new contemporary holiday home with separate studio. We will be applying for the title consolidation shortly. The proposed new home will be predominantly on the ground floor with a small semi submerged basement with garage. The proposed studio will be a small single storey building. The proposed development will be located within the area which the existing demolished home occupied with the studio taking a similar location to the demolished garage.

54.02		NEIGHBOURHOOD CHARACTER AND INFRASTRUCTURE
	YES	Refer 55.01 – 1

54.03 **SITE LAYOUT AND BUILDING MASSING**

54.03 – 1	YES	**Street Setback** The front portion of the proposed residence will be over 15m from the street.
54.03 – 2	YES	**Building Height** The roof of the ground floor at its highest point will be 7.90m above the natural ground level. Below the maximum allowable height of 8m.
54.03 – 3	YES	**Site Coverage** The total site Coverage of the proposal is 16% which is the below the maximum 20% allowable control.
54.03 – 4	YES	**Site Permeability** The site has a permeability of 84% which exceeds the minimum 20% of pervious surfaces required.
54.03 – 5	YES	**Energy efficiency** The proposal is orientated to allow for maximum use of natural light and heat. The operable openings and open plan nature of the design allows for good cross ventilation. Eaves have been designed into the architectural form of the building to ensure adequate shading to living areas. All ceiling and wall insulation will incorporate energy rated reflective foils to maximise the energy efficiency of the house.
54.03 – 6	YES	**Significant trees objective** No significant trees or shrubs will be removed as part of the proposed works.

54.04 **AMENITY IMPACTS**

54.04 – 1	YES	**Side and rear setbacks** All side and rear setbacks meet the objectives set out in the Colac Otway Shire Planning Scheme
54.04 – 2	YES	**Walls on boundaries** There are no new walls on boundary
54.04 – 3	YES	**Daylight to existing windows** The proposal has no impact on existing habitable room windows.
54.04 – 4	YES	**North Facing Windows** There is no additional overshadowing of north facing habitable windows on adjoining properties.

54.04 – 5	NO	**Overshadowing private open space** There is new overshadowing of private open space on 34 Morley Ave. Although the proposal does meet the Rescode setback, new overshadowing of open space according to September 22 occurs at 3pm It is the applicant's opinion that the new overshadowing does not pose any amenity impact to 34 Morley Ave given the shadowing occurs to the vegetated and service area at the rear area of the property. The applicant considers this acceptable.
54.04 – 6	YES	**Overlooking** Windows have also been located to negate any possible overlooking of private open space.

54.05 **ON SITE AMENITY AND FACILITIES**

54.05 – 1	YES	**Daylight to new windows** The design incorporates large operable and fixed glazing to all new habitable areas.
54.05 – 2	YES	**Private open space** The proposal provides ample private open space and exceeds the required secluded private open space as per the schedule.
54.05 – 3	YES	**Solar access to open space** Throughout the duration of the day the proposed private open space will have good access to natural light.

54.06 **DETAILED DESIGN**

54.06 – 1	YES	**Design Detail** The proposed design response has been considered with the immediate context of Wye River in mind. The number of storeys, siting of building and building materials/colours have all been made in a conscious effort to respect the neighbourhood character of the area.
54.06 – 2	YES	**Front fences objective** There is no existing front fence and none is proposed.

D17/101942

AGR ASSESSING GEOLOGICAL RISK

AGR GEOSCIENCES PTY LTD

LAND CAPABILITY ASSESSMENT REPORT

FOR

30, 32, 36 Morley Avenue WYE RIVER, VICTORIA

Prepared for:	Bruce Carter C/- Rob Kennon Architects
Prepared by:	David J Horwood Senior Engineering Geologist *BAppSc (Geology); MAusIMM CP(Geo); MAIG*
Approved by:	David J Horwood Senior Engineering Geologist *BAppSc (Geology); MAusIMM CP(Geo); MAIG*
Reference No.	17F189LCA
Date:	7/9/2017
Revised:	

AGR

CONTENTS

List of Tables

List of Appendices

AGR

1. INTRODUCTION

AGR Geosciences Pty Ltd was engaged by ARKit to undertake a Land Capability Assessment (LCA) for a 2,852m² site at No. 30, 32, 36 Morley Avenue, Wye River. Due to the high landslide risk in the Wye River area, AGR Geosciences Pty Ltd (AGR) were engaged to provide specific advice regarding on-site waste water management to conform to appropriate landslide risk management.

This report is a risk assessment for on-site waste water management undertaken in accordance with EPA Vic Publication 891.4 *Code of Practice Onsite Waste Water Management* (2016) and AS/NZ1547:2012 *On-site Domestic Wastewater management* (2012).

The field investigation and report which accompany this review have been undertaken and prepared by suitably experienced staff. AGR has appropriate professional indemnity insurance for this type of work.

1.1. REPORT SUMMARY

This report will accompany an application for a Septic Tank Permit to Install submitted Colac-Otway Shire Council for an onsite wastewater management system for a private residence. This document provides information about the site and soil conditions. It also provides a detailed LCA for the 2,852m² site and includes a conceptual design for a suitable onsite wastewater management system, including recommendations for monitoring and management requirements.

Our recommendation is for the proposed 4 bedroom dwelling and the detached 2 bedroom studio to dispose of wastewater on-site to separate disposal systems. We also recommend that a split disposal strategy be implemented for disposal of wastewater for the proposed 4 bedroom dwelling. The split disposal strategy should comprise of drip irrigation partially terraced and partially installed direct to the natural contour at a reduced application rate.

The requirement for terracing on site can be minimised by reducing the daily wastewater loading rate by 25% by either by reducing the number of bedrooms or by removing blackwater loading from the system. This can be achieved by splitting blackwater and greywater waste and treating both to an advanced secondary level by a suitable EPA-approved treatment system and applying treated blackwater to the land via pressure compensated sub-surface drip irrigation in terraces built out from the slope. Split greywater should then be treated to advanced secondary treatment standard and recycled in house for use in toilets, with the remainder disposed via subsurface irrigation.

Another method of reducing the daily wastewater loading is to install incinerating or dry composing toilets, effectively eliminating black wastewater loading from the system and treating the remaining effluent loading to an advanced secondary treatment standard and disposing to the land via pressure compensated sub-surface drip irrigation.

The preferred method for disposal on-site is pressure compensated sub-surface drip irrigation because it is the most practical method for installing a compliant disposal system on steep slopes whilst minimising the impact of on-site disposal on slopes susceptible to landslides.

Advanced secondary level treatment options may include an AWTS, single-pass sand filter, membrane bioreactor or any other suitable EPA approved alternative with tertiary disinfection.

1.2. SITE OVERVIEW

Development:

- Single property consisting of 3 separate allotments on opposite the intersection of Morley Avenue and Sturt Court.
- Developed property with an existing dwelling and garage on allotment, No. 30 Morley Avenue, An existing driveway and shed on No. 36 while No. 32 is vacant.
- Some existing cut and fill earthworks and landscape alteration. Established gardens, shrubs and trees. Dense vegetation and native trees along the eastern property boundary above Morley Avenue.

Landscape position and Landforms:

- Located on the high (west) side of Morley Avenue. The property has dual aspects and slope orientations to the east to north-east and to the south.
- Mid slope of a north-south striking low ridge line within the near shore foothills of the Otway Ranges.
- Clearly defined scarps and breaks of slope through the centre and at the base of the property.

Slopes:

- Natural slope angles on site range from 13° to 19° generally to the north-east and to the south. Slope angles steepen to between 20° and 26° below a break in slope extending across allotments No. 32 and No. 30 at the north-eastern end of the property above Morley Avenue. Overall ground slope is approximately 24° to the north-east and 17° to the south.
- Existing site excavations relate to existing driveway and site access and the existing dwelling on site No. 30.
- Cut and fill slope angles are battered between 46° and 69°.

Slope shapes:

- Slope shapes on and surrounding the site are typically convex and divergent. Minor convergent slope shapes in the north-eastern corner of the property.
- Major convex break in slope through the centre of No. 32.

Drainage:

- Generally fair to good drainage conditions over the entire property.
- Typically moist to very moist surface and sub-surface conditions across most of the site.
- Ponding surface water, concentrated run-on and ground water seeps evident over depressed or gentler sloping southern portion of the Site above the existing site access.

AGR

2. DESCRIPTION OF THE DEVELOPMENT

Site Address: 30, 32, 36 Morley Avenue, Wye River, Victoria.

Owner/Developer: **Bruce Carter**

Postal Address:

Contact: Jack Leishman – 03 9015 8621

Council Area: Colac-Otway Shire Council.

Zoning: Township Zone (TZ)

Overlays:
Bushfire Management Overlay (BMO)
Design and Development Overlay (DDO)
Design and Development Overlay (DDO)
Erosion Management Overlay (EMO)
Neighbourhood Character Overlay (NCO)
Significant Landscape Overlay (SLO)

Property Size: 2,852m².

Domestic Water Supply: Tank water only.

Availability of Sewer: The area is unsewered and highly unlikely to be sewered within the next 10-20 years, due to low development density in the area and the considerable distance from existing wastewater services.

Proposed Development: Single storey, 4-bedroom residential dwelling and detached 2 bedroom studio/bungalow

Anticipated Wastewater Load: A 4 bedroom residence with full water-reduction fixtures @ 5 people per maximum occupancy will have a wastewater generation of 150L/person/day (full water saving fixtures) for a total design load of **750L/day** (Table 4 EPA Code of Practice, 2016).

A 2 bedroom residence with full water-reduction fixtures @ 3 people per maximum occupancy will also have a wastewater generation of 150L/person/day (full water saving fixtures) for a total design load of **450L/day** (Table 4 EPA Code of Practice, 2016).

AGR

SITE AND SOIL ASSESSMENT

David Horwood and Matt Fyffe undertook a site investigation on the 20th July 2016.

3.1. SITE KEY FEATURES

Table 1 summarises the key features of the site in relation to effluent management proposed for the site.

NOTE:
- The site is not within a special water supply catchment area.
- The site experiences high stormwater run-on.
- There is no evidence of a shallow water table.
- The risk of effluent transport offsite is moderate.

An aerial photograph is appended to provide recent and current site context (Appendix I).

A site plan describing the location of the proposed building envelope and other development works, wastewater management system components and physical site features is appended (Appendix II).

Table 1: Risk Assessment of Site Characteristics

Feature	Description	Level of Constraint	Mitigation Measures
Buffer Distances	Relevant buffer distances in Table 5 of the Code (2016) are not achievable for nominated effluent fields.	Major	Increase treatment level to advanced secondary standard (10/10/10) in order to reduce mandatory setback distances.
Climate	70th percentile average annual rainfall 981 mm (SILO data), max. average 128 mm in August, min. average 43 mm in January. Average annual pan evaporation is 897mm.	Major	Use water balance to size effluent fields. Increase water treatment to minimum advanced secondary standard.
Drainage	No visible signs of surface dampness, spring activity or hydrophilic vegetation in the proposed effluent management area or surrounds.	Minor	Install surface drainage up slope of the proposed effluent areas to minimise surface water run on to effluent fields.
Erosion & Landslip	No evidence of sheet or rill erosion; no evidence of tunnel erosion. Past experience suggests tunnel erosion is extensive on nearby lots and does occur in the area. The erosion hazard is moderate. Historical landslip area and evidence of past relict landslides on site and neighbouring properties. Landslip hazard is moderate.	Moderate	Reduce water loading as much as possible by utilising mandatory 3 star or better rated water efficient fixtures. Reduce number of bedrooms or install recycling or alternatively use waterless toilet systems. Revegetate slopes and embankments. Install cut off drains up and down slope of effluent field. Disperse widely via sub-surface drip irrigation or apply effluent via appropriately designed terraces. Minimise terracing where possible by reducing application rates.

AGR

Feature	Description	Level of Constraint	Mitigation Measures
Exposure & Aspect	Dwelling: North-easterly aspect, moderate wind exposure, dappled shade. Studio: southerly aspect, high wind exposure, low solar radiation, dappled shade.	Moderate Major	Increase treatment level to an advanced secondary (tertiary) standard; use appropriate crop factors in water balance.
Flooding	The proposed effluent management area is located above the 1:100 year flood level (source WSC).	Nil	NN
Groundwater	No direct signs of shallow groundwater tables to 2.0mm depth. No known groundwater bores within 50m of the proposed effluent management area.	Nil	NN
Imported Fill	No disturbed soil or fill material was observed within the proposed effluent envelope.	Minor	NN
Land Available for LAA	The site has sufficient space for land application or all waste effluent with full daily flow rates for both 4 bedroom dwelling and 2 bedroom studio.	Minor	NN
Landform	Mid slope of high relief ridge within foothills in the Otway Ranges with approximately 17-20m local relief across the site.	Moderate	Use water balance. Minimise run on to LAA with use of catch drains. Increase effluent disposal area to accommodate slopes or install irrigation lines in raised terraces.
Rock Outcrops	No exposures of surface rocks and outcrops in areas of existing site cuts.	Nil	NN
Run-on & Runoff	Moderate to high stormwater run-on and moderate run-off hazard.	Moderate	Recommend catch drain installed above effluent field to intercept surface run on to the effluent field.
Slope	The proposed effluent management area is steeply sloping generally to the north-east and south Slopes are convex with divergent shaped sides.	Moderate	Install terracing to create a near level installation surface for 2 bedroom studio; utilise split disposal system for 4 bedroom dwelling incorporating separate terraced areas and widely disperses direct application irrigation with reduced application rate.
Surface Waters	There are no natural drainage lines or waterways on or near site.	Nil	NN
Vegetation	Plentiful grass cover and isolated large to small shrubs and trees.	Minor	Recommend vegetating disposal areas with high transpiration sedges and grasses. Maintain vegetation levels where possible.

NN: not needed

3.2. SITE ASSESSMENT RESULTS

The site is highly constrained due to site features such as steep slope angles, climate, run-on, run-off, landslip risk, setback distances, site aspect and shading.

As part of the site has a southerly aspect and sun exposure is limited because of dappled shading due to existing trees, it is recommended that the level of waste water treatment be increased to a minimum advanced secondary standard. We also recommended that the disposal area for the 2 bedroom studio be fully terraced. Crop factors used in water balance calculations should be appropriately selected to account for shading and restricted seasonal growth and transpiration rates.

Because solar radiation is partially limited due to the site's aspect and dappled shading through part of the day, it is recommended that the level of waste water treatment be increased to a minimum advanced secondary standard (10/10/10).

The risk of surface water run on may be addressed by installing a catch drain or alternative surface drainage above the proposed effluent fields to intercept surface run on from the catchment area above the proposed disposal areas.

Existing site cuttings associated with the site access are located below the proposed effluent disposal area. The EPA Code of Practice (2013) requires a minimum 15m setback to any cuttings or escarpments located on site. Maintaining this setback distance would severely limit the area available for waste water disposal to the point where the minimum area required for zero wet weather storage and complete nutrient uptake would be unachievable.

The EPA Code of Practice (document 891.4, 2016) Section 3.9 states that council may reduce a setback distance in a non-potable water supply catchment where it considers that the risk to public health and the environment is negligible. In order for waste water to be successfully managed on site as close to regulatory conditions as possible, the available space must be maximised. We propose that by increasing the treatment level to an advanced secondary (tertiary) standard which will create 10/10/10 quality waste water, the risk to public health can be minimised and seeing as the site is neither in a potable water catchment nor is it environmentally sensitive, we suggest that minimum set back conditions can be reduced to enable maximum available space for effluent disposal.

The very steep slopes pose a very high constraint on the methods of effluent disposal available for use on this site for reasons such as construction difficulty, risk of effluent run off and uniform waste water dispersal. Methods of disposal which require soil absorption such as trenches and modified ETA beds/trenches are not suitable for steep slopes. They require near flat ground surfaces for satisfactory construction. Absorption trenches are also inappropriate for high landslide risk areas where it is critical to avoid high volumes of water from accumulating in a concentrated way within the soil profile.

Drip irrigation, surface or subsurface is generally the most appropriate way to disperse waste water in high landslide risk areas because it utilises evapotranspiration as well as absorption over a wide surface area within the near surface soil profile minimising concentrated seepage. The slopes of this site are too steep however for surface irrigation which poses a significant risk of effluent run off well beyond the minimum irrigation area and the site boundaries. Sub surface drip irrigation is therefore the best solution for waste water disposal. Irrigation lines for the 2 bedroom studio will need to be installed in raised terraces constructed along the natural contour where as we recommend a split disposal strategy for the proposed 4 bedroom dwelling.

The proposal for a split disposal system incorporates a minimum area of raised terrace irrigation and direct irrigation to the natural slope. The intent of this strategy is to minimise the loading risk on the slopes and disperse as much effluent as possible over a greater surface area and a significantly reduced application rate thereby minimising concentrated sub-surface infiltration and the risk of surface run off or off site discharge.

After consideration of all constraints, we consider the overall land capability of the site to sustainably manage all effluent onsite is satisfactory providing recommended mitigation measures discussed above and in Table 1 are implemented and it is our recommendation that the setback requirement to the adjacent waterway be reduced.

3.3. SOIL KEY FEATURES

Soils on site have been assessed for their suitability for onsite wastewater management by a combination of soil survey and desktop review of published soil survey information.

A soil survey was conducted across the site to determine suitability for application of treated effluent. Soil investigations were conducted at one (1) location in the vicinity of the proposed effluent fields as shown in the Site Investigation Plan (Appendix III). Bore holes were established to a minimum depth of 2m or to refusal using manual hand augers. This was sufficient to adequately characterise the soils as only minor variation would be expected throughout the area of interest.

Measurement of in-situ saturated hydraulic conductivity was carried out using modified Talsma-Hallam permeameters applying the constant head method as described in AS1547:2012. A nest of eight (8) permeameters was installed across the property inserted to the deeper of a minimum depth of 250mm or 25mm into the limiting layer. Constant head draw down was monitored over a period of at least 60 minutes in order to calculate saturated hydraulic conductivity for the limiting soil layer. Recorded test results have been applied to equation G1 of AS1547:2012 to calculate Ksat for the limiting soil layer.

Ksat calculations are provided in Appendix V and permeameter locations are displayed in Appendix III.

Samples of all discrete soil layers for each soil type were collected for subsequent laboratory analysis of pH, Electrical Conductivity, Sodicity, Cation Exchange Capacity, Sodium Absorption Ratio and Emerson Aggregate Classification.

Two soil types were encountered during this investigation. Full profile descriptions are provided in the Bore logs (Appendix V). Soil descriptions may be summarised as follow:

- A topsoil (A_1-horizon) layer of dark grey, slightly moist, firm, low to very low plasticity clayey SILT with some sand (Category 4 clay loam) containing minimal root matter; root zone, overlying,
- A residual soil (B_1-horizon) layer of pale brown to pale grey / brown with up to 20% orange mottling, dry to moist, stiff, medium plasticity silty CLAY (Category 5 Light Clay), Limiting Layer, overlying,
- Highly to extremely weathered sandstone and mudstone bedrock.

Table 2 below provides an assessment of the physical and chemical characteristics of each soil type.

AGR

Table 2: Risk Assessment of Soil Characteristics

Feature	Assessment	Level of Constraint	Mitigation Measures
Cation Exchange Capacity (CEC)	Topsoil (sample 1): **9.9 MEQ%** Soil structural stability is considered unsatisfactory.	Major	Recommend adding organic matter (compost/humus) to soil profile to increase CEC and nutrient availability and ameliorate soil structure. Typically >15 MEQ% is recommended for land application areas.
	Subsoil (sample 2): **17.8 MEQ%** Soil structural stability is considered unsatisfactory.	Major	
Electrical Conductivity	Topsoil (sample 1): **0.033 ds/m** Soil conditions do not appear to be restricting plant growth.	Nil	NN
	Subsoil (sample 2): **0.024 ds/m**	Nil	NN
Emerson Aggregate Class	Topsoil (sample 1): **Class 2, , slaking and partial dispersion**	Major	Soil amelioration recommended. Application of gypsum to improve soil structure and dispersity.
	Subsoil (sample 2): **Class 2, slaking and partial dispersion**	Major	Soil amelioration recommended. Application of gypsum to improve soil structure and dispersity.
pH	Topsoil (sample 1): **5.4**	Minor	Suitable for most acid loving plants
	Subsoil (sample 2): **5.3**	Minor	Suitable for most acid loving plants
Rock Fragments	<10% coarse fragments in the soil profile.	Minor	NN
Sodicity (ESP)	Topsoil (sample 1): **20.3%. Strongly Sodic.** Limits soil structure and increases depressiveness. Limiting.	Major	Soil amelioration recommended. Application of liquid gypsum to improve soil structure and dispersity.
	Subsoil (sample 2): **21.7%. Strongly Sodic.** Limits soil structure and increases depressiveness. Limiting.	Major	Soil amelioration recommended. Application of liquid gypsum to improve soil structure and dispersity.

AGR

Feature	Assessment	Level of Constraint	Mitigation Measures
Sodium Absorption Ratio (SAR)	Topsoil (sample 1): **0.3.** Soil conditions do not appear to be restricting plant growth.	Minor	Recommend use of low sodium domestic products to reduce the high SAR ratio.
	Subsoil (sample 2): **0.54.** Soil conditions do not appear to be restricting plant growth.	Moderate	Recommend use of low sodium domestic products to reduce the high SAR ratio.
Soil Depth to rock or other impermeable layer	Overall soil profile depth is between 900mm and 1000m below surface.	Moderate	Suitable for sub-surface irrigation. Recommend using raised terraces with filled with good quality loam topsoil.
Soil Permeability & Design Loading/ Irrigation Rates	Topsoil: Clay Loam (Category 4); **Indicative** Ksat permeability is **0.12-0.5m/day.** 3.5mm/day Design Irrigation Rate (DIR) for subsurface irrigation (EPA, 2016). This is 3.0% of lowest indicative Ksat for soil. Recommended application rate is <10% of measured Ksat (TVA, 2004)	Minor	Use measured Ksat for limiting layer in water balance. Use up to 10% of Ksat value as a suitable application rate.
Soil Permeability & Design Loading/ Irrigation Rates	Subsoil (B Horizon): Light Clay (Category 5); **Measured** Ksat permeability is **0.25m/d**; 3mm/day Design Irrigation Rate (DIR) for subsurface irrigation (EPA, 2016). This is 6.3% of measured Ksat for the soil. Recommended application rate is <10% of measured Ksat (TVA, 2004).	Moderate	Use up to 10% of Ksat value as deep seepage rate in water balance. Design for reduced application rate in accordance with AS1547:2012 for sloping sites. Application rate to approximate 3mm/day.
Soil Texture & Structure	Topsoil: **Clay Loam (Category 4)** EPA (2016) and AS/NZS 1547:2012. Topsoil has an inferred weak structure.	Moderate	Soil amelioration recommended. Increasing organic content and apply liquid gypsum to improve soil structure.
	Subsoil: **Light Clay (Category 5)** EPA (2016) and AS/NZS 1547:2012. Subsoil has an inferred strong structure.	Moderate	Use up to 10% of Ksat value as deep seepage rate in water balance. Increase disposal area in order to minimise application rate.

Feature	Assessment	Level of Constraint	Mitigation Measures
Gleying	Subsoil: No evidence of any greenish grey/black or bluish grey/black soil colours	Minor	NN
Mottling	Subsoil: **Light Clay**. 10-20% orange mottling. Imperfectly drained soil.	Moderate	Improve soil structure and soil drainage with the addition liquid gypsum to the pump well bi-annually. Apply effluent via sub surface drip irrigation.
Water table Depth	Groundwater not encountered; boreholes terminated at 800mm in bedrock.	Minor	Sub surface drip irrigation.

NN: not needed

3.4. SOIL ASSESSMENT RESULTS

For the soils in the proposed land application area (clay loam and light clay) several features present a moderate or major constraint. Primary constraints relate to soil structure, soil permeability, soil dispersity, Sodicity, CEC, SAR, pH, depth to bedrock, soil drainage and soil texture and structure. Soil amelioration will be required prior to and during installation of the effluent field to improve soil chemistry.

The soil texture for the limiting soil layer is a **Light Clay**. Measured Ksat for the limiting layer on this site is 0.25m/day which infers a strongly structured light clay. This equates to a Category 5a Light Clay with indicative permeability between 0.12-0.5mm/day. Appropriate deep seepage rates should be carefully selected to reflect Ksat for the corresponding structure state.

Soil characteristics relating to poor soil structure, soil drainage and high dispersity can be remediated or improved with the addition of gypsum. Gypsum adds bi-charged calcium ions to the soil which acts as a flocculating agent helping soil particles to clump together and aggregate, displacing singularly charged sodium ions which lead to high soil dispersity and potential soil erosion.

Based on the cation exchange capacity (CEC) and soil sodicity (ESP), a gypsum requirement of **9.89t/ha** has been calculated in order to ameliorate the soil profile to a desired level of 6% ESP to 900mm below surface. The application of gypsum requires removal to the topsoil and deep ripping to a minimum depth of 600mm. As this is not always practical in areas of steep terrain with limited access and where deep soil disturbance can create slope instability problems, we recommend the application of liquid gypsum as an alternative to dry ground gypsum. Liquid gypsum can be added to the sump well of the irrigation system and mixed with treated waste water ready for direct application to the subsurface soil profile. We calculate that a total of **0.63L/m^2** of liquid gypsum is required for complete soil amelioration over the proposed effluent area. Gypsum requirement computations are provided in Appendix XI.

The soil overall soil profile is typically limited to a depth of 900-1000mm below surface. The minimum soil depth above bedrock for disposal system to work efficiently and adequate accommodate deep seepage is 1200mm for absorption trenches and 800mm for subsurface irrigation. The depth of soil is considered satisfactory for the application of sub-surface irrigation directly to the natural slope.

Soil chemistry elements such as CEC are also major constraints on this site. The cation exchange capacity is a measure of plant nutrient availability. CEC is below acceptable levels and adding organic compost and humus to the soil profile can help improve nutrient availability.

The overall capability of the soil to sustainably manage effluent onsite is considered satisfactory providing recommended mitigation measures discussed above and in Table 2 are implemented.

Soil chemistry laboratory results are provided in Appendix VII.

3.5. OVERALL LAND CAPABILITY RATING

Based on the results of the site and soil assessment tabled above, the overall land capability of the proposed effluent management area is **moderately constrained**. Subject to implementation of the mitigation measures recommended in Tables 1 and 2, it is possible to dispose treated wastewater on site. It is therefore our recommendation that considering the site's physiographic constraints and soil characteristics, the two proposed dwellings should have separate disposal areas and 'All Waste' effluent should be advanced secondary treated and disposed on-site via pressure compensating sub-surface drip irrigation in a combination of raised terraces and direct application irrigation using the lowest possible application rate.

3. WASTEWATER MANAGEMENT SYSTEM

The following sections provide an overview of a suitable on-site wastewater management system, with sizing and design considerations and justification for its selection. Detailed design for the system should be undertaken at the time of the building application and submitted to Council.

4.1. EFFLUENT DISPOSAL SYSTEM

A range of possible land application systems have been considered for part on-site disposal, such as absorption trenches, evapotranspiration/absorption (ETA) beds, wick trench and bed systems, subsurface irrigation and mounds.

The preferred system is **pressure compensating subsurface drip irrigation**. Subsurface irrigation will provide even and widespread dispersal of the treated effluent within the root-zone of plants, does not require a reserve area and can be installed on slopes up to 30% (17°) before requiring specialised irrigation design. This system will provide beneficial reuse of effluent, which is desirable given that the site is not serviced by town water. It will also ensure that the risk of effluent being transported off-site will be negligible and is the most accepted method of onsite waste disposal for minimising the risk of slope instability.

4.2. DESCRIPTION OF THE IRRIGATION SYSTEM

A detailed irrigation system design is beyond the scope of this report, however a general description of subsurface irrigation is provided here for the information of the client and Council.

Subsurface irrigation comprises a network of drip-irrigation lines that is specially designed for use with wastewater. The pipe contains pressure compensating emitters (drippers) that employ a biocide to prevent build-up of slimes and inhibit root penetration.

The lateral pipes are usually 1.5m to 2.0m apart, installed parallel along the contour. Installation depth is 100-150mm into a minimum of 200-250mm of good quality topsoil in accordance with

AS/NZS 1547:2012 for sloping sites. It is critical that the irrigation pump be sized properly to ensure adequate pressure and delivery rate to the irrigation network.
A filter is installed in the main line to remove fine particulates that could block the emitters. This must be cleaned regularly (typically monthly) following manufacturer's instructions. Vacuum breakers should be installed at the high point/s in the system to prevent air and soil being sucked back into the drippers when the pump shuts off. Flushing valves are an important component and allow periodic flushing of the lines, which should be done at six monthly intervals. Flush water can be either returned to the treatment system, or released to site drainage infrastructure and discharged to a legal point of discharge.

All trenching used to install the pipes must be backfilled properly to prevent preferential subsurface flows along trench lines. Irrigation areas must not be subject to high foot traffic movement, and vehicles and livestock must not have access to the area otherwise compaction around emitters can lead to premature system failure.

4.3. SIZING THE IRRIGATION SYSTEM

To determine the necessary size of the irrigation area water balance modelling has been considered based on the water balance method outlined in AS1547:2012 and Victorian Land Capability Assessment Framework (2014). Final sizing of the irrigation system has been undertaken adopting a justifiable deep seepage rate based on the measured saturated hydraulic conductivity (Ksat) and comparing the minimum area for zero storage with the maximum allowable application rate or DIR from Table 9 of the EPA (2016). The Tennessee Valley Authority (2004) in their peer reviewed guidelines for drip irrigation recommends that the seepage or percolation rate used in water balance modelling may be 10-12% of measured Kast and that the final application rate (DIR) should be less than 10% of measured Ksat.

The water balance presenting in this assessment adopts a trial land application area methodology to find the most suitably sized effluent field according to the justifiable deep seepage rate and the maximum allowable application rate.

The retained rainfall factor used in the water balance has been derived using the Rational Equation to calculate a weighted run off coefficient based on published run off coefficients for different land uses and surfaces and total catchment size. Professional judgement has been used where selected coefficients vary from published coefficients in the calculations and justification for the variation is provided with the computations attached to this report.

Crop factors used in the water balance may vary depending on the type of vegetation or degree of shading expected in the proposed effluent disposal area. Crop Nitrogen uptake rates used in the mass balance calculation may also vary and are selected with reference to either the type of vegetation growing on the subject area, or a particular vegetation type proposed for use in the effluent area. Published crop Nitrogen uptake rates are sourced from EPA Publication 168 (1991).

4.3.1 Water Balance

The water balance can be expressed by the following equation:

Precipitation + Effluent Applied = Evapotranspiration + Percolation

Data used in the water balance for the **proposed 4 bedroom dwelling** includes:

- Mean monthly rainfall and mean monthly pan evaporation;
- Design daily flow rate for a 4 bedroom dwelling – 750L/day (from Table 4 of the Code and Table H2 of the Standard);

- Deep seepage Rate – 4.55 mm/day[1]; (based on measured Ksat of 0.25m/day)
- Crop factor – 0.4; and
- Retained rainfall – 66% (steeply sloping site with 18% impervious coverage).

The results of the water balance are compared against the basic irrigation formula **A = Q/DIR** to ensure the final application rate for the disposal field (DIR) approximates that for the appropriate soil category in the EPA Code of Practice (2016) and AS1547:2012.

The water balance method is used to calculate the area required to balance all inputs and outputs to the water balance. As a result of these calculations at least **314m²** is required for on-site wastewater disposal based on hydraulic loading requiring not taking into account the minimum required buffers and offsets.

This yields an application rate of **2.4mm/day** which is less than maximum allowable 3mm/day from the EPA Code of Practice (2016) for application to a weakly structured or massive light clay.

Data used in the water balance for the **proposed 2 bedroom studio** includes:

- Mean monthly rainfall and mean monthly pan evaporation;
- Design daily flow rate for a 2 bedroom dwelling – 450L/day (from Table 4 of the Code and Table H2 of the Standard);
- Deep seepage Rate – 4.55 mm/day[2]; (based on measured Ksat of 0.25m/day)
- Crop factor – 0.4; and
- Retained rainfall – 66% (steeply sloping site with 18% impervious coverage).

The results of the water balance are compared against the basic irrigation formula **A = Q/DIR** to ensure the final application rate for the disposal field (DIR) approximates that for the appropriate soil category in the EPA Code of Practice (2016) and AS1547:2012.

The water balance method is used to calculate the area required to balance all inputs and outputs to the water balance. As a result of these calculations at least **188m²** is required for on-site wastewater disposal based on hydraulic loading requiring not taking into account the minimum required buffers and offsets.

This yields an application rate of **2.4mm/day** which is less than maximum allowable 3mm/day from the EPA Code of Practice (2016) for application to a weakly structured or massive light clay.

Water balance calculations are provided in Appendix VI.

4.3.2 Nutrient Balance

A nutrient balance is considered to check that the Land Application Area is of sufficient size to ensure nutrients are assimilated by the soils and vegetation. It is acknowledged that a proportion of nitrogen will be retained in the soil through processes such as mineralisation and volatilisation. Typically, only sensitive sites with limiting site or soil constraints require nutrient considerations.

[1] This rate is less than the recommended permeability rate of 10-12% of measured Ksat (TVA, 2004).
[2] This rate is less than the recommended permeability rate of 10-12% of measured Ksat (TVA, 2004).

NOTE: Soil has a high PRI (phosphorus retention index) in clayey soils. Phosphorus is readily removed under these circumstances from wastewater fixation in clayey soil by the action of adsorption. Phosphate in dispersed effluent is lost within a few centimetres of the soil.

This leaves nitrogen (N) as the limiting factor in this proposed development.

The nutrient balance can be expressed by the following Mass Balance equation:

$$\textbf{Land Application Area (m}^2\textbf{) = (C x Q)/L}_x$$

Data used in the nutrient balance for the **proposed 4 bedroom dwelling** includes:

- C = Concentration of nutrient - 25mg/L (from EPA Publication 464.2);
- Q = Design daily flow rate – 750L (from Table 4 of the Code and Table H2 of the Standard);
- L_x = Critical loading rate of nutrients – 60.27 mg/m^2/day (from EPA Publication 464.2).
- Nutrient loss to soil processes – 20% (Geary & Gardner 1996)

As a result of the Mass Balance calculations, the minimum **Land Application Area** required for complete nutrient (nitrogen) uptake is **249m^2** for on-site disposal.

Data used in the nutrient balance for the **proposed 2 bedroom studio** includes:

- C = Concentration of nutrient - 25mg/L (from EPA Publication 464.2);
- Q = Design daily flow rate – 450L (from Table 4 of the Code and Table H2 of the Standard);
- L_x = Critical loading rate of nutrients – 60.27 mg/m^2/day (from EPA Publication 464.2).
- Nutrient loss to soil processes – 20% (Geary & Gardner 1996)

As a result of the Mass Balance calculations, the minimum **Land Application Area** required for complete nutrient (nitrogen) uptake is **149m^2** for on-site disposal.

Nutrient balance calculations are provided in Appendix VI.

4.3.3 Minimum Disposal Field and Land Application Area

The hydraulic loading is the most limiting factor so we therefore recommend hydraulic loading and the water balance be used to calculate the minimum area required to balance both nutrient and hydraulic loading including all inputs and outputs, without the need for wet weather storage.

On this basis the minimum area required for effluent disposal excluding minimum required buffers and offsets is provided in the following table:

Table 3: Minimal Disposal Area

Building Type	Bedrooms	Minimum Disposal Area	Maximum Application Rate
Dwelling	4	314m^2	2.4mm/day
Studio	2	188m^2	2.4mm/day

Although both the water balance and nutrient mass balance indicate the minimum effluent disposal areas required to achieve zero storage and complete nutrient uptake, this does not make any allowance for the hydraulic gradient of the site and the potential for surface run off and off site discharge. As a result, effluent from both buildings would need to be applied to the land via raised terraces (over all proposed effluent disposal areas) so as to provide near horizontal application areas.

The construction of raised terracing can be a very costly addition to a waste water project and given the susceptibility to slope instability in the area, it is our preference to minimise additional loading to the steep, susceptible slopes. In order to minimise the amount of raised terracing required the application rate based on hydraulic loading should be reduced by at least 50%. This is effectively achieved by increasing the disposal area.

At the request of the client we have provided two optional solutions for minimising the need for terracing on this site.

Solution 1: Split Disposal Strategy for Proposed 4 Bedroom Dwelling

A split disposal strategy involves implementing two methods of disposal, partial terracing and partial direct irrigation, to account for the total daily wastewater loading. The overall disposal area is separated into two areas, one area sized according to a portion of the total daily wastewater load being disposed via irrigation line in raised terraces, and the other sized according to a portion of the total daily wastewater load being disposed of via irrigation lines installed directly to the natural contour of the slope at a significantly reduced application rate.

The following table provides the areas and application rates required in order to implement this strategy:

Table 4: Area Sizing for Split Disposal Strategy

Disposal Method	Maximum Wastewater Loading	Minimum Disposal Area	Maximum Application Rate	Reduction in Minimum Application rate
Raised Terracing	400L/day	167m^2	2.4mm/day	-
Direct Application	350L/day	291m^2	1.2mm/day	50%

This option requires advanced secondary treatment (10/10/10) in order to minimise mandatory buffer distances.

Solution 2: Reduction of Wastewater Loading by 25%

This solution involves reducing the overall wastewater loading rate for each of the proposed dwellings. Reducing the daily wastewater loading rate by 25% can be achieved in one of three ways:

- Installing a split greywater treatment system and recycling 10/10/10 advanced secondary treated greywater in house to all toilets. Excess greywater and remaining blackwater (also 10/10/10 advanced secondary treated) is disposed via the irrigation system; or
- Installing waterless toilet systems such as incinerating or dry composing toilets. All other waste water is treated to 10/10/10 advanced secondary level and disposed of via the irrigation system; or
- Reducing the number of bedrooms by 1.

The following tables provide the areas and application rates required in order to implement this strategy for each of the proposed dwellings:

Table 5: Area Sizing for Main Dwelling using Split Disposal Strategy and 25% Loading Reduction

Disposal Method	Maximum Wastewater Loading	Minimum Disposal Area	Maximum Application Rate	Reduction in Minimum Application rate
Raised Terracing	213L/day	89m^2	2.4mm/day	-
Direct Application	350L/day	291m^2	1.2mm/day	50%

Table 6: Area Sizing for Studio Using 25% Loading Reduction

Disposal Method	Maximum Wastewater Loading	Minimum Disposal Area	Maximum Application Rate
Raised Terracing	338L/day	141m^2	2.4mm/day

4.4. SITING AND CONFIGURATION OF THE IRRIGATION SYSTEM

The preferred areas for siting the irrigation fields is to the east of the proposed main dwelling and to the south of the proposed studio. The Site Investigation Plan shows the envelopes of land that are suitable for effluent management, (Appendix III).

Final placement and configuration of the irrigation system will be determined by the client and/or system installer, provided it complies with the mandatory setback and buffers. The minimum areas required according to the water balance for each of the presented solutions are shown to scale (Appendix III). The recommended locations for the effluent disposal areas shown in Appendix III have been selected on the basis that the available area with the greatest lateral width will encourage lateral hydraulic flow and minimise surface run off.

It is important that appropriate buffer distances to neighbouring properties and buildings be maintained. It is also important to note that buffers are measured as the overland flow path for run-off water from the effluent irrigation area.

The Site Investigation Plan shows the contours and flow path directions on the property (Appendix III).

It is highly recommended that the owner consult an irrigation expert familiar with effluent irrigation equipment and steeply sloping sites to design the system, and an appropriately registered plumbing/drainage practitioner to install the system. The irrigation plan must ensure even application of effluent throughout the entire irrigation area and that final configuration ensures an application rate or dosage to the irrigation field no greater than the rates indicated in the options detailed in Section 4.3.

4.5. BUFFER DISTANCES

Setback buffer distances from effluent land application areas and treatment systems are required to help prevent human contact, maintain public amenity and protect sensitive environments. The relevant buffer distances for this site, taken from Table 5 of the Code (2016) are:

- 20 metres upslope from potable or non-potable groundwater bores;
- 100 metres upslope from watercourses in a potable water supply catchment.
- 30 metres upslope from surface waters and waterways (non-potable).
- 3 metres if area upslope and 1.5 metres if area downslope of property boundaries, swimming pools and buildings.
- For advanced secondary treatment: 1 metre if application area upslope and 0.5 metres if area downslope of property boundaries.
- 15 metres upslope from escarpments or cuttings.

Not all required buffer distances are achievable on this site, however as discussed in section 3.2 we recommend that the minimum set back distances to cuttings down slope of the effluent field should be reduced in this circumstance due to the minimal public and environmental risk posed by the treatment and disposal systems proposed (10/10/10 advanced secondary treatment disposed partially in raised terraces via pressure compensating sub surface irrigation).

The appended site plan shows the location of the proposed wastewater management system components, recommended setback distances and other relevant features such as the recommended location of cut off drains (Appendix III).

AGR

4.6. INSTALLATION OF THE IRRIGATION SYSTEM

Installation of the irrigation system must be carried out by a suitably qualified, licensed plumber or drainer experienced with effluent irrigation systems.

To ensure even distribution of effluent, it is essential that the pump capacity is adequate for the size and configuration of the irrigation system, taking into account head and friction losses due to changes in elevation, pipes, valves, fittings etc. To achieve even coverage, irrigation areas should be dosed alternately using an automatic indexing or sequencing valve and line spacing's should be progressively increased down slope.

The irrigation area and surrounding areas must be vegetated or revegetated immediately following installation of the system, preferably with turf or dense ground covering shrubs, grasses and sedges with high transpiration rates. The area should be fenced or otherwise isolated (such as by landscaping), to prevent vehicle and stock access; and signs should be erected to inform householders and visitors of the extent of the effluent irrigation area and to limit their access and impact on the area.

Stormwater run-on is expected to pose a moderate amount of concern for the proposed disposal areas. Upslope diversion berms and surface drains should be constructed during installation of the disposal system. Stormwater from roofs and other impervious surfaces must not be disposed of into the wastewater treatment system or onto the effluent management system.

Due to the sloping nature of the terrain on site, the irrigation system should be designed by an irrigation specialist experienced with steeply sloping terrain to ensure an even distribution of effluent over the irrigation field including the construction of irrigation terraces.

All terracing **must** be built above the natural surface and not cut into the existing slope. Terraces should be constructed so that they are aligned parallel to the natural contour of the slope and built out from the slope so as to achieve a near level surface, by adding good quality loam topsoil equivalent to Category 3 soils. The down slope side of the terrace will require supporting with suitably installed retaining walls. Any benches equal to or greater than 1000mm high **must** have retaining walls designed by a suitably qualified engineer.

4.7. TREATMENT SYSTEM

The minimum secondary effluent quality required is:

- BOD < 20 mg/L
- TSS < 30 mg/L
- E.Coli < 10 cfu/100mg

The minimum advanced secondary (tertiary) effluent quality required is:

- BOD < 10 mg/L
- TSS < 10 mg/L
- E.Coli < 10 cfu/100mg

Either a signal treatment system or separate individual treatment systems may be appropriate for this site and the multi-dwelling proposal. The appropriate sizing of the treatment system(s) should be carefully considered by the client and the system installer.

Refer to the EPA website for the list of approved options that are available[3]. Many of the secondary or advanced secondary treatment system options are capable of achieving the desired level of performance. The property owner has the responsibility for the final selection of the secondary treatment system and will include the details of it in the Septic Tank Permit to Install application form for Council approval.

As a guide, the two types of treatment methods which are able to produce high quality waste water are Membrane Bioreactor or MBR systems and Trickling Filters. MBR's combine treatment technologies such as aerated water treatment systems (AWTS) and membrane filtration. They typically use a pre-treatment settling tank, followed by aerobic bioreactor (AWTS) and finally a filter membrane followed by disinfection with UV for higher quality waste water. Trickling Filters such as generic sand filters use aerobic biological processes and mechanical filtration to treat effluent. They incorporate a settling or septic tank (which may be generic or alternative such as a worm farm) for primary treatment after which effluent is applied to the filter and then may be disinfected with either by chlorine or UV. Other methods of secondary treatment system such as Aerated Wastewater Treatment System's (AWTS) are also acceptable utilising disinfection to achieve advanced secondary standard.

If the proposed dwellings are to be used intermittently for short stay and holiday rental, consideration should be given to passive systems which are less reliant on power and regular maintenance. In this situation we recommend the application of Trickling Filters with disinfection so long as the system can achieve 10/10/10 standard effluent for greywater recycling.

Further consideration should be given to selecting a system that includes a suitably sized storage or balancing tank to moderate flow into the wastewater treatment system or a system that integrally uses multiple chambers where intermittent or periodic surge flows are expected. Where an AWTS is to be considered in this situation, selection of a system which includes recirculation or some other technology to accommodate intermittent flow is recommended.

Alternative methods of waste management to provide a reduction in daily flow rates may include the use of dry compositing or incinerating toilets. Dry composting or incinerating toilets would effectively remove a portion of the daily water loading for the fixture from the water balance, thus reducing the required effluent disposal footprint. Recycling of advanced secondary treated greywater in house to toilets will also provide a similar outcome.

[3] http://www.epa.vic.gov.au/en/your-environment/water/onsite-wastewater

4. MONITORING, OPERATION AND MAINTENANCE

Maintenance is to be carried out in accordance with the EPA Certificate of Approval of the selected secondary treatment system and Council's permit conditions. The treatment system will only function adequately if appropriately and regularly maintained. We highly recommend the client enters into an ongoing service agreement with a service contractor approved by the treatment system manufacture.

To ensure the **treatment** system functions adequately, residents must:

- Have a suitably qualified maintenance contractor service the secondary or advanced secondary treatment system at the frequency required by Council under the permit to use;
- Use household cleaning products that are suitable for septic tanks;
- Keep as much fat and oil out of the system as possible; and
- Conserve water (3 star or better rating fixtures and appliances are recommended).

To ensure the **land application** system functions adequately, residents must:

- Regularly harvest (mow) vegetation within the LAA and remove this to maximise uptake of water and nutrients;
- Monitor and maintain the subsurface irrigation system following the manufacturer's recommendations, including flushing the irrigation lines;
- Regularly clean in-line filters;
- Not erect any structures and paths over the LAA;
- Avoid vehicle and livestock access to the LAA, to prevent compaction and damage;
- Ensure that the LAA is kept level by filling any depressions with good quality topsoil (not clay);
- Add 2L of concentrated liquid gypsum to the site via the irrigation system pump well upon commissioning of the irrigation system and thereafter at least quarterly. The regular addition of liquid gypsum will provide an ongoing soil remediation measure designed to improve soil structure and permeability, and prevent dispersion and erosion properties from developing;

AGR

5. CONCLUSIONS

As a result of our investigations, we conclude that sustainable onsite wastewater management is feasible for the proposed 4 bedroom dwelling and detached 2 bedroom studio at 30, 32, 36 Morley Avenue, Wye River with the implementation of appropriate mitigation measures as outlined.

Specifically, we recommend the following:

- Advanced secondary (tertiary) treatment of "All Waste" or a split grey water system by an EPA approved and accredited treatment system(s);
- **Split disposal strategy for the proposed 4 Bedroom Dwelling**:
  - Construction of raised terraces for partial application to at least **167m^2** (or 89m^2 if 25% loading reduction is implemented) as indicated in Appendix III applied at a maximum rate of **2.4mm/day or 400L/day** (or 213mm/day 25% loading reduction is implemented).
  - Direct application of dripper lines installed along the natural contour over a minimum area of **291m^2** as indicated in Appendix III applied at a maximum rate of **1.2mm/day (350L/day)**.
- **Proposed 2 Bedroom Studio Fully Terraced:**
  - Application of treated effluent to a **188m^2** area (or 141m^2 if 25% loading reduction is implemented) via pressure compensating subsurface drip irrigation which may be subdivided into evenly sized zones using a indexing or sequencing valves using an applied rate of **2.4mm/day**;
- Reduce daily water loading up to **25%** by either:
  - Installing a split greywater treatment system so that advanced secondary treated wastewater may be recycled in house for use in the toilets thus reducing the minimum required disposal field and daily wastewater loading. Or;
  - Utilising waterless toilet systems such as incinerating or dry composting toilets. This removes a percentage of daily water use from the overall water loading (nominally 20-30%) or;
  - Reducing the number of bedrooms by 1.
- Specialist design of the irrigation system by an irrigation expert experienced with steeply sloping terrain, including terracing of the effluent disposal area where slopes have a gradient greater than 10%.
- Soil amelioration of the soil profile upon commissioning of the irrigation system involving the application of liquid gypsum applied to the soil via the irrigation network.
- Detailed documentation of the as built irrigation design, including the filter, manifold, irrigation line location and diameter, number and length of dripper lines, number and location of vacuum breaker(s), sequencing valve(s), and location of flush valve(s);
- Installation of 3 star water saving fixtures or better appliances in the new residence to reduce the effluent load;

- Use of low phosphorus and low sodium (liquid) detergents to improve effluent quality and maintain soil properties for growing plants; and
- Operation and management of the treatment and disposal system in accordance with manufacturer's recommendations, the EPA Certificate of Approval, the EPA Code of Practice (2016) and the recommendations made in this report

DAVID J HORWOOD
BAppSc (Geology)
C.E.T. ACCREDITED

AGR

6. REFERENCES

Environment Protection Authority (2003). *Guidelines for Environmental Management: Use of Reclaimed Water* Publication 464.2.

Environment Protection Authority (1991). *Guidelines for Wastewater Irrigation* Publication 168.

Environment Protection Authority (2016). Publication 891.4 *Code of Practice for Onsite Wastewater Management.*

Geary, P. and Gardner, E. (1996). On-site Disposal of Effluent. In Proceedings from the one day conference *Innovative Approaches to the Management of Waste and Water*, Lismore 1996.

Isbell, R.F. (1996). The Australian Soil Classification. CSIRO Publishing, Melbourne.

McDonald, R.C., Isbell, R.F., Spreight, J.G., Walker, J. and Hopkins, M.S. (1990) Australian Land Survey: Field Handbook. Second Edition. Inkata Press, Melbourne.

Municipal Association of Victoria, Department of Environment and Sustainability and EPA Victoria (2016) *Victorian Land Capability Assessment Framework.*

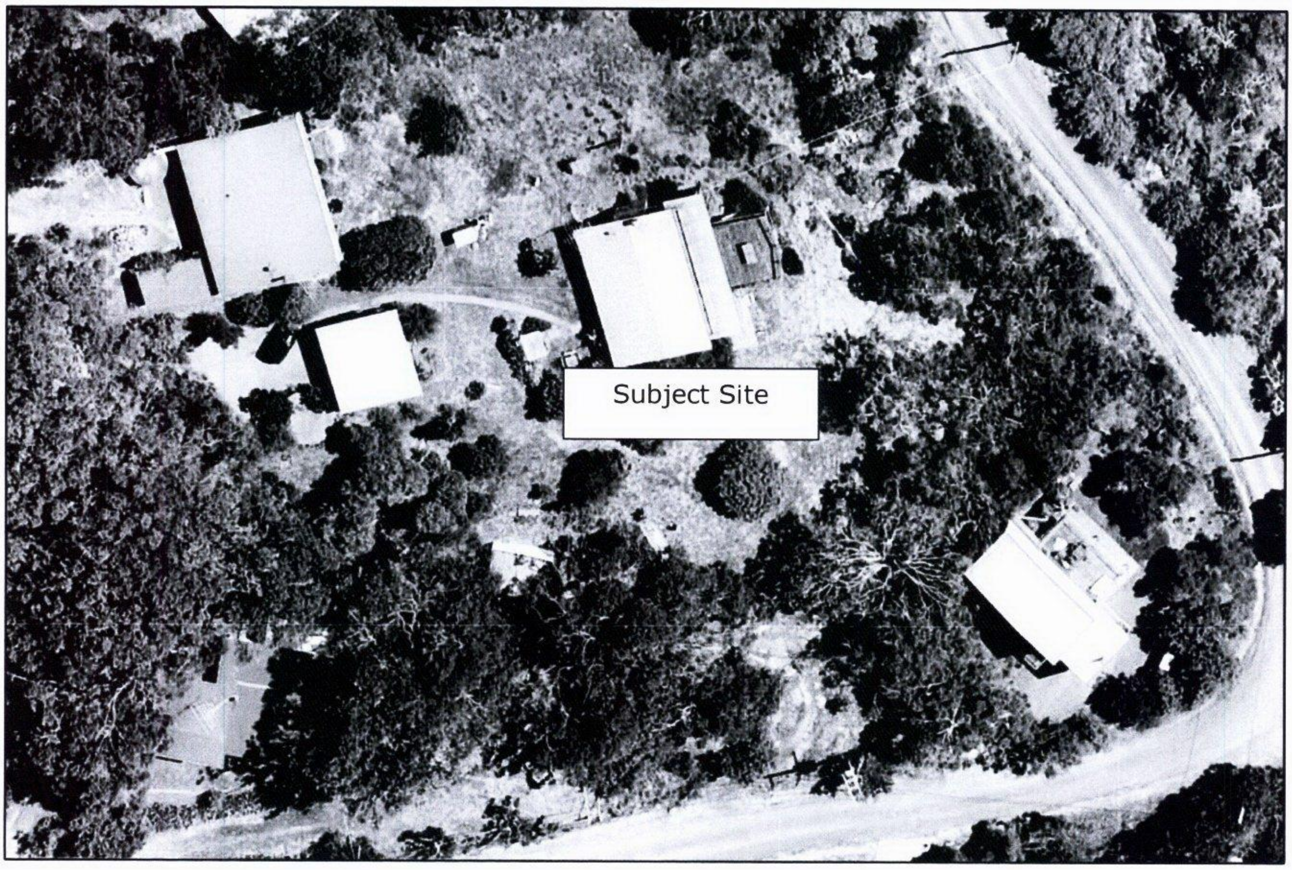
Sargeant and Imhof (2000). *Major Agricultural Soils of the Maffra Region*. Department of Natural Resources and Environment, Victoria, Australia.

Standards Australia / Standards New Zealand (2012). AS/NZS 1547:2012 *On-site domestic-wastewater management*.

TVA (2004). Wastewater Subsurface Drip Distribution: Peer Reviewed Guidelines for Design, Operation and Maintenance. Tennessee Valley Authority, Tennessee.

USEPA (2002). *Onsite Wastewater Treatment Systems Manual*. United States Environmental Protection Agency.

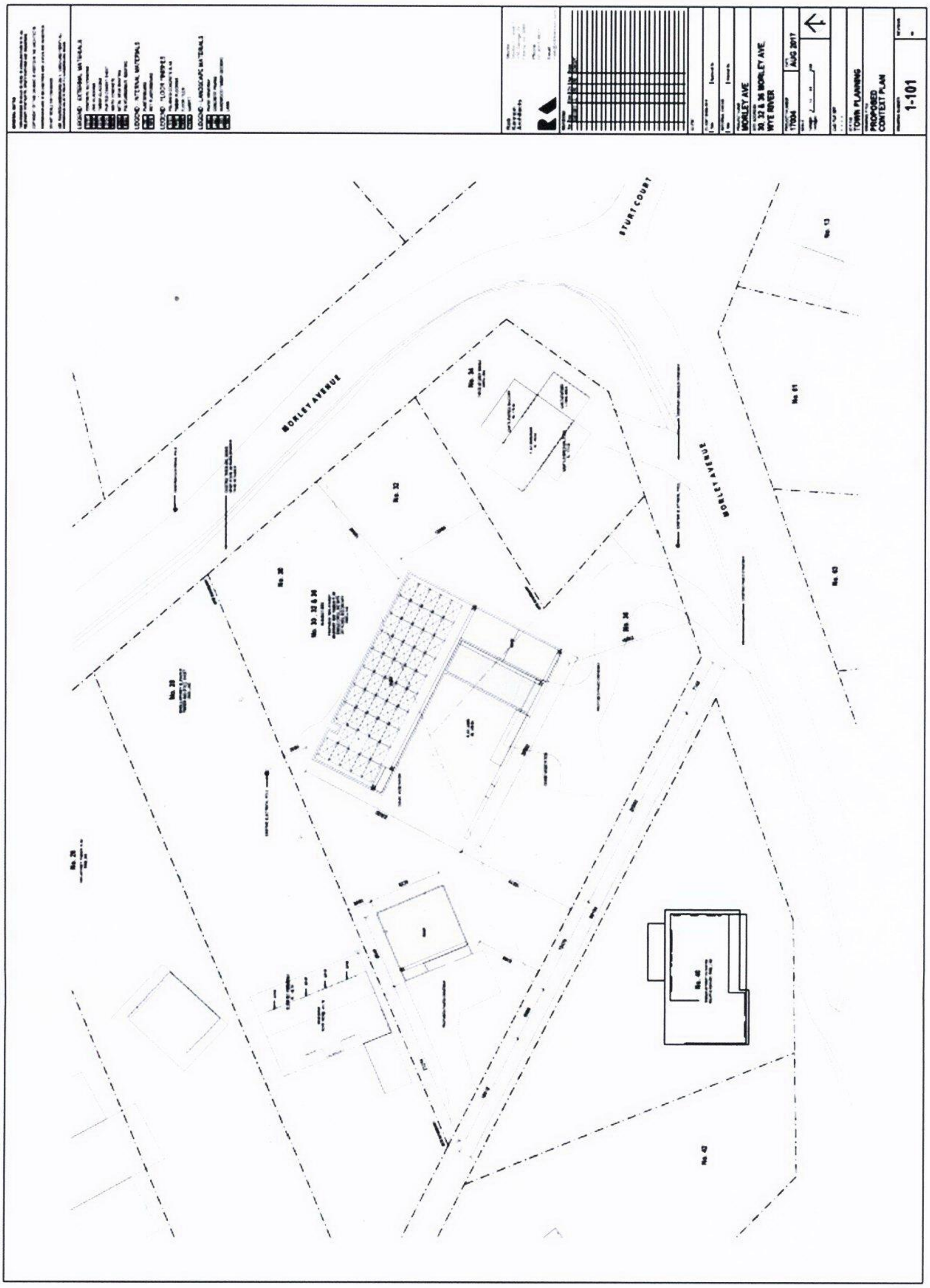
Appendix I: Aerial Photo



D17/101942

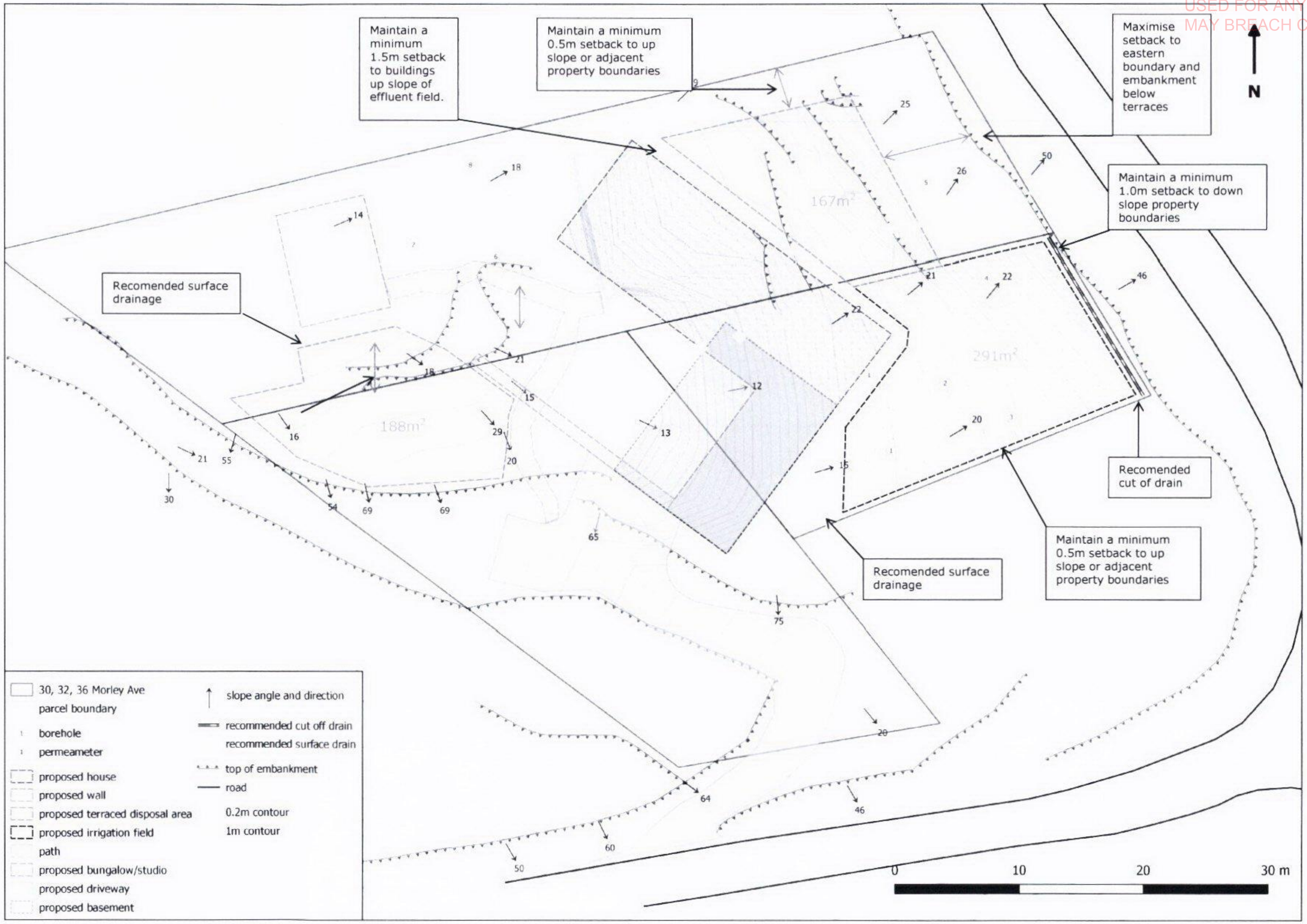
AGR

Appendix II: Proposed Site Plan



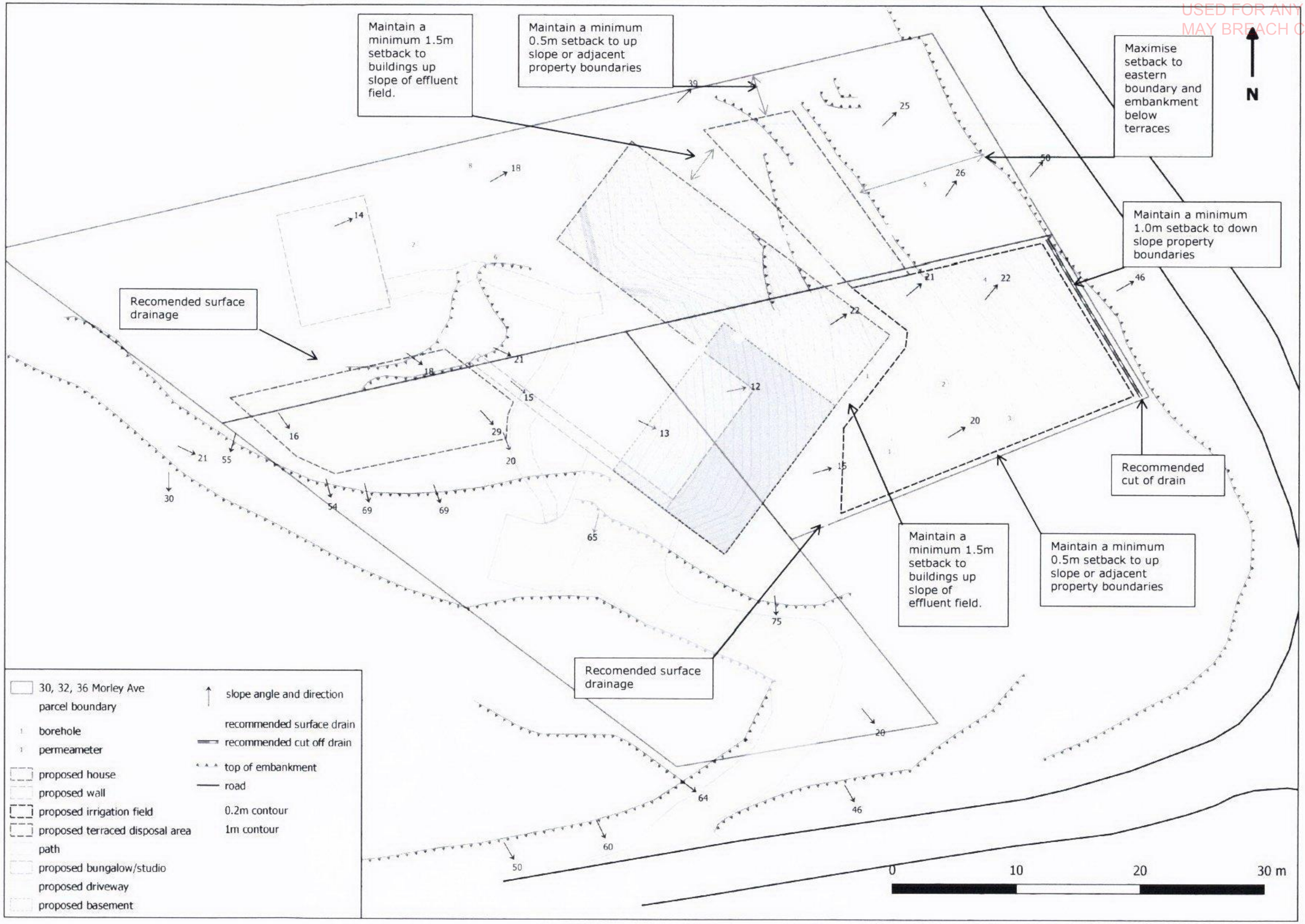
AGR

Appendix III: Site Investigation Plan – Solution 1



AGR

Appendix IV: Site Investigation Plan – Solution 2 (25% Wastewater Loading Reduction)



Appendix V: Borehole Descriptions

D17/101942

AGR GeoSciences

Client:	Rob Kennon Architects	Bore Hole	No. 1
Project Address:	30, 32, 36 Morley Ave	Field work Completed By:	David Horwood
Reference No:	17F189LCA	Field Work Date:	20/07/2017

Depth	Excavatoin Method	Graphic Log	Horizon	Material Description	Texture	Structure	Shade	Colour	Mottles	Moisture	Coarse Fragments	Boundary Type	Sample
100				Clayey Silt	CL		Dk	Gy		SM	<10%		1
200				Category 4 Clay loams									
300				Clay			Lt	Br		D	<10%		2
400				Category 5 Light clays									
500													
600													
700	Hand Auger						Lt	Gy / Br	Or 10-20%				
800													
900													
1000													
1100				Refusal Bedrock									
1200													
1300													
1400													
1500													
1600													
1700													
1800													
1900													
2000													
2100													
2200													
2300													
2400													
2500													

Comment:

Texture:

S	Sand	ZL	Silty Loam	SiC	Silty Clay
LS	Loamy Sand	SCL	Sandy Clay Loam	LC	Light Clay
CS	Clayey Sand	CL	Clay Loam	LMC	light Med Clay
SL	Sandy Loam	ZCL	Silty Clay Loam	MC	Medium Clay
FSL	Fine Sandy Loam	FSCL	Fine Sandy Clay Loam	HC	Heavy Clay
L	Loam	SC	Sandy Clay		

Moisture:

D	Dry
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet

Structure:

Gr	(Single) Grained
Mas	Massive
Wk	Weakly Structured
Md	Mod Structured
St	Strongly Structured

Colour: Dk Dark Lt Light Bk Black Br Brown Gy Grey Or Orange Yl Yellow Re Red Bl Blue Gn Green

Groundwater ▼

Sample: 1

Boundary Type: Sharp <5mm Abrut 5-20mm Clear 20-50mm Gradual 50-100mm Diffues >100mm

AGR

Appendix VI: Water Balance, Nutrient Balance and Ksat Computation

WATER BALANCE COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Land Application Area Sizing Using Water Balance & Storage Calculations
Propsoed 4 Bedroom Dwelling - Minimum Area Fully Terraced

Job No.: 17F189LCA
Comp: DH
Date: 6/09/2017
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

INPUT DATA

Design Wastewater Flow	Q	750	L/day	
Design Seepage Rate	DSR	4.55	mm/day	
Trial Land Application Area	LAA	314	m^2	
Crop Factor	C	Shade	unitless	
Rainfall Runoff Factor	RF	0.66	untiless	
Effective Void Ratio	N	0.3	unitless	
Minimum Freeboard Topsoil Layer	F	100	mm	
Mean Monthly Pan Evaporation Data	Kennett River 70th percentile SILO data			BoM Station
Mean Monthly Rainfall Data	Kennett River 70th percentile SILO data			BoM Station

Parameter	Symbol	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**
Evaporation	E		mm/month	129	106	90	58	39	28	32	44	61	87	102	121	897.0
Rainfall	R		mm/month	43	45	57	71	99	105	112	128	108	94	65	54	981.0
Crop Factor	C		unitless	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
OUTPUTS																
Evapotranspiration	ET	E x C	mm/month	51.6	42.4	36.0	23.2	15.6	11.2	12.8	17.6	24.4	34.8	40.8	48.4	**359**
Seepage	S	DSR x D	mm/month	141.1	127.4	141.1	136.5	141.1	136.5	141.1	141.1	136.5	141.1	136.5	141.1	**1660.8**
Total Outputs		ET+S	mm/month	192.7	169.8	177.1	159.7	156.7	147.7	153.9	158.7	160.9	175.9	177.3	189.5	**2019.6**
INPUTS																
Retained Rainfall	RR	R x RF	mm/month	28.4	29.7	37.6	46.9	65.3	69.3	73.9	84.5	71.3	62.0	42.9	35.6	**647.5**
Applied Effluent	W	QxD	L/month	23250	21000	23250	22500	23250	22500	23250	23250	22500	23250	22500	23250	**273750**
Total Inputs		RR+W	mm/month	51.6	50.7	60.9	69.4	88.6	91.8	97.2	107.7	93.8	85.3	65.4	58.9	**921.2**
DISPOSAL RATE																
Disposal Rate	DR	(ET+S)-RR	mm/month	164.3	140.1	139.4	112.8	91.3	78.4	79.9	74.2	89.6	113.8	134.4	153.8	
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	142	150	167	199	255	287	291	313	251	204	167	151	

MINIMUM AREA REQUIRED FOR ZERO STORAGE:	314	m^2
ADOPTED LAND APPLICATION AREA:	314	m^2
DESIGN APPLICATION RATE:	2.4	mm/day

STORAGE CALCULATION

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Application Rate	AR	Q/LAA	mm/month	74.0	66.9	74.0	71.7	74.0	71.7	74.0	74.0	71.7	74.0	71.7	74.0
Storage For The Month	ST	AR-DR	mm/month	-90.2	-73.2	-65.4	-41.2	-17.3	-6.7	-5.9	-0.1	-18.0	-39.8	-62.7	-79.8
Increase In Depth Of Stored Effluent	ΔH	ST/N	mm/month	-300.8	-244.1	-218.0	-137.3	-57.6	-22.5	-19.6	-0.4	-59.9	-132.6	-209.1	-265.9
Storage Remaining From Previous Month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cumulative Storage At End Of Month	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cumulative Storage From Previous Year	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Storage Depth for Nominated Area	MS			0	mm										

DESIGN DIMENSIONS SUMMARY

Land Application Area	LAA	314	m^2
Maximum Storage Height	MS	0	mm
Minimum Freeboard Topsoil Layer	F	100	mm
Min Depth Of Land Application System	Z		mm

D17/101942

AGR

WATER BALANCE COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Land Application Area Sizing Using Water Balance & Storage Calculations
Proposed 4 Bedroom Dwelling - Split Disposal; Terraced

Job No.: 17F189LCA
Comp: DH
Date: 6/09/2017
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

INPUT DATA

Design Wastewater Flow	Q	400	L/day	
Design Seepage Rate	DSR	4.55	mm/day	
Trial Land Application Area	LAA	167	m^2	
Crop Factor	C	Shade	unitless	
Rainfall Runoff Factor	RF	0.66	unitless	
Effective Void Ratio	N	0.3	unitless	
Minimum Freeboard Topsoil Layer	F	100	mm	
Mean Monthly Pan Evaporation Data	Kennett River 70th percentile SILO data			BoM Station
Mean Monthly Rainfall Data	Kennett River 70th percentile SILO data			BoM Station

Parameter	Symbol	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**
Evaporation	E		mm/month	129	106	90	58	39	28	32	44	61	87	102	121	897.0
Rainfall	R		mm/month	43	45	57	71	99	105	112	128	108	94	65	54	981.0
Crop Factor	C		unitless	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
OUTPUTS																
Evapotranspiration	ET	E x C	mm/month	51.6	42.4	36.0	23.2	15.6	11.2	12.8	17.6	24.4	34.8	40.8	48.4	**359**
Seepage	S	DSR x D	mm/month	141.1	127.4	141.1	136.5	141.1	136.5	141.1	141.1	136.5	141.1	136.5	141.1	**1660.8**
Total Outputs		ET+S	mm/month	192.7	169.8	177.1	159.7	156.7	147.7	153.9	158.7	160.9	175.9	177.3	189.5	**2019.6**
INPUTS																
Retained Rainfall	RR	R x RF	mm/month	28.4	29.7	37.6	46.9	65.3	69.3	73.9	84.5	71.3	62.0	42.9	35.6	**647.5**
Applied Effluent	W	QxD	L/month	12400	11200	12400	12000	12400	12000	12400	12400	12000	12400	12000	12400	**146000**
Total Inputs		RR+W	mm/month	40.8	40.9	50.0	58.9	77.7	81.3	86.3	96.9	83.3	74.4	54.9	48.0	**793.5**
DISPOSAL RATE																
Disposal Rate	DR	(ET+S)-RR	mm/month	164.3	140.1	139.4	112.8	91.3	78.4	79.9	74.2	89.6	113.8	134.4	153.8	
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	75	80	89	106	136	153	155	167	134	109	89	81	

MINIMUM AREA REQUIRED FOR ZERO STORAGE:	167	m^2
ADOPTED LAND APPLICATION AREA:	167	m^2
DESIGN APPLICATION RATE:	2.4	mm/day

STORAGE CALCULATION

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Application Rate	AR	Q/LAA	mm/month	74.3	67.1	74.3	71.9	74.3	71.9	74.3	74.3	71.9	74.3	71.9	74.3
Storage For The Month	ST	AR-DR	mm/month	-90.0	-73.0	-65.2	-41.0	-17.1	-6.5	-5.7	0.1	-17.8	-39.6	-62.5	-79.6
Increase In Depth Of Stored Effluent	ΔH	ST/N	mm/month	-300.1	-243.4	-217.3	-136.6	-56.9	-21.8	-18.9	0.3	-59.2	-131.9	-208.5	-265.2
Storage Remaining From Previous Month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Cumulative Storage At End Of Month	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Cumulative Storage From Previous Year	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Maximum Storage Depth for Nominated Area	MS			0	mm										

DESIGN DIMENSIONS SUMMARY

Land Application Area	LAA	167	m^2
Maximum Storage Height	MS	0	mm
Minimum Freeboard Topsoil Layer	F	100	mm
Min Depth Of Land Application System	Z	100	mm

AGR

WATER BALANCE COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Land Application Area Sizing Using Water Balance & Storage Calculations
Proposed 4 Bedroom Dwelling - 25% Daily Wastewater Loading Reduction - Split Disposal; Terraced

Job No.: 17F189LCA
Comp: DH
Date: 6/09/2017
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

INPUT DATA

Design Wastewater Flow	Q	213	L/day	
Design Seepage Rate	DSR	4.55	mm/day	
Trial Land Application Area	LAA	89	m^2	
Crop Factor	C	Shade	unitless	
Rainfall Runoff Factor	RF	0.66	untiless	
Effective Void Ratio	N	0.3	untiless	
Minimum Freeboard Topsoil Layer	F	100	mm	
Mean Monthly Pan Evaporation Data	Kennett River 70th percentile SILO data			BoM Station
Mean Monthly Rainfall Data	Kennett River 70th percentile SILO data			BoM Station

Parameter	Symbol	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**
Evaporation	E		mm/month	129	106	90	58	39	28	32	44	61	87	102	121	897.0
Rainfall	R		mm/month	43	45	57	71	99	105	112	128	108	94	65	54	981.0
Crop Factor	C		unitless	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
OUTPUTS																
Evapotranspiration	ET	E x C	mm/month	51.6	42.4	36.0	23.2	15.6	11.2	12.8	17.6	24.4	34.8	40.8	48.4	**359**
Seepage	S	DSR x D	mm/month	141.1	127.4	141.1	136.5	141.1	136.5	141.1	141.1	136.5	141.1	136.5	141.1	**1660.8**
Total Outputs		ET+S	mm/month	192.7	169.8	177.1	159.7	156.7	147.7	153.9	158.7	160.9	175.9	177.3	189.5	**2019.6**
INPUTS																
Retained Rainfall	RR	R x RF	mm/month	28.4	29.7	37.6	46.9	65.3	69.3	73.9	84.5	71.3	62.0	42.9	35.6	**647.5**
Applied Effluent	W	QxD	L/month	6603	5964	6603	6390	6603	6390	6603	6603	6390	6603	6390	6603	**77745**
Total Inputs		RR+W	mm/month	35.0	35.7	44.2	53.3	71.9	75.7	80.5	91.1	77.7	68.6	49.3	42.2	**725.2**
DISPOSAL RATE																
Disposal Rate	DR	(ET+S)-RR	mm/month	164.3	140.1	139.4	112.8	91.3	78.4	79.9	74.2	89.6	113.8	134.4	153.8	
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	40	43	47	57	72	82	83	89	71	58	48	43	

MINIMUM AREA REQUIRED FOR ZERO STORAGE:	89	m^2
ADOPTED LAND APPLICATION AREA:	89	m^2
DESIGN APPLICATION RATE:	2.4	mm/day

STORAGE CALCULATION

				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Application Rate	AR	Q/LAA	mm/month	74.2	67.0	74.2	71.8	74.2	71.8	74.2	74.2	71.8	74.2	71.8	74.2
Storage For The Month	ST	AR-DR	mm/month	-90.1	-73.1	-65.2	-41.0	-17.1	-6.6	-5.7	0.0	-17.8	-39.6	-62.6	-79.6
Increase In Depth Of Stored Effluent	ΔH	ST/N	mm/month	-300.3	-243.6	-217.5	-136.8	-57.1	-22.0	-19.1	0.1	-59.4	-132.1	-208.7	-265.4
Storage Remaining From Previous Month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Cumulative Storage At End Of Month	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Cumulative Storage From Previous Year	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Maximum Storage Depth for Nominated Area	MS			0	mm										

DESIGN DIMENSIONS SUMMARY

Land Application Area	LAA	89	m^2
Maximum Storage Height	MS	0	mm
Minimum Freeboard Topsoil Layer	F	100	mm
Min Depth Of Land Application System	Z	100	mm

AGR

WATER BALANCE COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Land Application Area Sizing Using Water Balance & Storage Calculations
Proposed 4 Bedroom Dwelling - Split Disposal; Direct Application

Job No.: 17F189LCA
Comp: DH
Date: 6/09/2017
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

INPUT DATA

Design Wastewater Flow	Q	350	L/day	
Design Seepage Rate	DSR	4.55	mm/day	
Trial Land Application Area	LAA	291	m^2	
Crop Factor	C	Shade	unitless	
Rainfall Runoff Factor	RF	0.66	unitless	
Effective Void Ratio	N	0.3	unitless	
Minimum Freeboard Topsoil Layer	F	100	mm	
Mean Monthly Pan Evaporation Data	Kennett River 70th percentile SILO data			BoM Station
Mean Monthly Rainfall Data	Kennett River 70th percentile SILO data			BoM Station

Parameter	Symbol	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**
Evaporation	E		mm/month	129	106	90	58	39	28	32	44	61	87	102	121	897.0
Rainfall	R		mm/month	43	45	57	71	99	105	112	128	108	94	65	54	981.0
Crop Factor	C		unitless	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
OUTPUTS																
Evapotranspiration	ET	E x C	mm/month	51.6	42.4	36.0	23.2	15.6	11.2	12.8	17.6	24.4	34.8	40.8	48.4	**359**
Seepage	S	DSR x D	mm/month	141.1	127.4	141.1	136.5	141.1	136.5	141.1	141.1	136.5	141.1	136.5	141.1	**1660.8**
Total Outputs		ET+S	mm/month	192.7	169.8	177.1	159.7	156.7	147.7	153.9	158.7	160.9	175.9	177.3	189.5	**2019.6**
INPUTS																
Retained Rainfall	RR	R x RF	mm/month	28.4	29.7	37.6	46.9	65.3	69.3	73.9	84.5	71.3	62.0	42.9	35.6	**647.5**
Applied Effluent	W	QxD	L/month	10850	9800	10850	10500	10850	10500	10850	10850	10500	10850	10500	10850	**127750**
Total Inputs		RR+W	mm/month	39.2	39.5	48.5	57.4	76.2	79.8	84.8	95.3	81.8	72.9	53.4	46.5	**775.2**
DISPOSAL RATE																
Disposal Rate	DR	(ET+S)-RR	mm/month	164.3	140.1	139.4	112.8	91.3	78.4	79.9	74.2	89.6	113.8	134.4	153.8	
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	66	70	78	93	119	134	136	146	117	95	78	71	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 146 m^2
ADOPTED LAND APPLICATION AREA: 291 m^2
DESIGN APPLICATION RATE: 1.2 mm/day

STORAGE CALCULATION

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Application Rate	AR	Q/LAA	mm/month	37.3	33.7	37.3	36.1	37.3	36.1	37.3	37.3	36.1	37.3	36.1	37.3
Storage For The Month	ST	AR-DR	mm/month	-127.0	-106.4	-102.1	-76.8	-54.0	-42.3	-42.6	-36.9	-53.5	-76.5	-98.3	-116.5
Increase In Depth Of Stored Effluent	ΔH	ST/N	mm/month	-423.3	-354.7	-340.5	-255.9	-180.1	-141.1	-142.1	-122.9	-178.5	-255.1	-327.7	-388.4
Storage Remaining From Previous Month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cumulative Storage At End Of Month	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cumulative Storage From Previous Year	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Storage Depth for Nominated Area	MS			0 mm											

DESIGN DIMENSIONS SUMMARY

Land Application Area	LAA	146	m^2
Maximum Storage Height	MS	0	mm
Minimum Freeboard Topsoil Layer	F	100	mm
Min Depth Of Land Application System	Z		mm

D17/101942

AGR

WATER BALANCE COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Land Application Area Sizing Using Water Balance & Storage Calculations
Proposed 2 Bedroom Studio - Minimum Disposal Area Fully Terraced

Job No.: 17F189LCA
Comp: DH
Date: 6/09/2017
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

INPUT DATA

Design Wastewater Flow	Q	450	L/day	
Design Seepage Rate	DSR	4.55	mm/day	
Trial Land Application Area	LAA	188	m^2	
Crop Factor	C	Shade	unitless	
Rainfall Runoff Factor	RF	0.66	unitless	
Effective Void Ratio	N	0.3	unitless	
Minimum Freeboard Topsoil Layer	F	100	mm	
Mean Monthly Pan Evaporation Data	Kennett River 70th percentile SILO data			BoM Station
Mean Monthly Rainfall Data	Kennett River 70th percentile SILO data			BoM Station

Parameter	Symbol	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**
Evaporation	E		mm/month	129	106	90	58	39	28	32	44	61	87	102	121	897.0
Rainfall	R		mm/month	43	45	57	71	99	105	112	128	108	94	65	54	981.0
Crop Factor	C		unitless	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
OUTPUTS																
Evapotranspiration	ET	E x C	mm/month	51.6	42.4	36.0	23.2	15.6	11.2	12.8	17.6	24.4	34.8	40.8	48.4	**359**
Seepage	S	DSR x D	mm/month	141.1	127.4	141.1	136.5	141.1	136.5	141.1	141.1	136.5	141.1	136.5	141.1	**1660.8**
Total Outputs		ET+S	mm/month	192.7	169.8	177.1	159.7	156.7	147.7	153.9	158.7	160.9	175.9	177.3	189.5	**2019.6**
INPUTS																
Retained Rainfall	RR	R x RF	mm/month	28.4	29.7	37.6	46.9	65.3	69.3	73.9	84.5	71.3	62.0	42.9	35.6	**647.5**
Applied Effluent	W	QxD	L/month	13950	12600	13950	13500	13950	13500	13950	13950	13500	13950	13500	13950	**164250**
Total Inputs		RR+W	mm/month	42.3	42.3	51.6	60.4	79.3	82.8	87.9	98.4	84.8	76.0	56.4	49.6	**811.7**
DISPOSAL RATE																
Disposal Rate	DR	(ET+S)-RR	mm/month	164.3	140.1	139.4	112.8	91.3	78.4	79.9	74.2	89.6	113.8	134.4	153.8	
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	85	90	100	120	153	172	175	188	151	123	100	91	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 188 m^2
ADOPTED LAND APPLICATION AREA: 188 m^2
DESIGN APPLICATION RATE: 2.4 mm/day

STORAGE CALCULATION

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Application Rate	AR	Q/LAA	mm/month	74.2	67.0	74.2	71.8	74.2	71.8	74.2	74.2	71.8	74.2	71.8	74.2
Storage For The Month	ST	AR-DR	mm/month	-90.1	-73.1	-65.2	-41.0	-17.1	-6.6	-5.7	0.0	-17.8	-39.6	-62.6	-79.6
Increase In Depth Of Stored Effluent	ΔH	ST/N	mm/month	-300.2	-243.6	-217.4	-136.8	-57.0	-22.0	-19.1	0.1	-59.4	-132.0	-208.6	-265.4
Storage Remaining From Previous Month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Cumulative Storage At End Of Month	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Cumulative Storage From Previous Year	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Maximum Storage Depth for Nominated Area	MS			0 mm											

DESIGN DIMENSIONS SUMMARY

Land Application Area	LAA	188	m^2
Maximum Storage Height	MS	0	mm
Minimum Freeboard Topsoil Layer	F	100	mm
Min Depth Of Land Application System	Z	100	mm

D17/101942

AGR

WATER BALANCE COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter

Subject: Land Application Area Sizing Using Water Balance & Storage Calculations
Proposed Studio - 25% Daily Wastewater Loading Reduction Fully Terraced

Job No.: 17F189LCA
Comp: DH
Date: 6/09/2017
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

INPUT DATA

Design Wastewater Flow	Q	338	L/day	
Design Seepage Rate	DSR	4.55	mm/day	
Trial Land Application Area	LAA	141	m^2	
Crop Factor	C	Shade	unitless	
Rainfall Runoff Factor	RF	0.66	untiless	
Effective Void Ratio	N	0.3	untiless	
Minimum Freeboard Topsoil Layer	F	100	mm	
Mean Monthly Pan Evaporation Data	Kennett River 70th percentile SILO data			BoM Station
Mean Monthly Rainfall Data	Kennett River 70th percentile SILO data			BoM Station

Parameter	Symbol	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**
Evaporation	E		mm/month	129	106	90	58	39	28	32	44	61	87	102	121	897.0
Rainfall	R		mm/month	43	45	57	71	99	105	112	128	108	94	65	54	981.0
Crop Factor	C		unitless	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
OUTPUTS																
Evapotranspiration	ET	E x C	mm/month	51.6	42.4	36.0	23.2	15.6	11.2	12.8	17.6	24.4	34.8	40.8	48.4	**359**
Seepage	S	DSR x D	mm/month	141.1	127.4	141.1	136.5	141.1	136.5	141.1	141.1	136.5	141.1	136.5	141.1	**1660.8**
Total Outputs		ET+S	mm/month	192.7	169.8	177.1	159.7	156.7	147.7	153.9	158.7	160.9	175.9	177.3	189.5	**2019.6**
INPUTS																
Retained Rainfall	RR	R x RF	mm/month	28.4	29.7	37.6	46.9	65.3	69.3	73.9	84.5	71.3	62.0	42.9	35.6	**647.5**
Applied Effluent	W	QxD	L/month	10478	9464	10478	10140	10478	10140	10478	10478	10140	10478	10140	10478	**123370**
Total Inputs		RR+W	mm/month	38.9	39.2	48.1	57.0	75.8	79.4	84.4	95.0	81.4	72.5	53.0	46.1	**770.8**
DISPOSAL RATE																
Disposal Rate	DR	(ET+S)-RR	mm/month	164.3	140.1	139.4	112.8	91.3	78.4	79.9	74.2	89.6	113.8	134.4	153.8	
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	64	68	75	90	115	129	131	141	113	92	75	68	

MINIMUM AREA REQUIRED FOR ZERO STORAGE:	141	m^2
ADOPTED LAND APPLICATION AREA:	141	m^2
DESIGN APPLICATION RATE:	2.4	mm/day

STORAGE CALCULATION

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Application Rate	AR	Q/LAA	mm/month	74.3	67.1	74.3	71.9	74.3	71.9	74.3	74.3	71.9	74.3	71.9	74.3
Storage For The Month	ST	AR-DR	mm/month	-90.0	-73.0	-65.1	-40.9	-17.0	-6.5	-5.6	0.1	-17.7	-39.5	-62.5	-79.5
Increase In Depth Of Stored Effluent	ΔH	ST/N	mm/month	-299.9	-243.3	-217.1	-136.4	-56.7	-21.6	-18.7	0.5	-59.0	-131.7	-208.3	-265.0
Storage Remaining From Previous Month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
Cumulative Storage At End Of Month	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
Cumulative Storage From Previous Year	CS		mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
Maximum Storage Depth for Nominated Area	MS			0 mm											

DESIGN DIMENSIONS SUMMARY

Land Application Area	LAA	141	m^2
Maximum Storage Height	MS	0	mm
Minimum Freeboard Topsoil Layer	F	100	mm
Min Depth Of Land Application System	Z	100	mm

AGR

Nitrogen Balance

Site Address: **4 Bedroom Dwelling - 30, 32, 36 Morley Avenue Wye River**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE	249	m^2

INPUT DATA[1]

Wastewater Loading		
Hydraulic Load	750	L/day
Effluent N Concentration	25	mg/L
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal
Total N Loss to Soil	3750	mg/day
Remaining N Load after soil loss	15000	mg/day

Nutrient Crop Uptake					
Crop N Uptake	220	kg/ha/yr	which equals	60.27	$mg/m^2/day$

NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	249	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	314	m^2
Predicted N Export from LAA	-1.43	kg/year
Minimum Buffer Required for excess nutrient	0	m^2

CELLS

	Please enter data in blue cells
XX	Red cells are automatically populated by the spreadsheet
XX	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

[1] Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as:

- *EPA Guidelines for Effluent Irrigation*
- *Appropriate Peer Reviewed Papers*
- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *USEPA Onsite Systems Manual*

D17/101942

AGR

Nitrogen Balance

Site Address:	**2 Bedroom Dwelling - 30, 32, 36 Morley Avenue Wye River**

SUMMARY - LAND APPLICATION AREA REQUIRED BASED NITROGEN BALANCE	**149**	m^2

INPUT DATA[1]

Wastewater Loading		
Hydraulic Load	450	L/day
Effluent N Concentration	25	mg/L
% N Lost to Soil Processes (Geary & Gardner 1996)	0.2	Decimal
Total N Loss to Soil	2250	mg/day
Remaining N Load after soil loss	9000	mg/day

Nutrient Crop Uptake					
Crop N Uptake	220	kg/ha/yr	which equals	60.27	$mg/m^2/day$

NITROGEN BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	149	m^2

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nominated LAA Size	189	m^2
Predicted N Export from LAA	-0.87	kg/year
Minimum Buffer Required for excess nutrient	0	m^2

CELLS

	Please enter data in blue cells
XX	Red cells are automatically populated by the spreadsheet
XX	Data in yellow cells is calculated by the spreadsheet, DO NOT ALTER THESE CELLS

NOTES

[1] Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as:

- *EPA Guidelines for Effluent Irrigation*
- *Appropriate Peer Reviewed Papers*
- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *USEPA Onsite Systems Manual*

COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Soil Permeability Calculations

Job No.: 17F189LCA
Comp: DH
Date: 6/09/17
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

SOIL PERMEABILITY CALCULATIONS

Refer Site Investigation Plan for locations of test sites
Refer Borehole Profiles for soil types and depths encountered

Test Number:		1	2	3	4	5	6	7	8
Time Step (min):		5	5	5	5	5	5	5	5
Hole Depth(mm):		450	500	500	650	700	300	350	300
Hole Dia. (mm)		75	75	75	75	75	75	75	75
Tube Inside Dia. (mm):		40	40	40	40	40	40	40	40
Lim. Layer Depth(mm):		400	450	450	600	650	250	300	250
Lim. Layer Material:		clay	clay	clay	clay	clay	clay	clay	clay
Tube Insert. Depth:		400	400	400	550	400	250	300	250
Tube Number:									
Test Liquid:		Tap Water	Tap Water	Tap Water	Tap Water	Tap Water	Tap Water	Tap Water	Tap Water
Soil Moisture:		moist	moist	moist	moist	moist	moist	moist	moist
	Time								
Time	0	180	115	170	150	105	180	227	193
Reading:	5	220	135	190	215	105	200	227	193
Drop:		40	20	20	65	0	20	0	0
Reading:	10	515	155	200	290	105	225	227	193
Drop:		295	20	10	75	0	25	0	0
Reading:	15	730	197	210	385	105	225	227	193
Drop:		215	42	10	95	0	0	0	0
Reading:	20	945	239	211	521	105	230	227	193
Drop:		215	42	1	136	0	5	0	0
Reading:	25		270	212	630	105	235	227	193
Drop:			31	1	109	0	5	0	0
Reading:	30		310	212	725	105	240	227	193
Drop:			40	0	95	0	5	0	0
Reading:	35		346	212	835	105	245	231	194
Drop:			36	0	110	0	5	4	1
Reading:	40		381	212	915	105	250	232	194
Drop:			35	0	80	0	5	1	0
Reading:	45		415	212		105	255	235	194
Drop:			34	0		0	5	3	0
Reading:	50		445	212		105	260	237	194
Drop:			30	0		0	5	2	0
Reading:	55		475	212		105	265	240	194
Drop:			30	0		0	5	3	0
Reading:	60		512	212		105	275	243	194
Drop:			37	0		0	10	3	0
Reading:	65		547	212				245	
Drop:									
Reading:	70								
Drop:									
Reading:	75								
Drop:									
Reading:	80								
Drop:									
Reading:	85								
Drop:									
Reading:	90								
Drop:									

D17/101942

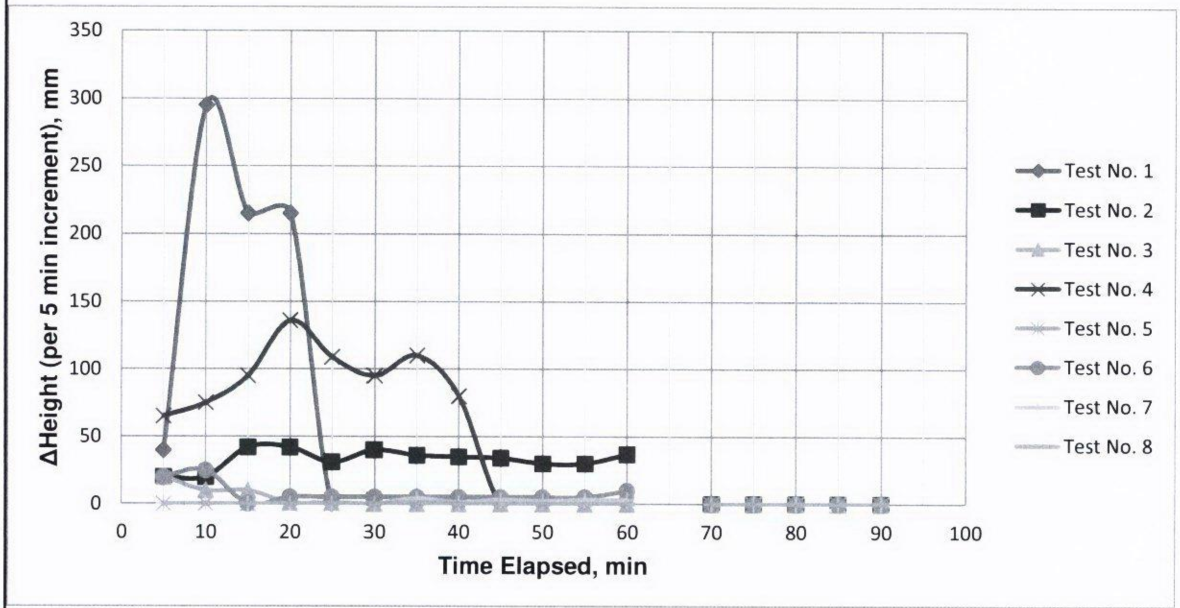
COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Soil Permeability Calculations

Job No.: 17F189LCA
Comp: DH
Date: 6/09/17
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK



	1	2	3	4	5	6	7	8
Starts uniform drop		25	10	15		20	35	
Stops uniform drop		60	20	40		55	60	
Time elapsed(min)		35	10	25		35	25	
Total Drop (cm)		24.2	1.1	53.0		3.5	1.2	
z		1.3	1.3	1.3		0.7	0.7	
Flow, Q (cm^3/min)		8.7	1.4	26.6		1.3	0.6	
K_{sat} (cm/min)		0.0182	0.0029	0.0558		0.0057	0.0027	
K_{sat} (m/day)		0.262	0.042	0.804		0.082	0.039	
					Average K_{sat} (m/day)			**0.2458**

AGR

Appendix VII: Gypsum Requirement

GYPSUM REQUIREMENT COMPUTATION SHEET

Project:	30, 32, 36 Morley Avenue Wye River	**Job No.:**	17F189LCA
		Comp:	DH
		Date:	6/09/2017
Client:	Bruce Carter	**Attendee:**	DH & MF
Subject:	Gypsum Requirement	**Review:**	DH

AGR ASSESSING GEOLOGICAL RISK

Calculation CEC x 1.6 x (ESP - ESP_D)

Sample 1

	meq/100g	%
Exchangeable Calcium	3.6	36.4
Exchangeable Magnesium	4.5	45.5
Exchangeable Potassium	0.9	9.1
Exchangeable Sodium	0.9	9.1
Exchangeable Hydrogen		0.0

Sample Depth (mm)	200
Depth of soil (mm)	400
Gypsum factor (tons)[1]	1.6
t/ha to kg/m² conversion	0.1

Cation Exchange Capacity (CEC)	MEQ%	9.9
Excangable Sodium Percentage (ESP)	%	8.8
Desirable Exchangable Sodium Percentage (ESP_D)	%	6.0
Calcium Replacement (ESP - ESP_D)	%	2.8

Gypsum Requirement	t/ha	1.77
	kg/m²	0.18

[1]US Department of Agriculture (1954) Agrigulture Handbook No. 60; Davis *et al* (2012)

AGR

GYPSUM REQUIREMENT COMPUTATION SHEET

Project: 30, 32, 36 Morley Avenue
Wye River

Client: Bruce Carter
Subject: Gypsum Requirement

Job No.: 17F189LCA
Comp: DH
Date: 6/09/2017
Attendee: DH & MF
Review: DH

AGR ASSESSING GEOLOGICAL RISK

Calculation CEC x 1.6 x (ESP - ESP_D)

Sample 2

	meq/100g	%
Exchangeable Calcium	1.6	9.0
Exchangeable Magnesium	13.3	74.7
Exchangeable Potassium	0.8	4.5
Exchangeable Sodium	2.1	11.8
Exchangeable Hydrogen		0.0

Sample Depth (mm)	600
Depth of soil (mm)	500
Gypsum factor (tons)[1]	[redacted]
t/ha to kg/m^2 conversion	[redacted]

Cation Exchange Capacity (CEC)	MEQ%	17.8
Excangable Sodium Percentage (ESP)	%	11.7
Desirable Exchangable Sodium Percentage (ESP_D)	%	6.0
Calcium Replacement (ESP - ESP_D)	%	5.7

Gypsum Requirement	t/ha	8.12
	kg/m^2	0.81

[1]US Department of Agriculture (1954) Agrigulture Handbook No. 60; Davis *et al* (2012)

AGR

Appendix VIII: Run Off Calculations

Runoff Computations

Project:	30, 32, 36 Morley Avenue Wye River	**Job No.:**	17F189LCA
		Comp:	DH
		Date:	6/09/2017
Client:	Bruce Carter	**Attendee:**	
Subject:	Run off Coefficient	**Review:**	DH

AGR ASSESSING GEOLOGICAL RISK

Proportional Land Use Zones areas of Total Catchment Area

Total area [ ] km^2 [3000] m^2

Land Use	Prop. Of Land A_i	C_i
House, Roof	0.18	0.95
Driveway, pavement	0.12	0.3
Very Steep, clayey soil	0.6	0.2
Flat sandy soil	0.08	0.1
A_{total}	1.0	

Runoff coefficient for total area (Weighted C) **0.342**

Weighted C = $\sum C_i A_i / A_{total}$

NOTE: Runoff Factor used in LCA water balance calculations is the inverse of the Runoff Coefficient. Ie the proportion of water retained or that infiltrates the soil as apposed to water runs off. If C = 0.3 then RF = 0.7

D17/101942

AGR ASSESSING GEOLOGICAL RISK

AGR GEOSCIENCES PTY LTD

LANDSLIP RISK ASSESSMENT

FOR

30, 32, 36 MORLEY AVENUE WYE RIVER, VICTORIA

Prepared for:	Bruce Carter C/- Rob Kennon Architects
Prepared by:	David J Horwood Senior Engineering Geologist *BAppSc (Geology); MAusIMM CP(Geo); MAIG*
Approved by:	
Reference No.	17F190LRA
Date:	11/9/2017
Revised:	

AGR GeoSciences Pty Ltd
ABN: 32 601 372 632
ACN: 601 372 632

P PO Box 178 Mount Clear VIC 3350 M 0412 105 026 E office@agrgeo.com.au W agrgeo.com.au

AGR ASSESSING GEOLOGICAL RISK

AGR GEOSCIENCES PTY LTD

22/2/2018

Rob Kennon Architects
Studio 1, Level 1
156 George St
Fitzroy Vic 3065
Att: Jack Leishman

RE: 30, 32, 36 Morley Avenue, Wye River

Dear Mr Leishman,

AGR Geosciences Pty Ltd (AGR) was engaged by Rob Kennon Architects on behalf of Bruce Carter (the Client) to conduct a Landslip Risk Assessment (LRA) dated 11/9/2017 relating to a proposed development located at the above address.

Following completion of the assessment a set of revised plans have been provided for review including the removal of several small trees.

I have now reviewed the full set of amended plans for 30, 32, 36 Morley Avenue Wye River (dated 28/11/2017) and can confirm that the amended plans are consistent with the preliminary drawings and development description provided to AGR by Rob Kennon Architects at the time of the assessment.

I conclude that removal of the trees at the specified locations as indicated in the revised plans will not adversely affect slope stability on this site. The revised plans (including tree removal) do not alter the findings or conclusions of the landslip risk assessment (17F190LRA dated 11/9/2017) so long as the recommendations in the report are adhered to.

Recommendations from the report which may relate to the proposed tree removal include:

- Trees should be cut off at ground level with the root structures left intact.
- If root structures interfere with dwelling structure and need to be removed, then any excavations works should be supported with suitable retaining walls or related earthworks battered to safe batter angles defined in the Landslip Risk Assessment.
- The proposed site cuts must be supported with an engineer designed retaining walls.
- Drainage measures as described in the Landslip Risk Assessment and supporting Land Capability Assessment (17F189LCA) are to be implemented including cut off and surface drainage as indicated.

I trust this information is satisfactory to your requirements.

Yours Sincerely,

DAVID J HORWOOD
BAppSc (Geology); MAusIMM CP (Geo); MAIG
SENIOR ENGINEERING GEOLOGIST

AusIMM THE MINERALS INSTITUTE CHARTERED PROFESSIONAL GEOLOGY David Horwood

Appendix I: Geotechnical Declaration

FORM **A**

Geotechnical Declaration and Verification Development Application

Office Use Only		Regulator: COLAC-OTWAY SHIRE

To be submitted with a development application. If this form is not submitted with the geotechnical report the report will be refused.
This form is essential to verify that the geotechnical report has been prepared in accordance with Schedule 1 to the Erosion Management Overlay and that the author of the geotechnical report is a geotechnical engineer or engineering geologist as defined by Schedule 1 to the Erosion Management Overlay. Alternatively, where a geotechnical report has been prepared for subdivision or is greater than two years old or by a professional person not recognized by Schedule 1 to the Erosion Management Overlay, then this form may be used as technical verification of the geotechnical report if signed by a geotechnical engineer or engineering geologist as defined by Schedule 1 to the Erosion Management Overlay.

Section 1 Related Application

Reference	
DA Site Address	30, 32, 36 Morley Avenue WYE RIVER VIC
DA Applicant	Bruce Carter

Section 2 Geotechnical Report

Details	Title: Landslip Risk Assessment for 30, 32, 36 Morley Avenue	
	Author's Company/Organization Name: AGR Geosciences Pty Ltd	Report Reference No: 17F190LRA
	Author: David J Horwood	Dated: 11 / 9 / 2017

Section 3 Checklist

Geotechnical Requirements (Tick as appropriate, either Yes or No)

The following checklist covers the minimum requirements to be addressed in a geotechnical report. This checklist is to accompany the report. Each item is to be cross-referenced to the section or page of the geotechnical report which addresses that item.

Yes	No	
☒	☐	A review of readily available history of slope instability in the site or related land as per *section 4.1; 4.1.2; 4.1.3*
☒	☐	An assessment of the risk posed by all reasonably identifiable geotechnical hazards as per *Sections 4.4, 5.0, 6.0, 7.0*
☒	☐	Plans and sections of the site and related land as per *Figures 1-8, Section 4.0*
☒	☐	Presentation of a geological model as per *Figures 1-6 Section 4.1.1; Section 4.2 & Section 4.3*
☒	☐	Photographs and/or drawings of the site as per *Appendices ii-iii*
☒	☐	A conclusion as to whether the site is suitable for the development proposed to be carried out either conditionally or unconditionally as per *Section 8.0*
☐	☐	If any items above are ticked No, an explanation is to be included in the report to justify why. *<Add reference>*

Subject to recommendations and conditions relevant to:

Yes	No	
☒	☐	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 and the proposal, from a geotechnical viewpoint,
☒	☐	highlighting and detailing the inspection regime to provide the Colac-Otway Shire and builder with adequate notification for all necessary inspections.
☒	☐	State Design life adopted: 50 Years

FORM A

Geotechnical Declaration and Verification Development Application

Section 4 — List of Drawings referenced in Geotechnical Report

Design Documents

Description	Plan or Document No.	Revision or Version No.	Date	Author
Survey Plan	0-101		28/11/2017	Rob Kennon Architects
Context and Roof plan	0-201		28/11/2017	Rob Kennon Architects
Context, roof & landscape plan	1-101		28/11/2017	Rob Kennon Architects
Basement Plan	1-102		28/11/2017	Rob Kennon Architects
Ground floor plan	1-103		28/11/2017	Rob Kennon Architects
Elevations	2-101-102		28/11/2017	Rob Kennon Architects
Sections	3-101		3/7/2017	Rob Kennon Architects
Site Analysis Survey	1070-001SA		6/7/2017	Smith Land Surveying

Section 5 — Declaration

Declaration (Tick all that apply)

I am a geotechnical engineer or engineering geologist as defined by the Schedule 1 to the Erosion Management Overlay **and on behalf of the company below, I:**

Yes		
☒	No ☐	am aware that the geotechnical report I have either prepared or am technically verifying (referenced above) is to be submitted in a support of a development application for the proposed development site (referenced above) and its findings will be relied upon by Colac-Otway Shire in determining the development application.
☒	N/A ☐	prepared the geotechnical report referenced above in accordance with the AGS (2007c) as amended and Schedule 1 to the Erosion Management Overlay.
☒	N/A ☐	am willing to technically verify that the Geotechnical Report referenced above has been prepared in accordance with the AGS (2007c) as amended and Schedule 1 to the Erosion Management Overlay.
☒	No ☐	am willing to technically verify that the landslip risk assessment prepared for the development application for the site confirms the land will achieve the level of <*tolerable risk*> of slope instability as a result of the considerations described in Section 2.0 of Schedule 1 to the Erosion Management Overlay taking into account the total development and site disturbances proposed.
☐	N/A ☒	am willing to technically verify that the landslip risk assessment prepared for the site and related land being greater than two years old confirms the land will achieve the level of <*tolerable risk*> of slope instability as a result of the considerations described Section 2.0 of Schedule 1 to the Erosion Management Overlay *taking into account the total development and site disturbances proposed.*
☒	No ☐	have professional indemnity insurance in accordance with and Schedule 1 to the Erosion Management Overlay of not less than $1.0 million, being in force for the year in which the report is dated, with retroactive cover under this insurance policy extending back to the engineer's first submission to Colac-Otway Shire.

Section 6 — Geotechnical Engineer or Engineering Geologist Details

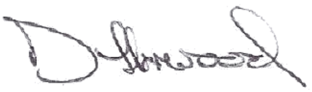
Company/ Organization Name	AGR Geosciences Pty Ltd	
Name (Company Representative)	Surname: Horwood	Mr /Mrs /Other: Mr
	Given Names: David John	
	Chartered Professional Status: **CP (Geo)**	Registration No: **321719**
Signature		Dated: 22 / 02 / 2018

Table of Contents

List of Figures

List of Tables

List of Appendices

EXECUTIVE SUMMARY

Our assessment has found that as with many sites in the Wye River area, there are risks to life and property due to conceivable landslide events on the subject site.

- Mid slope of a north-south striking low ridge line within the near shore foothills of the Otway Ranges. Clearly defined scarps and breaks of slope through the centre and at the base of the property.
- Natural slope angles on site range from 13° to 19° generally to the north-east and to the south. Slope angles steepen to between 20° and 26° below a break in slope extending across allotments No. 32 and No. 30 at the north-eastern end of the property above Morley Avenue. Overall ground slope is approximately 24° to the north-east and 17° to the south.
- Natural soils consist of clayey SILT overlying, silty CLAY and CLAY with trace fine grained sand and varying degrees of highly weathered sandstone rock fragments.
- The soil profile is between 500-1200mm thick, overlying extremely to highly weathered mudstone covered in part by a veneer of extremely weathered to highly weathered sandstone.
- Bedrock strata dip at 16° toward a dip direction varying between 137° and 157° (Dip/D'Dir: 16°/137° and 16°/157°) and with a plunge of 5° towards the east. The dip direction is perpendicular with the site's slope aspect in the northern and eastern parts of the property and parallel with the site's slope aspect in the south-west of the property.
- Discontinuities and the abrupt change in dip and dip direction in the bedding structure is interpreted to be the result of possible left lateral thrust slip on a fault proximal to the bend in Morley Avenue (refer to Figure 1). Faulting has most likely occurred over a zone of shearing (100-200m wide or more) rather than along a discrete fault plane.
- The local ground models for landslide hazards involves shallow rotational earth slides, shallow translational earth slides and earth flows, deep seated translational debris or rock slides, local failures in cuttings and fill slopes.

The Geotechnical Assessment was up graded to a Landslide Risk Assessment due to the steep slopes exceeding the tolerances specified within Schedule 1 to the Colac-Otway Ranges Shire EMO and the presence of pre-existing slope failures.

Concerning the proposed development at 30, 32, 36 Morley Avenue, Wye River, we conclude that the risks to property assuming existing conditions remain or development is unmitigated, are considered "HIGH" (for the most at risk elements). The risk to life is ABOVE the recommended "TOLERABLE" risk limit defined as 1×10^{-5} by the AGS Guidelines (2007) and Schedule 1 to the Colac-Otway Ranges Shire EMO.

The risks to property can be reduced if recommended mitigation measures are adhered to.

The risks to property associated with developing a residential dwelling on the subject site assuming risk management conditions are implemented, can be reduced to "LOW" and "VERY LOW" for most hazards while at least one hazard will remain at a MODERATE risk. In quantitative terms, the risk to life can be reduced to below the recommended "TOLERABLE" risk limit for all hazard elements.

Based on our assessments of the risks, we conclude that there are no geotechnical reasons to prevent the issue of a permit to develop on this site, subject to the implementation of the recommendations outlined in Section 9.0 of this report, which outline management strategies to reduce or maintain the likelihood and/or consequences of the major risk events.

1.0 INTRODUCTION

Landslides and other forms of earth and rock movements are common throughout the Otway Ranges and like erosion, they are a natural process of geological shaping of the environment.

Any building within a "geologically active" environment such as the Otway Ranges is potentially at risk of damage due to natural soil movements. In some circumstances, 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 can often be taken to manage or reduce the risks to acceptable levels, it is not feasible to eliminate the risks of damage or injury entirely.

2.0 SCOPE OF REPORT

AGR Geosciences Pty Ltd (AGR) was commissioned by Rob Kennon Architects on behalf of Mr Bruce Carter (the Client) to provide a Geotechnical Assessment of No. 30, 32, 36 Morley Avenue (the Site) to meet the geotechnical assessment requirements of the Colac-Otway Shire Planning Scheme Amendment C68: Schedule 1 to the Erosion Management Overlay (EMO). A decision was reached to advance the Geotechnical Assessment to a Landslip Risk Assessment on the basis that automatic trigger conditions as defined in Schedule 1 to the EMO did exist on site.

The principles used in conducting the Landslip Risk Assessment follow the guidelines published in the Australian Geomechanics Society (AGS) journal Volume 42 No 1 of March 2007, entitled "Landslide Risk Management". This report contains all the information required for a Geotechnical Assessment as well as all additional information required for a Landslip Risk Assessment as defined by Schedule 1 to the EMO.

The purpose of the assessment is to identify possible landslide hazards within and near the elements at risk and to provide guidance and options on how the risks can be reduced, avoided or controlled.

For the purpose of this Landslip Risk Assessment, "the elements at risk" for the proposed development are defined as the proposed dwelling and any related infrastructure, drive ways, access roads or ancillary structures, and all users or residents of the proposed dwelling and any related infrastructure, drive ways, access roads or ancillary structures.

2.1 IMPACTS OF PAST FIRE EVENTS

In December 2015 severe wildfire decimated the townships of Wye River and Separation Creek destroying over 100 houses and burring more than 2000 hectares of forest surrounding the settlements. Not only did the fires destroy infrastructure and buildings but they have also impacted on the already high landslide susceptibility of the area. Additional hazards are likely to have eventuated as a result of these fires including hazards directly related to fire damage such burnt out retaining walls and also indirect hazards relating to alteration of soil structure, removal of vegetation and increase run off.

This report recognises that the impacts of fire to the Wye River and Separation Creek area has created additional infrastructure related hazards and also had an impact on the type, severity and potential frequency of naturally occurring landslide hazards which can and do occur in the region.

The following assessment has considered the impacts of fire on the site under investigation and taken into account the effect fire has as a contributing factor to landslide hazard risk in the surrounding area.

3.0 DEVELOPMENT DESCRIPTION

- Demolition of existing timber clad dwelling.
- Proposed single storey, 4 bedroom, clad framed and steel framed residential dwelling including a sub-basement lower level garage.
- Proposed lower floor concrete slab and blockwork external walls.
- Expected site cut up to 3000mm.
- Proposed single storey, 2 bedroom studio/bungalow to replace existing brick and timber garage.
- Upgrade of existing driveway site access from Morley Avenue
- Approximate building footprint for new dwelling 396m^2. Approximate building footprint for new studio/bungalow 66m^2.

A site plan for the proposed development is attached as Appendix II.

4.0 HAZARD ANALYSIS

4.1 DATA GATHERING – DESK TOP STUDIES AND PREVIOUS INVESTIGATIONS

Numerous landslide risk assessments and landslide studies have been conducted in the Otway Ranges, many by private consultants for individual clients and some published reports are also available. Many of these reports confirm that landslide hazards are present and that in some cases, inappropriate development can lead to slope failure.

In preparation for conducting a field investigation of the site, preliminary data was gathered from the following sources:

- Landslide and Erosion Susceptibility mapping published by the Corangamite Catchment Management Authority.
- Landslide and Erosion Inventory mapping published by the Corangamite Catchment Management Authority.
- Fed Uni Spatial Landslide and Erosion Database Online.
- Geological Reports and Maps published by the Geological Survey of Victoria and published 1:50,000 and 1:250,000 geological mapping published online via GeoVic and Earth Resources Victoria.
- Factor Data Sets such as slope, elevation, rainfall, aspect, land use, vegetation, geomorphology and soil landforms published by the Corangamite Catchment Management Authority.
- Geomorphological, landform, topographic, soil and climatic data published by the Department of Environment and Primary Industries available via Victorian Resources Online.
- Aerial photos and maps published by Google and NearMaps.

- Previous investigations and reports by AGR and other consultants both published and unpublished.
- Architectural designs prepared by Ron Kennon Architects
- Site Analysis Survey prepared by Smith Land Surveyors.

4.1.1 Geology and Geomorphology

Regional development of the Otway Ranges began as Australia pulled away from Antarctica during the Late Jurassic to Early Cretaceous initiating rift valley volcanism and deposition which ultimately formed the Otway Ranges. Lower Cretaceous sediments of the regionally expansive Otway Group make up most of the Otway Ranges in southwestern Victoria. The Eumeralla Formation, by far the most expansive formation in Otway Group, comprises mostly of fluvial channel deposited lithic sandstones, mudstones, siltstones and minor mud-clast conglomerate.

The sandstones and mudstones are characteristically quartz-poor volcanogenic sediments high in calcic feldspars derived from dacitic volcanic material which originated from contemporaneous rift valley volcanism to the north of the Otway Ranges. Post deposition the Otway Group has been gently folded, faulted and uplifted along a series of parallel faults trending north-east.

The composition of the Eumeralla Formation makes it highly susceptible to weathering producing clay rich soils typically 0.5-1m thick in sandstone dominant areas and up to and greater than 2m deep in siltstone/mudstone dominant areas. A typical soil profile is generally well developed overlying and sometimes grading into extremely and highly weathered rock. The weathering profile continues to progressively grade into fresh rock.

Following significant uplift during the Late Cretaceous a period of widespread erosion prevailed resulting in the deposition of terrestrial sediments during the Paleocene in braided river systems belonging to a high energy fluviatile environment. At the cessation of this period of erosion, the sea again transgressed and a variety of sediments were deposited in the mostly marine conditions which existed on the flanks of the Otway Ranges throughout the Tertiary Period. At this time, these marine sediments were lapping the Otway Ranges which protruded from the sea like and island. During the Late Miocene the sea began to retreat giving way to shallower marine conditions.

During the Pliocene, following widespread uplift, a peneplain developed over Miocene sediments formed in shallow marine conditions following shallowing of the sea during the Oligocene. At this time sea level again rose depositing the sediments in a shallow marginal-marine environment extensively covering the Otway Basin and flanks of the Otway Ranges.

The local geology of the subject site has been mapped to entirely include Eumeralla Formation sediments.

Since the end of the Tertiary sea levels have consistently fluctuated with the last major interglacial period occurring around 110,000BP (before present). Between 14,000 and 6,000BP sea levels rose rapidly following the last glacial maximum around 17,000 to 20,000BP. As the sea advanced it pushed coastal dunes in front of it on lapping Tertiary aged sediments along the coast until sea levels again dropped slightly renewing erosion rates around 6,000 years ago.

Wye River can be described as belonging to the Lorne Land System or the deeply dissected upland ranges of the Southern Uplands (Geomorphic Unit 3.1.2). This land system occupies much of the coast line from Lorne to Apollo Bay along the Great Ocean Rd characterized by steep hills, coastal cliffs and rock shore platforms. Inland from the coast the topography consists of steeply dissected hills, spurs and ridges of moderate relief with cliffs and waterfalls.

Geomorphic development of the landscape is heavily influenced by landslides. Rapid valley development by the rivers and creeks and their tributaries resulted from uplift of the Otway Ranges and fluctuations in sea levels. Landslide activity is commonly correlated to over steepened valley slopes where their occurrence has continuously shaped the landscape over the past 5000-6000 years since lower stream base levels and warmer (wetter) climates have prevailed.

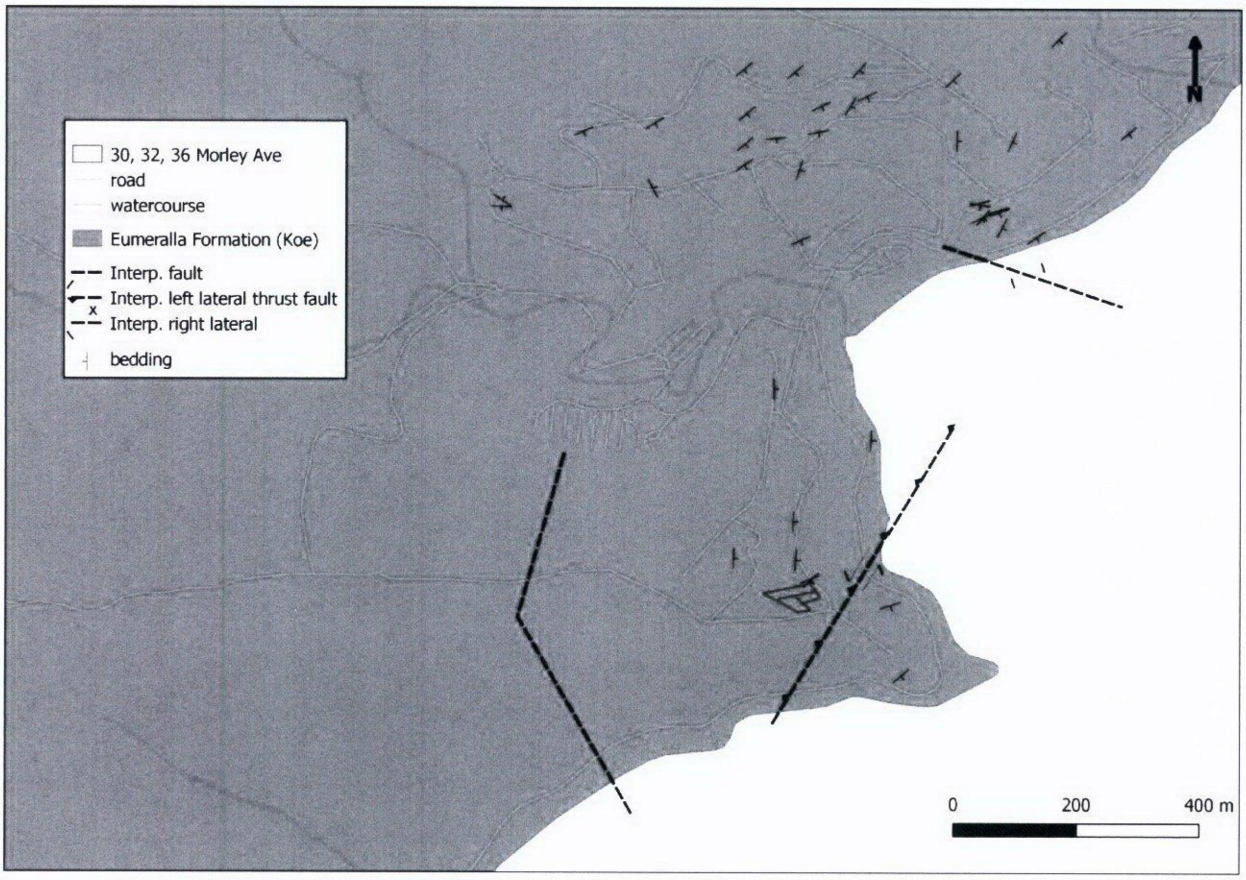


Figure 1: Regional geology of the greater Wye River area

4.1.2 Regional Landslide Factors

Landslides are rarely attributed to a single geomorphic factor alone and usually require a combination of factors to exist often with equal bearing on the susceptibility of a site to landslide activity. Terrain slope, aspect and rainfall along with the geology and geomorphology are all factors which can have a profound influence on the occurrence of landslides. Landslide susceptibility mapping conducted by A.S. Miner Geotechnical (2006) in the Wye River area indicates that the site has **HIGH** to **VERY HIGH** landslide susceptibility.

Slope angle has been attributed as a contributing factor in landslide occurrence (Cooney, 1980; Wood, 1980), although the steepest slope angles do not always pose the greatest risk.

The depth of weathering of a regolith profile can be related to slope aspect in the Otway Ranges and incised valleys of the Otway Ranges with deeper more weathered regolith profiles typically occurring on the wetter southwestern slopes. It is logical to assume some relationship between aspect and landslide activity although no direct correlation has been observed in previous studies.

Extreme rainfall is a dominant trigger for landslides in the Otway Ranges and previous studies locally, nationally and globally tend to confirm that intense or prolonged rainfall is the most common trigger of landslides in general.
Earthquakes attributed to active fault lines are another potential trigger for landslides on the Otway region. Intraplate earthquakes such as those experienced in Victoria are extremely unpredictable and occur unexpectedly. These types of earthquakes are caused by compressive stresses associated with thrust faults. The nearest large fault to the region is the Torquay Fault which is considered to be active and may be correlated to historical earthquake activity. Higher magnitude earthquakes could trigger landslides and townships proximal to a fault line with a history of higher magnitude earthquakes puts them at a higher risk than other localities. In the greater Wye River region more than 40 earthquakes have been recorded since 1837 with three measured as being greater than a magnitude of four.

While not a direct triggering event itself, fire is also a significant factor contributing to an areas susceptibility to landslides. Steeply sloping areas burnt by fires may be subject to increased risk of landslide in the months and even years following the fire event, especially if the fire is followed by a prolonged wet season or high rain fall event. The shallow soil layers become more susceptible to erosion and potential landslides following fires for several reasons including the removal of organic matter from the surface and upper soil layers which otherwise has a strong influence on soil structure. Drying and aeration of the soil structure following fire can weaken the shear strength of the soil making it more susceptible to failure given exposure to triggering events. When fires remove ground cover and lower storey vegetation, the root binding effects on soil structure are also removed. Fires expose bare soils to the impacts of surface run off and erosion without vegetation to bind the soils and intercept rain fall and surface water flow. A reduction in vegetation may also create medium to long term effects on soil moisture as the reduction in vegetation results in an increase in surface water infiltration and shallow sub-surface through flow. Increasing soil moisture (groundwater or surface infiltration) is a trigger of landslides.

Fires alter surface hydrology, especially in steep mountain catchments. The removal of vegetation from the landscape increases surface flow and run-off. Following fires, surface soils can also undergo chemical alteration and become hydrophobic. Hydrophobic soils contribute to surface run-off and increased surface flow velocity. High volume, high velocity surface run-off is one of the triggering factors of debris flows.

Other risk factors which may influence the initiation of landslides include unfavourable orientation of the rock strata, inherently weak rock mass, anthropogenic alterations to the slope morphology, hydrology and drainage.

Table 1 provides a general summary of some of the typical climatic and physiological features for the Soil Landform Unit 64 belonging to the Lorne Land System of Otway Ranges which characterises the Wye River area.

Table 1: Regional Features for Hills of the Soil Landform Unit 64

GEOMORPHIC UNIT	Dissected upland ranges of the Southern Uplands (3.1.2)		
LANDFORM	Hills		
LANDFORM ELEMENT	Lower slope and drainage line	South and east facing slopes	Steepest slopes
ELEVATION	0-400m		
LOCAL RELIEF	150m		
SLOPE ANGLE AND RANGE (%)	20 (1-35)	45 (5-65)	60 (20-70)
SLOPE SHAPE	Concave	Linear	Linear
RAINFALL	850-1300mm Annual		
TEMPERATURE	13^{o} Annual Average		

4.1.3 Previous Landslides Movements

Numerous landslide studies and geotechnical investigations have been previously conducted in the Wye River area. Roberts (2006), Dahlhaus (2002), Cooney (1980), Dahlhaus and Cooney (1986) and Yttrup (2001) have all identified previous landslide failures from either aerial stereo photogrammetry interpretation, Lidar interpretation or field mapping in and around the subject site and more widely in the Wye River area as can be seen in Figure 2.

Coffee Geotechnics (2011) reviewed the Wye River and Separation Creek inventory utilising remote sensing interpretation as well as detailed field mapping and ground proofing of inventory listed landslides. The results confirmed the majority of the previously listed landslides as well as delineating some additional ancient or fossil landslides and areas of instability in old colluvium coinciding with previously mapped failures.

There are several known areas in Wye River with landforms which consist of either active or relict landslides or which are susceptible to instability. The three main large landslide complexes in Wye River include the Illowra Landslide, a 40ha relict landslide north-east of the Wye River, the Riverside Drive Landslide complex, an active landslide at the toe of the Illowra Landslide and the Morley Avenue Landslide, a 3ha active rockslide between Morley Avenue and the Great Ocean Road south of the main Township.

The well-defined head scarp of the active Morley Avenue rockslide was mapped by Dahlhaus (2002) and is approximately located between numbers 4 and 12 Morley Avenue. The main feature of the landslide is anecdotally believed to have moved during the 1960's. A retaining wall was built at the base of the scarp below the current day 6 Morley Avenue to prevent continual slumping of the scarp impacting the road. The scarp regularly failed by way of small debris slides until the 1990's.

Several other landslide features were identified along Morley Avenue by Roberts (2006), including two medium sized scarps which pass through the subject site.

In 1986 a field based landslide investigation was undertaken by P. Dahlhaus and A. Cooney of the Geological Survey of Victoria on Lot 1 Morley Avenue (No. 32 of the current subject site) the results of which were recorded in an internal government report. At the time of the investigation the site was undeveloped and covered in native forest. Slope angles were measured at around 27°. The investigation concluded that the site had been subjected to historical landslide activity although it is unclear whether the investigation was in response to recently observed slope movement. Dahlhaus and Cooney classified the landslide as a Single, Slide of Recent age and determined the activity state as Active.

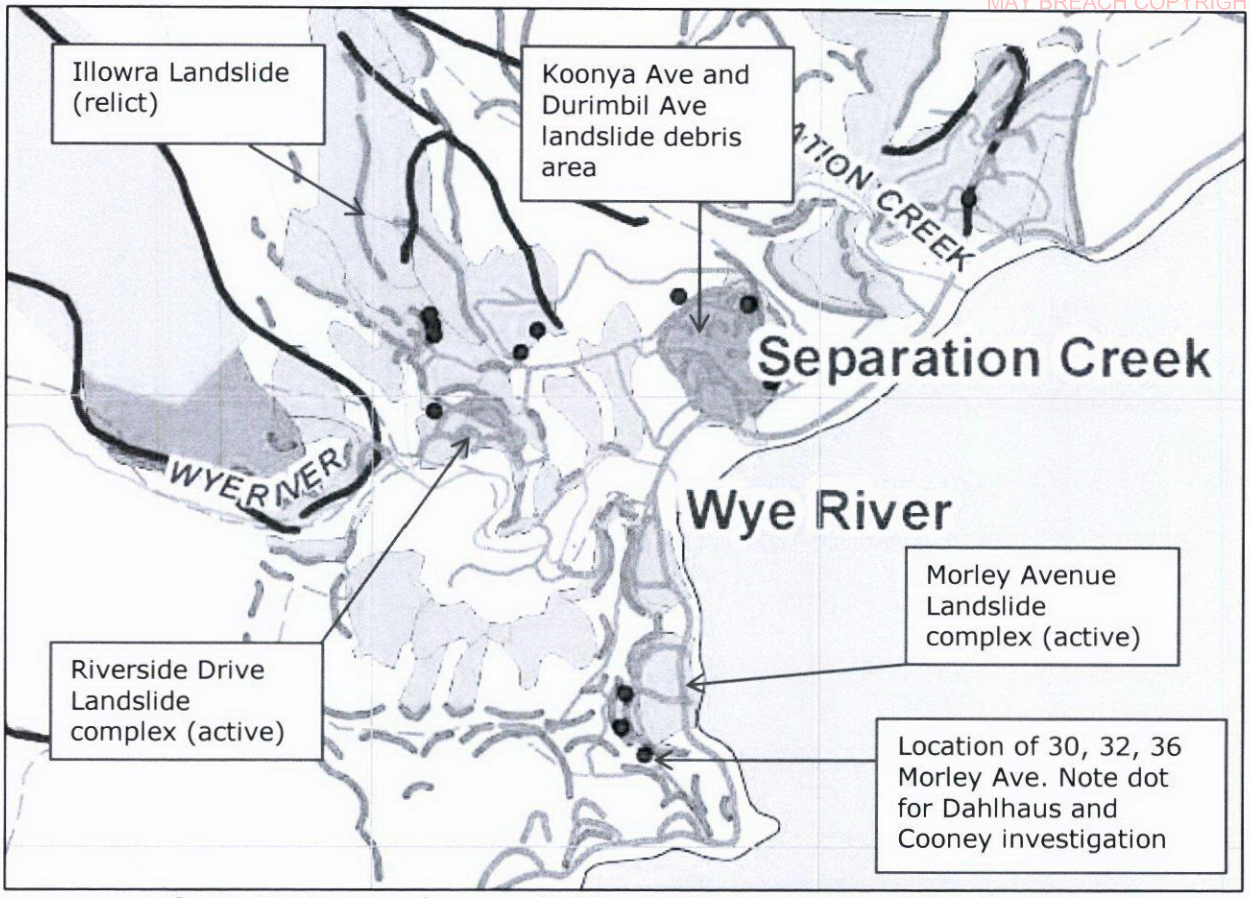


Figure 2: Previously recorded landslides on the landslide inventory (modified from AS Miner Geotechnical, 2007)

4.2 FIELD INVESTIGATIONS

4.2.1 Site Inspection and Mapping

A thorough visual appraisal was made of the geomorphological features of the proposed development site and the surrounding area to search for evidence of slope instability and past slope failures. Slope angles were measured with a laser Forestry Range Finder and inclinometer and a Brunton geological compass.

A scaled engineering geology and geomorphology map showing the main features of the subject site is presented in Figure 3 while the local geological model is presented in cross-section in Figures 4-8. Site photographs are also attached as Appendix III.

4.2.2 Site Description and Physiography

Development:

- Single property consisting of 3 separate allotments opposite the intersection of Morley Avenue and Sturt Court.
- Developed property with an existing dwelling and garage on allotment, No. 30 Morley Avenue, an existing driveway and shed on No. 36, while No. 32 is vacant.
- Some existing cut and fill earthworks and landscape alteration. Established gardens, shrubs and trees. Dense vegetation and native trees along the eastern property boundary above Morley Avenue.

Landscape position and Landforms:

- Located on the high (west) side of Morley Avenue. The property has dual aspects and slope orientations to the east to north-east and to the south.
- Mid slope of a north-south striking low ridge line within the near shore foothills of the Otway Ranges.
- Clearly defined scarps and breaks of slope through the centre and at the base of the property.

Slopes:

- Natural slope angles on site range from 13° to 19° generally to the north-east and to the south. Slope angles steepen to between 20° and 26° below a break in slope extending across allotments No. 32 and No. 30 at the north-eastern end of the property above Morley Avenue. Overall ground slope is approximately 24° to the north-east and 17° to the south.
- Existing site excavations relate to existing driveway and site access and the existing dwelling on site No. 30.
- Cut and fill slope angles are battered between 46° and 69°.

Slope shapes:

- Slope shapes on and surrounding the site are typically convex and divergent. Minor convergent slope shapes in the north-eastern corner of the property.

- Major convex break in slope through the centre of No. 32.

Drainage:

- Generally fair to good drainage conditions over the entire property.
- Typically moist to very moist surface and sub-surface conditions across most of the site.
- Ponding surface water, concentrated run-on and ground water seeps evident over depressed or gentler sloping southern portion of the Site above the existing site access.

Observations and evidence of instability:

Evidence of instability and existing hazards are described below and annotated on the engineering geology map in Figure 3.

a) Newly constructed retaining walls for wastewater disposal on adjacent property.

b) Existing timber sleeper retaining wall partly burnt supported by star pickets. Leaning down slope, distressed.

c) Concrete retaining wall cracked and distressed. Bulging down slope.

d) Historical landslide scarp. Relatively sharp head scarp features and rounded minor scarps inside larger feature. Landslide previously identified by AGR as part of previous assessment. Scarp appears to cross over subject site and line up with a prominent convex break in slope although scarp is more rounded on the subject site than on the neighbouring property.

e) Stormwater pipe not connected and discharging from cutting beneath neighbouring dwelling. Stormwater freely running over slope and onto subject site.

f) Soil creep and minor low relief hummocky surface beneath break in slope.

g) Dry stone retaining wall; stones loose and dislodging in places.

h) Sandstone outcrop in base of cutting and in table drain on Morley Avenue.

i) Unsupported cutting 500mm to 1300mm high along existing driveway with slumping and cracking; over steep; overhangs and active erosion.

j) Slump above road cutting with 200mm vertical displacement. Over steep cutting with overhangs. Sandstone outcrop in drain.

k) Rock outcrop in Morley Avenue road cutting and drain. Lithological contact; sandstone overlying mudstone.

l) Seep from jointed sandstone outcrop in road cutting. Near clay infill bedded shear in cutting (see Figure 4).

m) Recent slump in road cutting. Slump has undercut tree in face of cutting.

4.2.3 Sub-Surface Conditions

Subsurface conditions were investigated via inspection of soil and cuttings retrieved from boreholes established using hand held soil augers and inspection of exposed cuttings both on and near site.

- The natural soil profile is between 500-1200mm thick.

- Natural soils consist of very low plasticity clayey SILT overlying medium to high plasticity mottled, silty CLAY and CLAY with trace fine grained sand and varying degrees of pebble sized, round to sub-angular highly weathered sandstone rock fragments.

- Below a prominent break in slope above the Morley Avenue road cutting at the eastern end of the property, clay development in the soil profile is completely lacking. The profile consists of deep (600-800mm deep) clayey to sandy SILT. This profile is interpreted to be a combination of a young soil development and transported soils which have accumulated post landslide activity and subsequent striping of the residual soil.

- Bedrock was encountered between 500-1200mm below surface varying between low strength extremely to highly weathered laminated mudstone and low strength extremely to highly weathered sandstone. Sandstone bedrock at the surface seems to exist as a veneer overlying a thick mudstone unit. The sandstone is thicker towards the east where is exposed in the Morley Avenue road cutting. In this location the sandstone is highly weathered to a depth of 400-600mm Depth to bedrock is expected to be variable across the site. Mudstone drilled in BH1 is extremely weathered and of very low strength to a depth of 1500mm below surface and highly weathered to a depth of 2900mm below surface. Strength appears to increase gradually with depth below 1500mm. Moderately weathered mudstone of medium strength was encountered at a depth of 4400mm below surface.

- In the road cutting above Morley avenue at the east end of the property there is a 40-50mm wide moist to very moist, soft to very soft clay seam. The clay seam is concurrent with bedding and is inferred to be a bedding parallel fault or bedded shear.

- The underlying geology encountered is consistent with that of the Lower Cretaceous Eumeralla Formation referenced in published geological maps and confirmed by drilling.

- The composition of the upper soil layers indicates the natural soils are interpreted as a belonging to a young residual profile having formed in-situ following historical striping of existing residual soils and deepening of the weathering profile.

Full subsurface descriptions can be observed in the logs for Test Sites 1-5 in Appendix IV.

Borehole locations are provided in Figure 3.

4.2.4 Geological Structure

Geological mapping of outcrop exposures and cuttings near site was undertaken to establish geological structure.

- Bedrock structure was observed in the Morley Avenue road cutting at the eastern end of the property. Bedrock strata dip at 16° toward a dip direction varying between 137° and 157° (Dip/D'Dir: 16°/137° and 16°/157°) and with a plunge of 5° towards the east. The dip direction is perpendicular with the site's slope aspect in the northern and eastern parts of the property and parallel with the site's slope aspect in the south-west of the property. Bedrock dips at a steeper to sub-parallel angle to the overall slope angle where dip direction and slope aspect are concurrent.

- Approximately 50m to the north bedrock strata dips between 13° and 24° towards 95°. Bedding structure at the subject site has been dragged to the south-west.

- Discontinuity development is related to flexural slip on open anticlinal folds and gentle monoclines typical of the regional structure of the Otway Ranges. Bedding plane shears, conjugate diagonal shear joints and open, longitudinal and traverse joints are common.
- The orientation of discontinuities such as jointing and faulting were observed during this investigation in the road cutting at the eastern end of the property. Three prominent joints sets were observed. One dipping 80° towards 330° (longitudinal joint set), a second dipping 80° towards 60° (traverse joint set) and a third dipping 55° towards 211° (diagonal shear joint set).
- A clay seam embedded in sandstone outcropping in Morley Avenue is concurrent with bedding as is most likely a bedding plane shear, shearing in the same direction as the bedding dip direction (137-157°).
- Discontinuities and the abrupt change in dip and dip direction in the bedding structure is interpreted to be the result of possible left lateral thrust slip on a fault proximal to the bend in Morley Avenue (refer to Figure 1). Faulting has most likely occurred over a zone of shearing (100-200m wide or more) rather than along a discrete fault plane.

4.2.5 Groundwater Conditions

- Soil conditions were generally considered moist to slightly moist. Very moist sub-surface conditions were observed in BH4.
- Distinct mottling was observed throughout clayey subsoil suggesting surface water infiltration and periodic seepage of shallow groundwater through the profile.
- A "perched water table" often develops in the soil layers after prolonged wet periods form surface water infiltrating the soil profile. Such a perched water table can prove problematic on many sites if construction is commenced after wet periods and deep excavations may collapse without warning.
- Perched groundwater was observed in BH4 established during this investigation. This may be the result of concentrated surface water infiltration resulting from poor drainage conditions up slope and form the adjoining property.
- Groundwater seeps were observed discharging from the exposed cutting above Morley Avenue at the eastern end of the property. It is common for groundwater to seep from open joints and bedding shears in cuttings in Wye River.
- Regional groundwater exists as fractured aquifers throughout the Otway Group sediments of the Otway Ranges within fractures, open joints and discontinuities as well as between bedding layers of less weathered rock throughout the Otway Group bedrock strata. Seeps and discharging groundwater are often seen discharging out of steep rock cliffs and road cuttings such as the Great Ocean Road. Fractured rock groundwater can influence rock failures and create excavation hazards if encountered during deep excavations.

4.2.6 Existing Retaining Walls, Excavations, Embankments, Cuts/Fills

- Existing retaining walls include a dry stone wall supporting part of the site access located across the southern end of the property. The retaining wall is in poor condition and loose stones are becoming detached.
- Timber retaining walls also exist east of the existing dwelling (including several for wastewater terraces), below the water tank west of the existing garage and behind the existing dwelling inside a pre-existing site excavation. The retaining walls below the water tank and behind the existing dwelling show some signs of distress.
- Existing site cuts include a low (400-1000mm high) 20-25m long batter located along a site access road entering the property from the north-west. The cutting is typically battered between 54° and 69° unsupported although there are no obvious signs of instability.
- The existing driveway entering the site form the south also hosts an unsupported cut batter ranging in height from 400mm to 1300mm high. The face of the cutting slopes at around 64°. Several small slumps have occurred along this cutting.
- The road cutting above Morley Avenue is up to 3500mm high and slopes between 46° and 51°. A recent failure in this cutting has undermined a tree growing from the face.

4.2.7 Existing Vegetation

- This site has not suffered the fire damage that many other properties located in the north of Wye River did in December 2015. Vegetation coverage is good including a thick covering of grass, numerous shrubs, trees and landscaped gardens spread across the site. The eastern end of the property is covered in thick vegetation including large native trees.

4.2.8 Features of Adjacent Sites

- Adjacent lots to the north and south are developed and contain existing dwellings.
- Vegetation coverage is thick in all directions.
- An identifiable landslide scarp is located on the property immediately north of the subject site. The head scarp likely crosses the subject site in line with a major convex break in slope.
- Morley Avenue is well known for recent landslide activity including documented rock and debris slides during the 1960's to 1990's.

4.3 SUMMARY of GEOLOGICAL MODEL

- Considering the geomorphology of the site and the surrounding area, the geological model formed implies that the soil profile on site has formed predominately from in-situ weathering of the mudstone bedrock with a young, partly transported soil profile developing below an historical landslide scarp.

- The soil profile is between 500-1200mm thick, overlying extremely to highly weathered mudstone covered in part by a veneer of extremely weathered to highly weathered sandstone.

- Bedrock structure was observed in the Morley Avenue road cutting at the eastern end of the property. Bedrock strata dip at 16° toward a dip direction varying between 137° and 157° (Dip/D'Dir: 16°/137° and 16°/157°) and with a plunge of 5° towards the east. The dip direction is perpendicular with the site's slope aspect in the northern and eastern parts of the property and parallel with the site's slope aspect in the south-west of the property. Bedrock dips at a steeper to sub-parallel angle to the overall slope angle where dip direction and slope aspect are concurrent.

- A clay seam embedded in sandstone outcropping in Morley Avenue is concurrent with bedding as is most likely a bedding plane shear, shearing in the same direction as the bedding dip direction (137-157°).

- Discontinuities and the abrupt change in dip and dip direction in the bedding structure is interpreted to be the result of possible left lateral thrust slip on a fault proximal to the bend in Morley Avenue (refer to Figure 1). Faulting has most likely occurred over a zone of shearing (100-200m wide or more) rather than along a discrete fault plane.

- The local ground models for landslide hazards involves shallow rotational earth slides, shallow translational earth slides and earth flows, shallow and deep seated translational rock slides and local failures in cuttings and fill slopes.

D17/101942

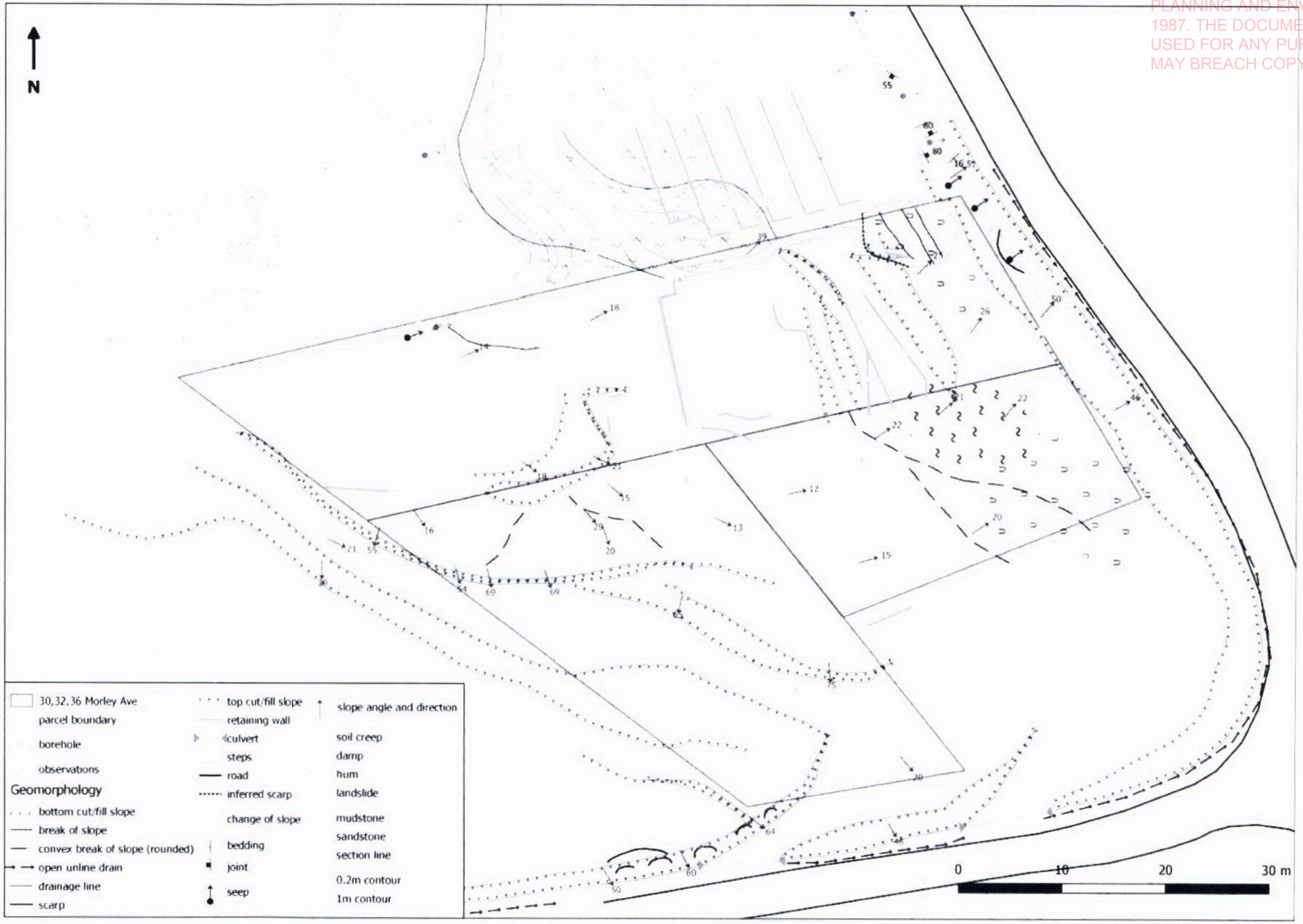


Figure 3: Engineering Geology and Geomorphology of 30, 32, 36 Morley Avenue.

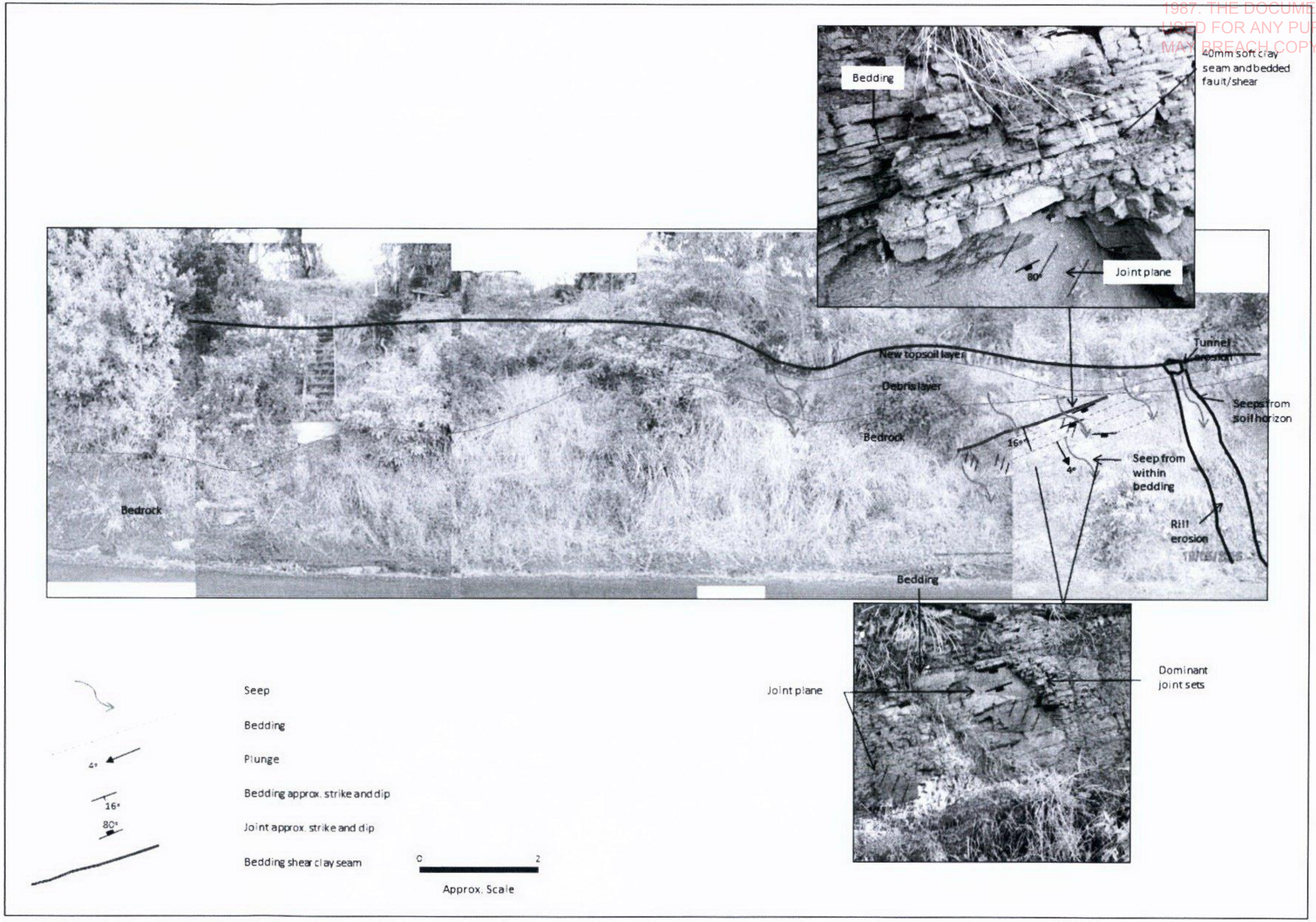


Figure 4: Long-section E and Test Site 5

D17/101942

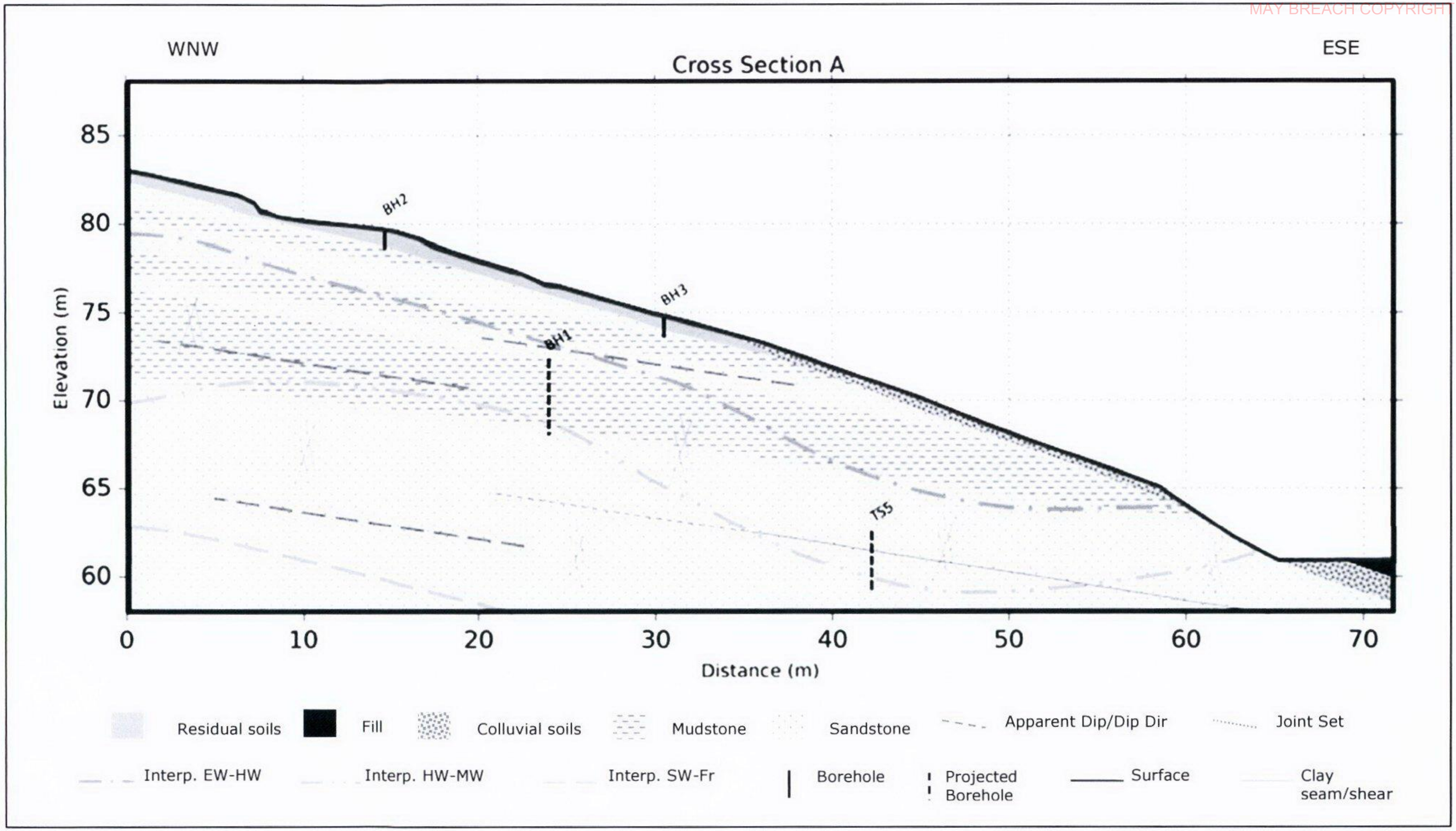


Figure 5: Cross-section A representing the local geological model

D17/101942

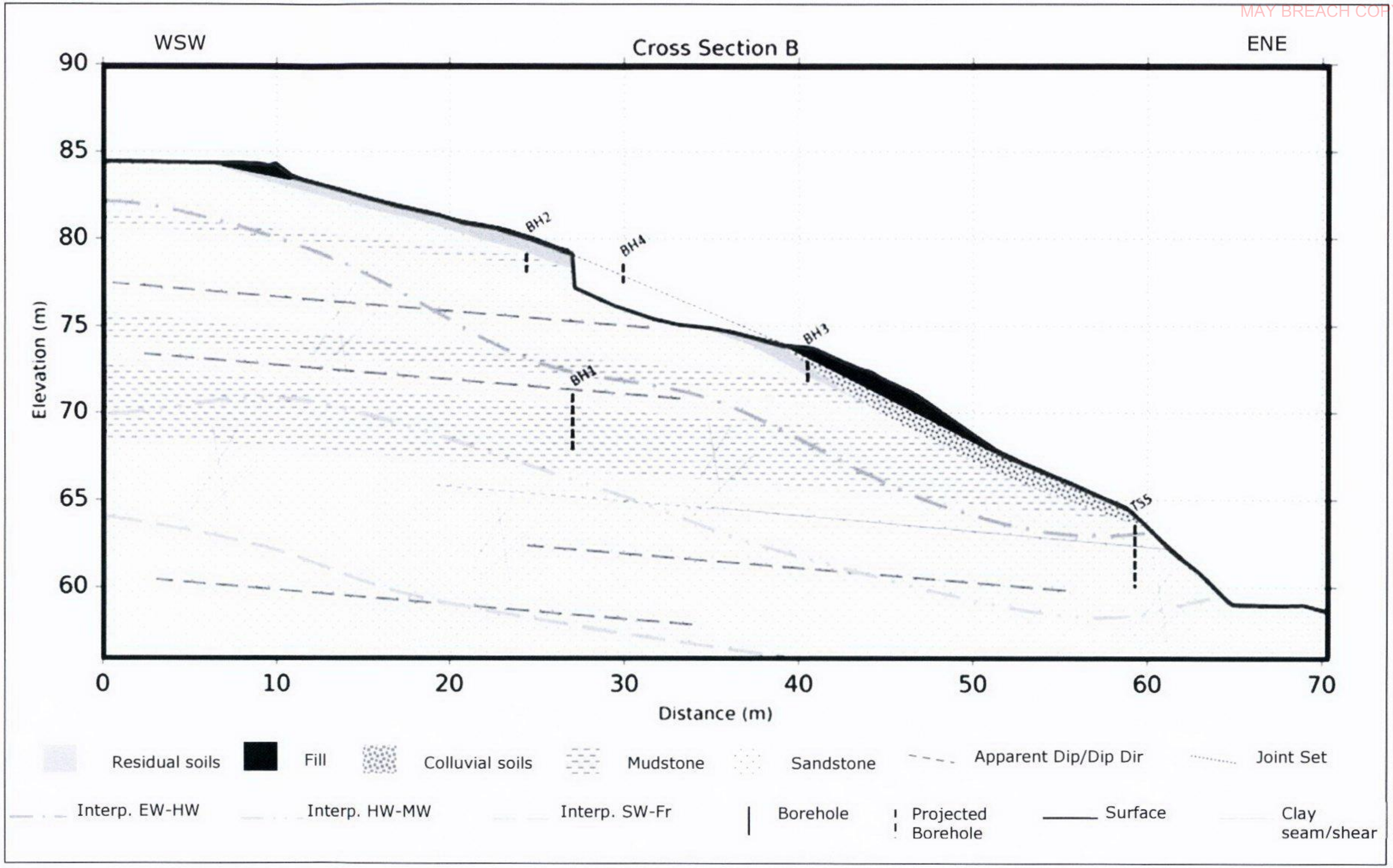


Figure 6: Cross-section B representing the local geological model

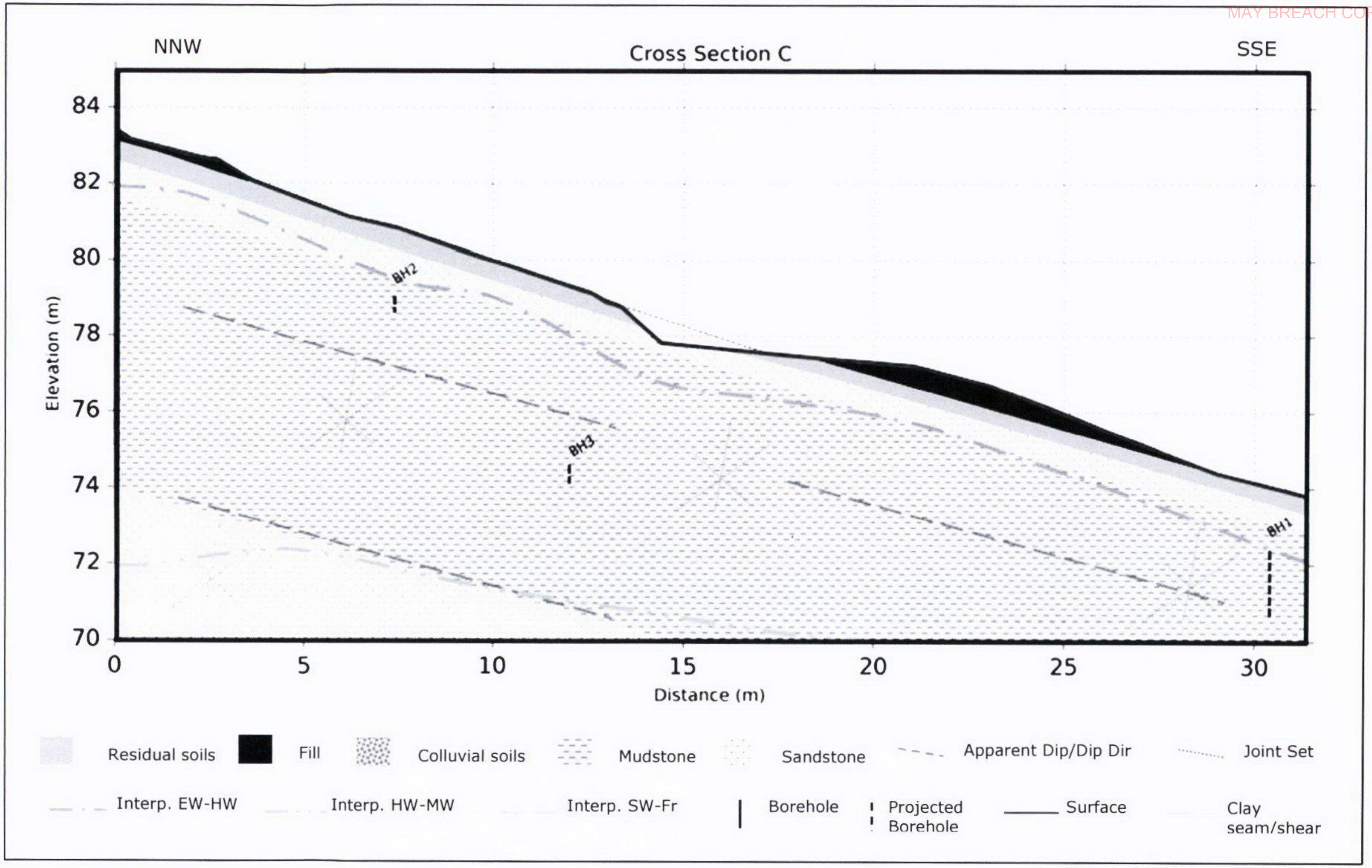


Figure 7: Cross-section C representing the local geological model

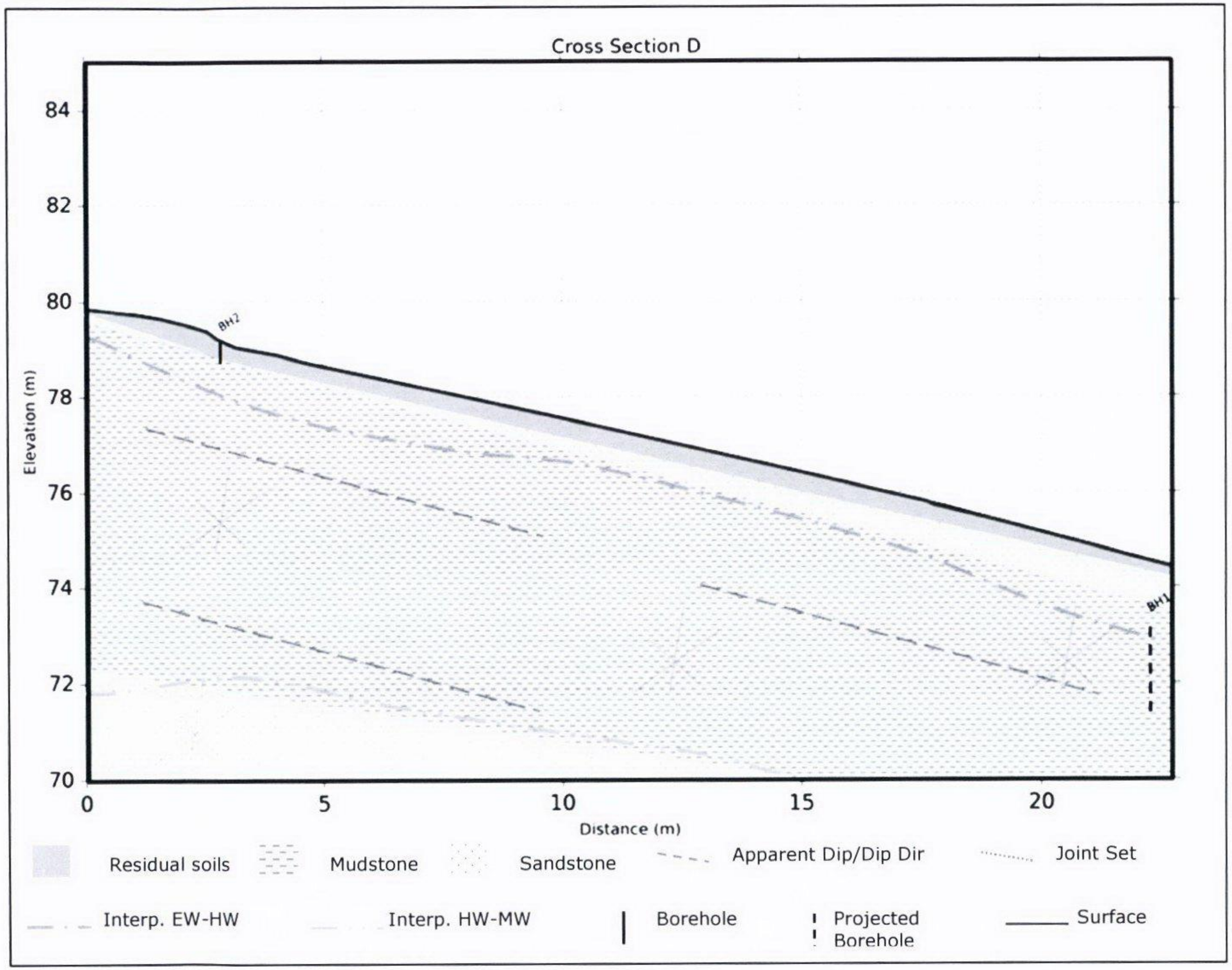


Figure 8: Cross-section D representing the local geological model

4.4 HAZARD IDENTIFICATION

The following **possible** hazards which **may** affect the subject site are:

HAZARD A. SMALL, LOCAL FAILURE OF CUTTING BEHIND DWELLING
HAZARD B. SHALLOW TRANSLATIONAL EARTH SLIDE BEHIND DWELLING
HAZARD C. SHALLOW ROTATIONAL EARTH SLIDE BENEATH DWELLING
HAZARD D. SHALLOW TRANSLATIONAL EARTH SLIDE-EARTH FLOW BELOW DWELLING
HAZARD E. SMALL TRANSLATIONAL ROCK SLIDE BELOW DWELLING
HAZARD F. DEEP SEATED TRANSLATIONAL ROCK SLIDE BENEATH DWELLING
HAZARD G. FAILURE OF FILL PAD BENEATH STUDIO
HAZARD H. LOCALISED FAILURE OF CUTTING ABOVE MORLEY AVENUE
HAZARD I. SHALLOW TRANSLATIONAL EARTH SLIDE BENEATH STUDIO
HAZARD J. SHALLOW ROTATIONAL EARTH SLIDE BELOW STUDIO
HAZARD K. SMALL, LOCAL FAILURE OF CUTTING ABOVE DRIVEWAY
HAZARD L. LOCALISED ROCK SLIDE/ROCK FALL FAILURE OF CUTTING BENEATH DWELLING

Hazard A. Small, local failure of cutting behind dwelling

- Very small, localized, shallow, slope rotational debris slide or slump (0.5-1m deep, 1-2m wide, and 0.5-1 m high). Approximately 2m long run out distance. Estimated volume range of sliding mass between $0.25m^3$ and $2m^3$.
- Relevant to all exposed excavated surface areas relating to proposed sites cuts for the proposed dwelling and sub-basement. Hazards A and A_1 of Figures 9-12.
- Fast moving, instantaneous failure.
- Residual soil profile with moderate to low internal friction angles and low drained effective cohesion. Variable undrained shear strength.
- Mechanism for failure: Rotational slumping related internal shearing of poorly cohesive soils within a weakened or fully softened shear plane with low shear strength. Induced by high cut angle exceeding friction angle of soils.
- Triggered: Gravity, high cut angle and heavy to extreme rainfall increasing pore water pressure due to high surface infiltration and surface run off and seeping groundwater.

Hazard B. Shallow translational earth slide behind dwelling

- Shallow (0.5-1m deep), wide (5-10m wide), translational earth slide of residual soils. Length of area affected 5-10m long. Estimated volume range of sliding mass between $12.5m^3$ and $100m^3$.
- Failure may develop quickly or very slowly. Movement likely to be slow to fast in a single event. Horizontal displacement may be expected up to 1m.
- Mechanism for failure: Sliding along a fully softened plane of weakness which may develop where a well-defined competency contrast exists between residual soils and underlying weathered bedrock.
- Trigger: Induced by stress release on the slope and rebound of new cutting in conjunction with prolonged, above average rainfall resulting in groundwater through flow or seepage along soil/rock interface developing a softened plane of weakness and preferential slip

surface. May also be triggered by earthquake. May become fluid if trigger is earthquake or if slide is impacted by high volume, high velocity run off and surface flow.

Hazard C. Shallow rotational earth slide beneath dwelling

- Small, rotational debris slide (0.5-1 deep, 5-7m wide, and 5-10 m long). May move up to 1m. Estimated volume range of sliding mass between 12.5m^3 and 70m^3.
- Fast moving, instantaneous failure with rotation and toe bulge.
- Residual silty CLAY profile with moderate to low friction angles and low drained effective cohesion. Moderate to variable undrained shear strength.
- Mechanism for failure: Rotational sliding related internal shearing of cohesive, unconsolidated, moderate to low shear strength clay.
- Trigger: Increasing pore water pressure due to seeping groundwater and surface water infiltration from prolonged heavy rainfall.

Hazard D. Shallow translational earth slide-earth flow below dwelling

- Shallow (0.5-0.8m deep), wide (5-10m wide), translational earth slide of young transported soils. Length of area affected 10-20m long. Estimated volume range of sliding mass between 25m^3 and 160m^3.
- Failure may develop quickly. Movement fast to rapid in a single event. Has potential to develop into an earth-debris flow. Horizontal displacement may be expected up to 10's of meters with 10-15m run out distance.
- Mechanism for failure: Initial sliding along a fully softened plane of weakness which may develop where a well-defined competency contrast exists between residual soils and underlying weathered bedrock. Potential to become fluid and flow down slope after initial sliding failure.
- Trigger: Extreme rainfall and high volume, high velocity run off and surface flow. Increased pore water pressure and softening and lubricating debris/rock interface from surface infiltration and shallow through flow. May also be triggered by earthquake. May become fluid if trigger is earthquake or if slide is impacted by high volume, high velocity run off and surface flow.

Hazard E. Small translational rock slide below dwelling

- Small size, translational rock slide within rock mass.
- Deeper (2-3m deep), wide (5-10m wide), translational rock slide. Length of area affected up to 10m long. Estimated volume range of sliding mass between 100m^3 and 300m^3.
- Failure may develop quickly or very slowly. Movement likely to be moderately fast to rapid in a single event. Initial horizontal displacement may be 1cm up to 1m.
- Mechanism for failure: Sliding along rock mass discontinuities.
- Trigger: Prolonged heavy, soaking rainfall resulting in excessive groundwater recharge and groundwater seepage along and within rock mass structures and discontinuities especially

within infilled open joints and shears at lithological contacts. Also large scale seismic activity and earthquakes.

Hazard F. Deep seated translational rock slide beneath dwelling

- Medium size, translational rock slide within rock mass.
- Deeper (5-10m deep), wide (10-30 wide), translational rock slide. Length of area affected may range from 5m up to 40m long. Estimated volume range of sliding mass between 250m^3 and 12000m^3.
- Failure may develop quickly. Movement likely to be slow to moderately fast in a single event. Initial horizontal displacement may be 1cm up to 1m.
- Mechanism for failure: Sliding along rock mass discontinuities (F. Figure 9) and sliding along clay infilled bedding plane shear within lower sandstone unit (F_1 Figure 10. Release mechanism related to interconnecting vertical discontinuities.
- Trigger: Prolonged heavy, soaking rainfall resulting in excessive groundwater recharge and groundwater seepage along and within rock mass structures and discontinuities especially within the clay infilled. Also large scale seismic activity and earthquakes.

Hazard G. Failure of fill pad beneath studio

- Small, rotational slope or toe earth slide or slump.
- Very small, localized, shallow, slope rotational debris slide or slump (0.5-1m deep, 2-3m wide, and 1-2 m high). Approximately 2-5m long run out distance. Estimated volume range of sliding mass between 1m^3 and 6m^3.
- Mechanism for failure: Rotational slumping related internal shearing of poorly compacted, unconsolidated fill soils with low undrained shear strength.
- Triggered: Triggered by heavy rainfall and increased soil moisture due to seeping or perched groundwater; influenced by over steep batter angles.

Hazard H. Localised failure of cutting above Morley Avenue

- Very small, localized, shallow, slope rotational debris slide or slump (0.5-1m deep, 1-2m wide, and 0.5-1 m high). Approximately 2m long run out distance. Estimated volume range of sliding mass between 0.25m^3 and 2m^3.
- Fast moving, instantaneous failure.
- Unconsolidated young transported soil profile with low internal friction angles and low drained effective cohesion. Variable undrained shear strength.
- Mechanism for failure: Rotational slumping related internal shearing of poorly cohesive soils within a weakened or fully softened shear plane with low shear strength. Induced by high cut angle exceeding friction angle of soils.
- Triggered: Gravity, high cut angle and heavy to extreme rainfall increasing pore water pressure due to high surface infiltration and surface run off and seeping groundwater.

Hazard I. Shallow translational earth slide beneath studio

- Deeper (0.5-1m deep), wide (15-20m wide), translational earth slide of young residual soils. Length of area affected 10-15mm long. Estimated volume range of sliding mass between 75m^3 and 300m^3.
- Failure may develop quickly or very slowly. Movement likely to be slow to fast in a single event. Horizontal displacement may be expected up to 1-5m.
- Mechanism for failure: Sliding along a fully softened plane of weakness which may develop where a well-defined competency contrast exists between residual soils and underlying weathered bedrock.
- Trigger: Prolonged soaking high volume rainfall resulting in groundwater through flow or seepage and surface water infiltration increasing pore water pressure, and softening and lubricating debris/rock interface. May also be triggered by earthquake. May become fluid if trigger is earthquake or if slide is impacted by high volume, high velocity run off and surface flow.

Hazard J. Shallow rotational earth slide below studio

- Small, rotational earth slide (0.5-1 deep, 5-10m wide, and 5-10 m long). May move up to 1m. Estimated volume range of sliding mass between 12.5m^3 and 100m^3.
- Fast moving, instantaneous failure with rotation and toe bulge.
- Residual silty CLAY profile with moderate to low friction angles and low drained effective cohesion. Moderate to variable undrained shear strength.
- Mechanism for failure: Rotational sliding related internal shearing of cohesive, unconsolidated, moderate to low shear strength clay.
- Trigger: Increasing pore water pressure due to seeping groundwater and surface water infiltration from prolonged heavy rainfall.

Hazard K. Small, local failure of cutting above driveway

- Very small, localized, shallow, slope rotational debris slide or slump (0.5-1m deep, 1-2m wide, and 0.5-1 m high). Approximately 2m long run out distance. Estimated volume range of sliding mass between 0.25m^3 and 2m^3.
- Relevant to all exposed excavated surface areas relating to existing sites cuts above the existing driveway.
- Fast moving, instantaneous failure.
- Residual soil profile with moderate to low internal friction angles and low drained effective cohesion. Variable undrained shear strength.
- Mechanism for failure: Rotational slumping related internal shearing of poorly cohesive soils within a weakened or fully softened shear plane with low shear strength. Induced by high cut angle exceeding friction angle of soils.
- Triggered: Gravity, high cut angle and heavy to extreme rainfall increasing pore water pressure due to high surface infiltration and surface run off and seeping groundwater.

Hazard L. Localised rock slide/rock fall failure of cutting beneath dwelling

- Very small, localized, rock slide and rock fall (0.2-1m^3). Approximately 0.5-2m long travel distance.
- Fast moving, instantaneous failure.
- Mechanism for failure: Sliding along open, softened infilled discontinuities or bedding planes. Falling of boulders detached from rock mass due to discontinuities such as open joints and shears.
- Triggered: Gravity, stress release on the slope and structural rebound of new cutting, high cut angle and heavy to extreme rainfall causing rapid infiltration into rock mass discontinuities.

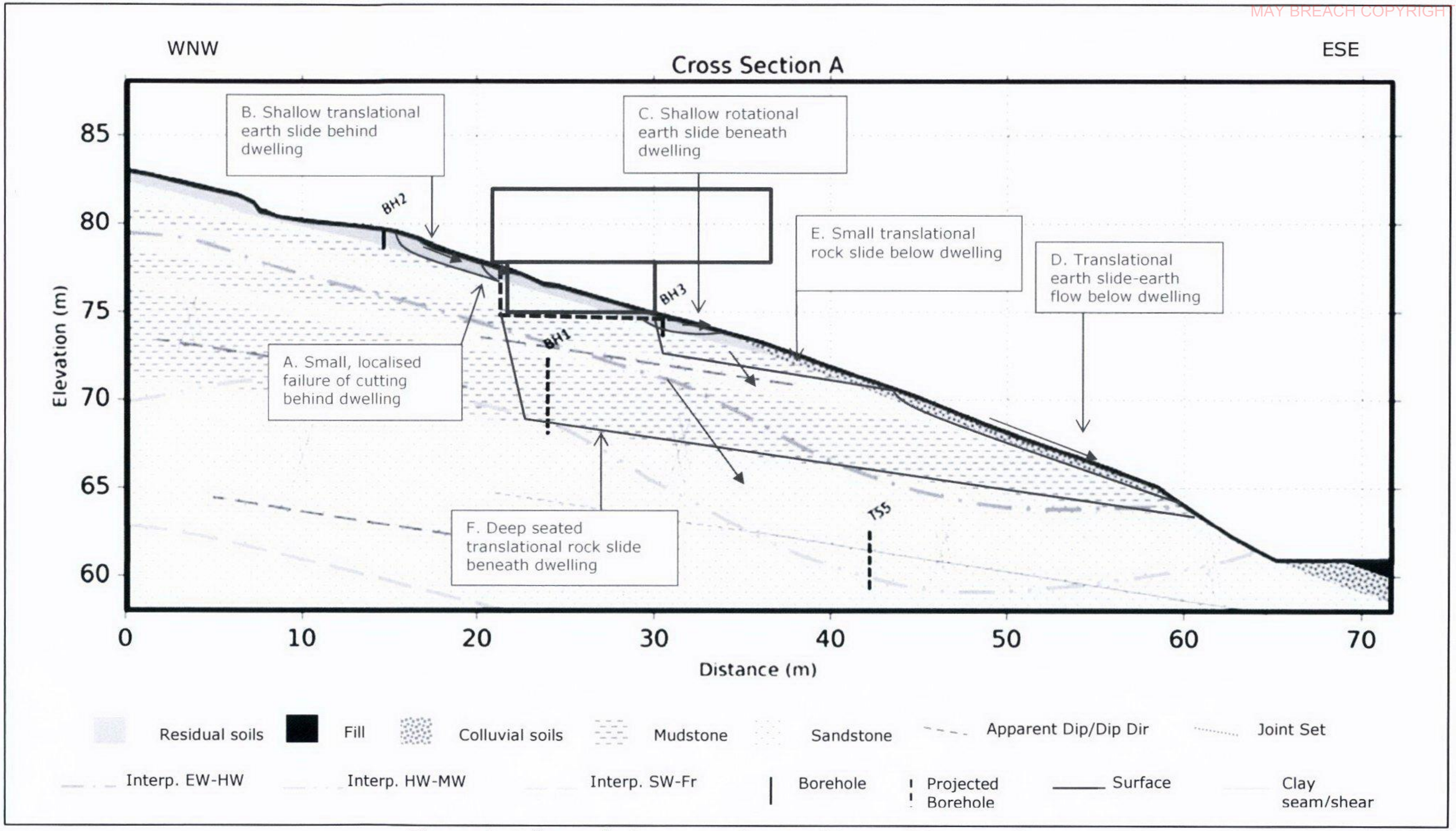


Figure 9: Schematic Cross-section A with possible hazards.

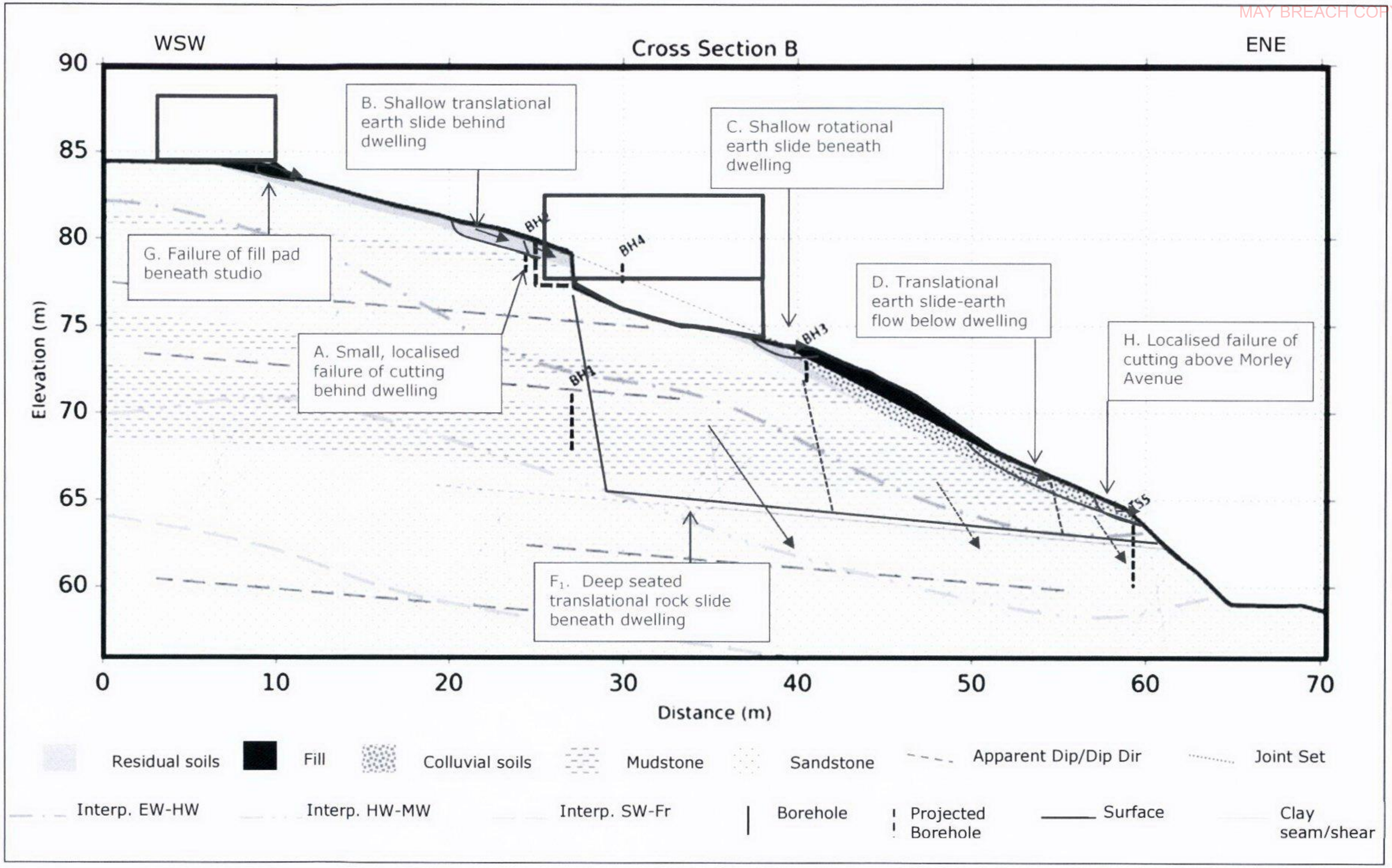


Figure 10: Schematic Cross-section B with possible hazards.

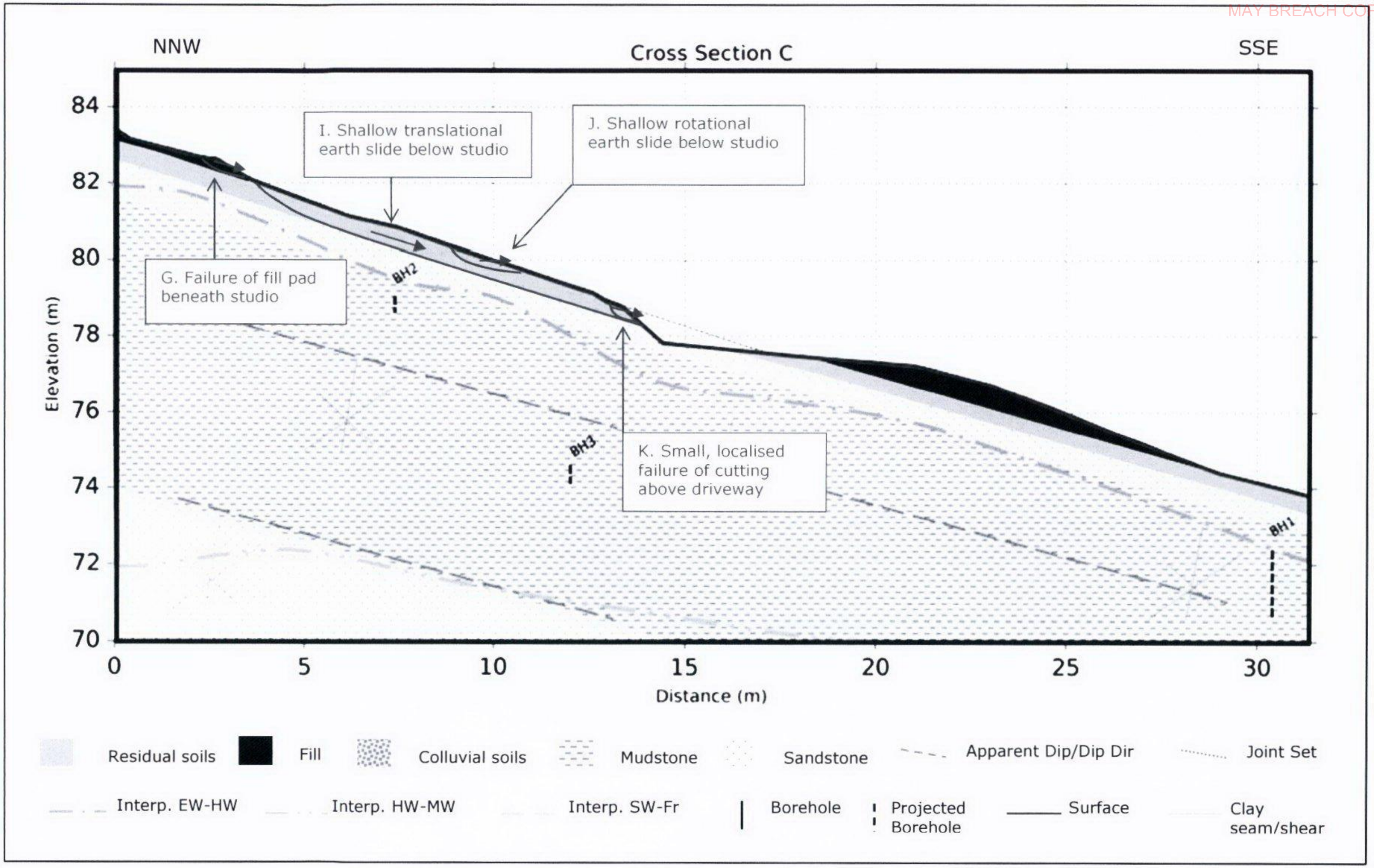


Figure 11: Schematic Cross-section C with possible hazards.

D17/101942

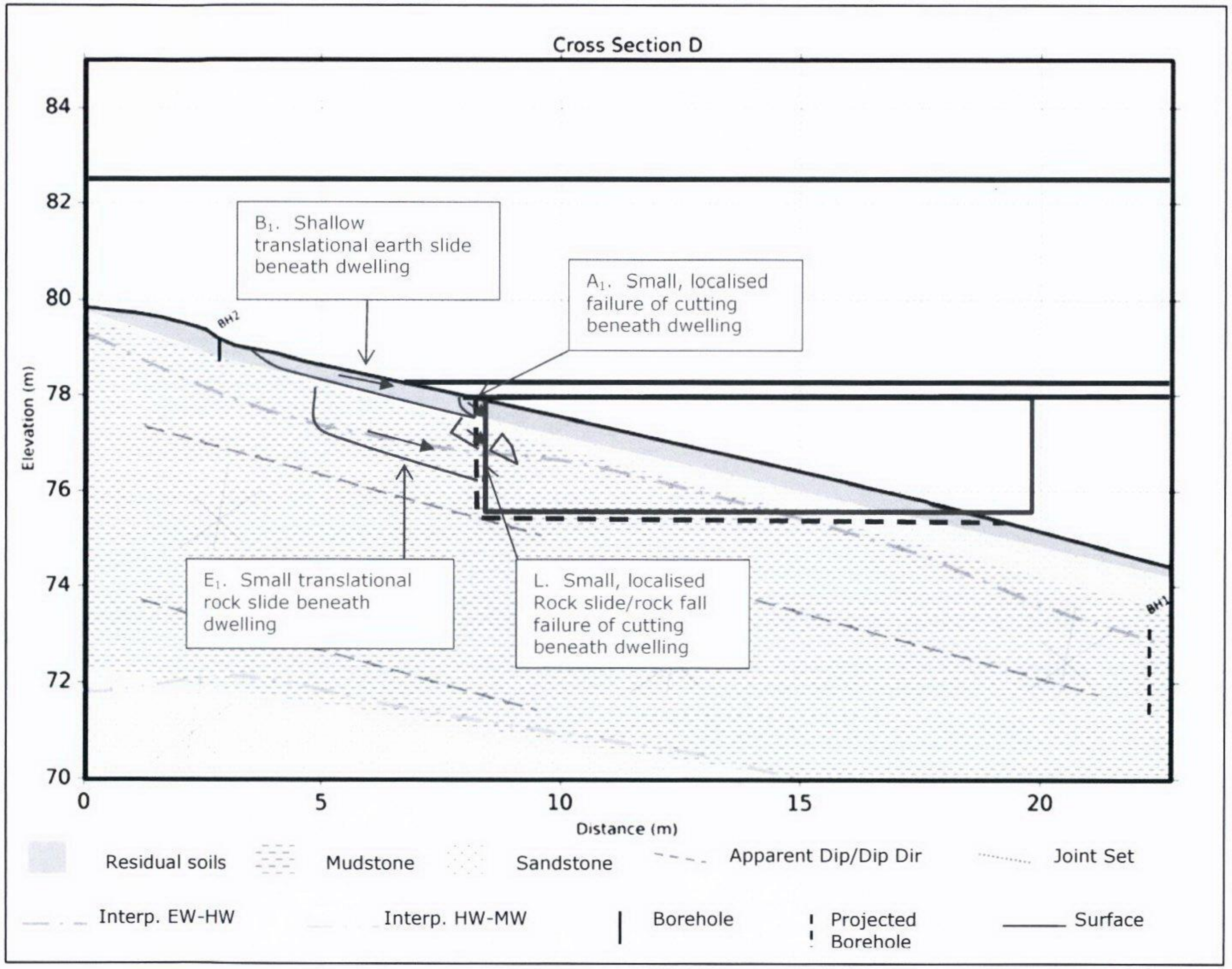


Figure 12: Schematic Cross-section D with possible hazards.

5.0 FREQUENCY ANALYSIS

In order to conduct a frequency analysis for each hazard the terminology in Appendix C of the AGS Guidelines (2007) has been adopted to carry out a qualitative assessment as to the *Frequency* or number of hazard events occurring over a given time period This is also referred to as the *Likelihood* which is the qualitative measure of frequency or probability of an event occurring subject to a quantified measure of belief.

Hazard A. Small, local failure of cutting behind dwelling

- Residual, sandstone derived, moderate plasticity, moderate friction angle, low shear strength soil (firm).
- Proposed sub vertical excavation.
- New cutting may induce stress release and rebound on slopes.
- Groundwater seepage not evident from existing cuttings or slope.
- Inappropriate concentrated surface flow and surface discharge from next door stormwater infrastructure
- Highly to moderately susceptible slopes, east and south facing, high rainfall area.
- Site has history of previous slope failures.
- Likelihood of occurring during design life: **ALMOST CERTAIN.**

Hazard B. Shallow translational earth slide behind dwelling

- Residual, silty CLAY soil profile, medium to high plasticity, moderate to low friction angle, low shear strength. Derived from both sandstone and mudstone parent lithology.
- Moderately steep natural slopes (12° to 18°).
- No signs of existing soil creep or hummocky features above proposed dwelling.
- Groundwater seepage not evident from existing cuttings or slopes.
- Inappropriate concentrated surface flow and surface discharge from next door stormwater infrastructure. Run on potential from up slope.
- Expected stress release and slope rebound from site cut. May induce fissuring or shearing is soils allowing surface water infiltration and groundwater seepage.
- Bedding planes and inferred discontinuities oblique or perpendicular to the slope angle and direction. Bedrock contact expected to be rough.
- Highly to moderately susceptible slopes, east and south facing, high rainfall area.
- Site has history of previous slope failures.
- **B1**: Likelihood of 10cm of movement in a single event: **LIKELY**
- **B2**: Likelihood of 1m of movement in a single event: **POSSIBLE**

Hazard C. Shallow rotational earth slide beneath dwelling

- Residual, silty CLAY soil profile, medium to high plasticity, moderate to low friction angle, low shear strength. Derived from both sandstone and mudstone parent lithology.
- Steep natural slopes below dwelling (20° to 22°).
- Major convex break in slope and history of previous slope failures. Translational slope failure in north-east corner of property probably active.
- Some run on potential. Surface water recharge catchment area located up slope.
- Groundwater seepage evident from Morley Avenue Cutting.
- Some existing evidence of active mechanisms such as soil creep.
- Highly susceptible slopes, east and south-east facing, high rainfall area.
- Static loading from new dwelling.
- Likelihood of occurring during design life: **LIKELY**

Hazard D. Translational earth slide-earth flow below dwelling

- Young transported, colluvial derived soil, low plasticity, moderate friction angle, low shear strength, poorly cohesive soil.
- Steep natural slopes (21° to 26°).
- Existing soil creep and prominent break in slope marking possible historical landslide.
- Groundwater seepage evident from Morley Avenue Cutting. High potential for stormwater run on.
- Below historical scarp line and recorded evidence of past shallow failures.
- Bedding planes and inferred discontinuities oblique or perpendicular to the slope angle and direction. Bedrock contact expected to be rough.
- Highly susceptible slopes, east and south-east facing, high rainfall area.
- Likelihood of occurring during design life: **LIKELY**

Hazard E. Small, translational rock slide below dwelling

- Bedrock bedding planes dip around 16° toward the south; dip and dip direction is perpendicular to oblique to slope orientation and slope angle.
- Intersecting orthogonal shear joint discontinuities may exist and vertical longitudinal and traverse joints may be open and have clay infill; observed joint spacing is close and the typical joint profile is planar, rough to smooth.
- Excavation may expose rock discontinuities to weathering and seepage. Bedrock may rebound from unloading of slope, opening discontinuities.

- Bedrock interpreted to consists of interbedded sandstone and mudstone subjected to shear deformation as a result of regional faulting.

- Thick brittle mudstone unit underlies thin sandstone unit. Bedding shears and faulting within at lithology contacts may provide preferential slip planes however the principle structure is perpendicular to slope direction. Movement would be oblique to slope.

- Residual bedrock structure not expected to be present in extremely weathered zone.

- Past seismic evidence suggests intraplate earthquakes are infrequent, off shore and of generally low magnitude in the Victorian coastal area. Probably requires an earthquake of high magnitude to initiate landslide.

- **E1**: Likelihood of 1cm of movement in a single event: **UNLIKELY**
- **E2**: Likelihood of 10cm of movement in a single event: **RARE**
- **E2**: Likelihood of 1m of movement in a single event: **BARELY CREDIBLE**

Hazard F. Deep seated translational rock slide beneath dwelling

- Bedrock bedding planes dip around 16° toward the south; dip and dip direction is perpendicular to oblique to slope orientation and slope angle.

- Intersecting orthogonal shear joint discontinuities may exist and vertical longitudinal and traverse joints may be open and have clay infill; observed joint spacing is close and the typical joint profile is planar, rough to smooth.

- 40mm clay infilled bedding plane shear exposed in sandstone outcrop in Morley Avenue road cutting.

- Excavation may expose rock discontinuities to weathering and seepage. Bedrock may rebound from unloading of slope, opening discontinuities.

- Bedrock interpreted to consists of interbedded sandstone and mudstone subjected to shear deformation as a result of regional faulting.

- Thick brittle mudstone unit underlies thin sandstone unit. Bedding shears and faulting within at lithology contacts may provide preferential slip planes however the principle structure is perpendicular to slope direction. Movement would be oblique to slope.

- Past seismic evidence suggests intraplate earthquakes are infrequent, off shore and of generally low magnitude in the Victorian coastal area. Probably requires an earthquake of high magnitude to initiate landslide.

- **F1**: Likelihood of 1cm of movement in a single event: **POSSIBLE**
- **F2**: Likelihood of 10cm of movement in a single event: **UNLIKELY**
- **F2**: Likelihood of 1m of movement in a single event: **RARE**

Hazard G. Failure of fill pad beneath studio

- Locally derived cohesive fill soils. Poorly compacted, variable shear strength and fiction angles.

- Acceptable existing batter angles (18° to 21°). No signs of existing or past batter failures.

- Some run on potential.

- Static loading from new dwelling.

- Likelihood of occurring during design life: **UNLIKELY**

Hazard H. Localised failure of cutting above Morley Avenue

- Exposed young transported soils and highly to moderately weathered heavily jointed bedrock.
- Groundwater seepage evident from Morley Avenue Cutting.
- Soil portion of cutting over steep (50°)
- Recent slump in cutting and undermining of existing tree.
- Highly to moderately susceptible slopes, east and south facing, high rainfall area.
- Site has history of previous slope failures.
- Likelihood of occurring during design life: **ALMOST CERTAIN.**

Hazard I. Shallow translational earth slide beneath studio

- Residual, mudstone derived silty CLAY soil, medium to high plasticity, moderate to low friction angle, moderate to low shear strength.
- Steep natural slopes (16° to 29°).
- No existing soil creep or recent slope failures. Historical slope failures elsewhere on site.
- Groundwater seepage not evident from existing cuttings or slopes.
- Minor distress in existing dry stone retaining wall.
- Bedding planes and inferred discontinuities parallel to the slope angle and direction. Bedrock of bedrock is out of the slope on the southern side of the property. Dip Slope. Bedrock contact expected to be planar and rough.
- Highly susceptible slopes, south facing, high rainfall area.
- Likelihood of occurring during design life: **POSSIBLE**

Hazard K. Small, local failure of cutting behind dwelling

- Residual, mudstone derived silty CLAY soil, medium to high plasticity, moderate to low friction angle, moderate to low shear strength.
- Proposed sub vertical excavation.
- Existing cutting with minor evidence of distress and very small failures.
- Groundwater seepage not evident from existing cuttings or slope.
- Run on over cutting face from up slope.
- Highly to moderately susceptible slopes, south facing, high rainfall area.

- Likelihood of occurring during design life: **ALMOST CERTAIN.**

Hazard L. Small, localised rock slide failure of cutting beneath dwelling

- Proposed sub-vertical excavation up to 2.9m high.
- Cutting into soil and bedrock.
- Dip slope with bedrock structure sub-parallel to natural slope angle. Bedding to dip out of the cut face.
- Cutting may expose clay infilled bedding plane shears within mudstone.
- Discontinuities in mudstone not determined, but local structure suggests open vertical and horizontal joints are not uncommon and at least 3 sets of longitudinal, traverse and diagonal shear joints related to regional tectonic deformation are expected.
- Groundwater seeps observed in Morley Avenue cutting inferring groundwater recharge and through flow in upper weathered rock mass.
- Likelihood of occurring during design life: **ALMOST CERTAIN**

6.0 CONSEQUENCE ANALYSIS

6.1 CONSEQUENCE TO PROPERTY

Consequence to property considers the potential damage and cost of the damage to the element at risk. This is done in relation to characteristics of the particular hazard such as the volume of the landslide, the position of the element at risk, the magnitude of the displacement of the landslide and the rate of movement of the landslide. Consequence has been evaluated qualitatively using the terminology in Appendix C of the AGS Guidelines (2007) and is summarised in Table 3 and Table 4.

6.2 CONSEQUENCE TO LIFE

Consequence to life is evaluated quantitatively by considering the vulnerability ($V_{(D:T)}$) of the individual impacted by the landslide hazard. The *Vulnerability* of the individual may also be referred to as the likelihood of deaths or injury of the person subjected to the hazard.

Appendix F of the AGS Guidelines (2007) provides vulnerability values derived from data collected from studies of landslide events in Hong Kong, for a person in a building or in a vehicle. The relevant part of the study is reproduced below in Table 2:

Table 2: Hong Kong Vulnerability Recommended Values for Loss of Life

Case	**Range in Data**	**Recommended Value**	**Comments**
Person in a Vehicle If vehicle is buried/crushed	0.9 – 1.0	1.0	Death almost certain
If vehicle is damaged only	0 – 0.3	0.3	High chance of survival
Person in a Building 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

7.0 RISK ASSESSMENT

7.1 RISK ASSESSMENT TO PROPERTY

Based on the measurements and observations that we have made, the conclusions drawn by other researchers and using the procedure and terminology from the AGS Guidelines (2007), the risks to property (over the design life of a building – nominally 50 years) can be summarised for each of the events described above, as shown in Table 3 and Table 4.

For an explanation of terms used and an example of a risk analysis matrix, refer to the attached "Appendix C" of the AGS Guidelines (2007) provided in this report as Appendix VI.

Table 3: Risk Assessment for Property in Unmitigated Conditions

HAZARD		ELEMENT AT RISK	LIKELIHOOD	CONSEQUENCE	RISK TO PROPERTY
A	Small, local failure of cutting behind dwelling	Dwelling	ALMOST CERTAIN	MINOR	**HIGH**
A_1	Small, local failure of cutting beneath dwelling	Dwelling	ALMOST CERTAIN	MINOR	**HIGH**
B_1	Shallow translational earth slide behind dwelling with 10cm of movement	Dwelling	LIKELY	MINOR	**MODERATE**
B_2	Shallow translational earth slide behind dwelling with 1m of movement	Dwelling	POSSIBLE	MEDIUM	**MODERATE**
C	Shallow rotational earth slide beneath dwelling	Dwelling	LIKELY	MINOR	**MODERATE**
D	Shallow translational earth slide-earth flow below dwelling	Infrastructure; neighbouring property; Road	LIKELY	MEDIUM	**HIGH**
E_1	Small translational rock slide below dwelling with 1cm of movement	Dwelling	UNLIKELY	INSIGNIFICANT	**VERY LOW**
E_2	Small translational rock slide below dwelling with 10cm of movement	Dwelling	RARE	MINOR	**VERY LOW**
E_3	Small translational rock slide below dwelling with 1m of movement	Dwelling	BARELY CREDIBLE	MEDIUM	**VERY LOW**
F_1	Deep seated translational rock slide beneath dwelling with 1cm of movement	Dwelling; Infrastructure; neighbouring property	POSSIBLE	INSIGNIFICANT	**VERY LOW**
F_2	Deep seated translational rock slide beneath dwelling with	Dwelling; Infrastructure; neighbouring	UNLIKELY	MINOR	**LOW**

HAZARD		ELEMENT AT RISK	LIKELIHOOD	CONSEQUENCE	RISK TO PROPERTY
	10cm of movement	property			
F_3	Deep seated translational rock slide beneath dwelling with 1m of movement	Dwelling; Infrastructure; neighbouring property	RARE	MEDIUM	**LOW**
G	Failure of fill pad beneath studio	Studio	UNLIKELY	MINOR	**LOW**
H	Localised failure of cutting above Morley avenue	Road	ALMOST CERTAIN	MINOR	**HIGH**
I	Shallow translational earth slide below studio	Studio	POSSIBLE	MEDIUM	**MODERATE**
J	Shallow rotational earth slide below studio	Studio; Access	POSSIBLE	MINOR	**VERY LOW**
K	Small, local failure of cutting above driveway	Access	ALMOST CERTAIN	MINOR	**HIGH**
L	Small, localised rock slide failure of cutting beneath dwelling	Dwelling	ALMOST CERTAIN	MINOR	**HIGH**

Table 4: Risk Assessment for Property in Mitigated Conditions

HAZARD		ELEMENT AT RISK	MITIGATION MEASURES	LIKELIHOOD	CONSEQUENCE	RISK TO PROPERTY
A	Small, local failure of cutting behind dwelling	Dwelling	Retain excavation with engineer designed retaining wall either independently or as part of the building structure including with sub-surface drainage; Provide surface drainage above the crest of the proposed cutting.	RARE	MINOR	**VERY LOW**
A_1	Small, local failure of cutting beneath dwelling	Dwelling	As Above	RARE	MINOR	**VERY LOW**
B_1	Shallow translational earth slide behind dwelling with 10cm of movement	Dwelling	Retain proposed cutting with engineer designed retaining wall either independently or as part of the building structure and design wall for lateral earth pressures; revegetate slopes with deep rooted trees, shrubs and grasses; install sub-surface cut off or curtain above dwelling; provide surface drainage along northern property boundary to divert any run on from neighbouring property.	UNLIKELY	MEDIUM	**LOW**
B_2	Shallow translational earth slide behind dwelling with 1m of movement	Dwelling	As Above	UNLIKELY	MEDIUM	**LOW**
C	Shallow rotational earth slide beneath dwelling	Dwelling	Deepen footings into competent bedrock; provide engineer designed drainage around dwelling and ensure stormwater is discharged to municipal drainage infrastructure or to drain on Morley Avenue;	POSSIBLE	MINOR	**VERY LOW**

AGR

HAZARD		ELEMENT AT RISK	MITIGATION MEASURES	LIKELIHOOD	CONSEQUENCE	RISK TO PROPERTY
D	Shallow translational earth slide-earth flow below dwelling	Infrastructure; neighbouring property; Road	Deepen engineer designed footings into competent bedrock; provide engineer designed drainage around dwelling and ensure stormwater is discharged to municipal drainage infrastructure or to drain on Morley Avenue; install surface and subsurface drainage across the width of the down slope side of the proposed dwelling; Re-vegetate steep slopes with deep rooted trees and shrubs; avoid concentrated soil absorption waste water disposal methods; spread waste water as widely as possible; reduce waste water loading.	POSSIBLE	MEDIUM	**MODERATE**
E_1	Small translational rock slide below dwelling with 1cm of movement	Dwelling	Deepen engineer designed footings into competent bedrock; Engineer designed structural footing system tying footings together to minimise impact of differential movement provide engineer designed drainage around dwelling and ensure stormwater is discharged to municipal drainage infrastructure or to drain on Morley Avenue; Deepen footings for any waste water infrastructure into bedrock.	UNLIKELY	INSIGNIFICANT	**VERY LOW**
E_2	Small translational rock slide below dwelling with 10cm of movement	Dwelling	As above	RARE	MINOR	**VERY LOW**
E_3	Small translational rock slide below dwelling with 1m of movement	Dwelling	As above	BARELY CREDIBLE	MINOR	**VERY LOW**
F_1	Deep seated translational rock slide beneath dwelling with 1cm of movement	Dwelling; Infrastructure; neighbouring property	Provide engineer designed drainage around dwelling and ensure stormwater is discharged to municipal drainage infrastructure or to drain on Morley Avenue; Re-vegetate site with deep rooted trees and shrubs.	POSSIBLE	INSIGNIFICANT	**VERY LOW**

HAZARD		ELEMENT AT RISK	MITIGATION MEASURES	LIKELIHOOD	CONSEQUENCE	RISK TO PROPERTY
F_2	Deep seated translational rock slide beneath dwelling with 10cm of movement	Dwelling; Infrastructure; neighbouring property	As Above	UNLIKELY	INSIGNIFICANT	**VERY LOW**
F_3	Deep seated translational rock slide beneath dwelling with 1m of movement	Dwelling; Infrastructure; neighbouring property	As Above; engineer designed structural and footing system tying footings together to minimise impact of differential movement	RARE	MINOR	**VERY LOW**
G	Failure of fill pad beneath studio	Studio	Deepen engineer designed studio footings through fill and into competent bedrock; Maintain a safe shallow batter angle for fill slope; Vegetate fill slopes below studio with deep rooted trees, shrubs and grasses.	UNLIKELY	INSIGNIFICANT	**VERY LOW**
H	Localised failure of cutting above Morley avenue	Road	Remove undermined tree; batter soils to safe batter angle; revegetate soil embankment with grasses and shrubs	LIKELY	MINOR	**LOW**
I	Shallow translational earth slide below studio with movement up to 1m	Studio	Deepen engineer designed footings into competent bedrock; Retain proposed cutting with engineer designed retaining wall either independently or as part of the building structure and design wall for lateral earth pressures; revegetate slopes with deep rooted trees, shrubs and grasses; install sub-surface cut off or curtain above dwelling; provide surface drainage beneath proposed studio; design wastewater disposal to avoid concentrated soil absorption methods; spread wastewater as widely as possible and reduce loading rate; deepen footings for wastewater terraces to bedrock.	UNLIKELY	MEDIUM	**LOW**
J	Shallow rotational earth slide below studio	Studio; Access	As above	UNLIKELY	MINOR	**LOW**

HAZARD		ELEMENT AT RISK	MITIGATION MEASURES	LIKELIHOOD	CONSEQUENCE	RISK TO PROPERTY
K	Small, local failure of cutting above driveway	Access	Retain proposed cutting with engineer designed retaining wall either independently or as part of the building structure	RARE	MINOR	**VERY LOW**
L	Small, localised rock slide failure of cutting beneath dwelling	Dwelling	Retain proposed cutting with engineer designed retaining wall either independently or as part of the building structure; inspect fresh cutting for loose or detached boulders; remove or scale any loose or detached boulders prior to continuing building works; engineering geologist to inspect cutting for discontinuities and bedding plane shears in exposed mudstone.	UNLIKELY	MINOR	**LOW**

7.2 RISK ASSESSMENT TO LIFE

The AGS guidelines (2007) recommend that the risk of loss of life be calculated quantitatively to ensure that the value obtained does not exceed the value of "TOLERABLE RISK" which is defined as "the risk that society can live with" and has a value defined by Schedule 1 to the Otway Ranges Shire EMO as 10^{-5} per annum (a reassurance interval of 1 in 100, 000).

The quantitative risk for 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. Results of the calculations are documented in Table 5.

7.2.1 Explanation of quantitative risk to life calculations

The values presented in the Table 5 are summed to achieve the estimated risk to life shown "R" in the table. Note that these calculations refer to an individual inside the building; the risks to a person outside have not been considered.

P(T:S) is calculated with respect to a person in a building as follows:

Annual occupancy of the dwelling: 6/12 months
Daily occupancy of the dwelling 20/24 hours
Building affected by the event: 1 (or 0.5 for part of the building)
Location of individual in the part of the building: 1/4
Location of individual in the residence if the building collapses: 1

Where part of the building is affected by the event, the calculation for P(T:S) is:
P(T:S) = 6/12 x 20/24 x 0.5 x 1/4 = **0.052 or 5.2 10^{-2}**

Where part of the building is affected by the event and that part collapses, P(T:S) is:
P(T:S) = 6/12 x 20/24 x 0.5 x 1 = **0.21 or 2.1 x 10^{-1}**

Where the whole building is affected by the event but doesn't collapse P(T:S) is:
P(T:S) = 6/12 x 20/24 x 1 x 1/4 = **0.10 or 1.0 x 10^{-1}**

Where the whole building is affected by the event and the house collapses P(T:S) is:
P(T:S) = 6/12 x 20/24 x 1 x 1= **0.42 or 4.2 x 10^{-1}**

P(T:S) is calculated with respect to a person in a vehicle belonging to the subject Site as follows:

Annual occupancy of the dwelling: 6/12 months
Daily occupancy of the vehicle (0.16/24) hours (5 min, 2 times a day)

P(T:S) = $0.5 \times 6.9 \times 10^{-3}$ = **3.45×10^{-3}**

P(T:S) is calculated with respect to a person in a vehicle passing the subject site along Morley Avenue as follows:

Number of Residences in south Wye River: 50
Annual occupancy of the dwelling: 6/12 months
Daily occupancy of the vehicle (5.6×10^{-3}/24) hours (10 sec, 2 times a day)

P(T:S) = $50 \times 0.5 \times 2.3 \times 10^{-4}$ = **5.75×10^{-3}**

A vulnerability value of 0 (zero) has been adopted for hazards that are not expected to impact any building or vehicle. We have adopted a P(S:H) value of 0.05 for the small or distal hazards, values of 0.1-0.5 for medium scale or intermediate distance failure events and values of 0.5-1.0 for the large scale failure event or a proximal hazard which could result in collapse or destruction of the building.

Table 5: Risk Assessment for Loss of Life in Unmitigated Conditions

Hazard		Element At Risk	Likelihood	P(H) Annual Probability	P(S:H) Spatial Impact Probability	Temporal Considerations	P(T:S) Temporal Probability	Vulnerability Comments	V(D:T) Vulnerability	R Loss To Life Annual Probability
A	Small, local failure of cutting behind dwelling	Dwelling	ALMOST CERTAIN	10^{-1}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	**2.1×10^{-4}**
A_1	Small, local failure of cutting beneath dwelling	Dwelling	ALMOST CERTAIN	10^{-1}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	**2.1×10^{-4}**
B_1	Shallow translational earth slide behind dwelling with 10cm of movement	Dwelling	LIKELY	10^{-2}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	**2.1×10^{-5}**
B_2	Shallow translational earth slide behind dwelling with 1m of movement	Dwelling	POSSIBLE	10^{-3}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building, not expected to collapse	0.4	**1.6×10^{-5}**
C	Shallow rotational earth slide beneath dwelling	Dwelling	LIKELY	10^{-2}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building, not expected to collapse	0.1	**4.2×10^{-5}**
D	Shallow translational earth slide-earth flow below dwelling	Vehicle	LIKELY	10^{-2}	0.8	10 sec exposure 2 times daily	0.00575	May fill or crush vehicle	0.8	**3.7×10^{-5}**

Hazard		Element At Risk	Likelihood	P(H) Annual Probability	P(S:H) Spatial Impact Probability	Temporal Considerations	P(T:S) Temporal Probability	Vulnerability Comments	V(D:T) Vulnerability	R Loss To Life Annual Probability
E_1	Small translational rock slide below dwelling with 1cm of movement	Dwelling	UNLIKELY	10^{-4}	0.2	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0	0
E_2	Small translational rock slide below dwelling with 10cm of movement	Dwelling	RARE	10^{-5}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building, not expected to collapse	0.1	4.2×10^{-8}
E_3	Small translational rock slide below dwelling with 1m of movement	Dwelling	BARELY CREDIBLE	10^{-6}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.21	Medium damage to the building, part may collapse	0.8	1.3×10^{-7}
F_1	Deep seated translational rock slide beneath dwelling with 1cm of movement	Dwelling	POSSIBLE	10^{-3}	1.0	Assume 20 hrs. occupancy per day for person most at risk; whole building affected	0.1	Minor damage to the building	0	0
F_2	Deep seated translational rock slide beneath dwelling with 10cm of movement	Dwelling	UNLIKELY	10^{-4}	1.0	Assume 20 hrs. occupancy per day for person most at risk; whole building affected	0.1	Medium damage to building, not expected to collapse	0.1	1.0×10^{-6}
F_3	Deep seated translational rock slide beneath dwelling with 1m of movement	Dwelling	RARE	10^{-5}	1.0	Assume 20 hrs. occupancy per day for person most at risk; whole building affected	0.21	Medium damage to the building, part may collapse	0.8	1.7×10^{-6}

	Hazard	Element At Risk	Likelihood	P(H) Annual Probability	P(S:H) Spatial Impact Probability	Temporal Considerations	P(T:S) Temporal Probability	Vulnerability Comments	V(D:T) Vulnerability	R Loss To Life Annual Probability
G	Failure of fill pad beneath studio	Studio	UNLIKELY	10^{-4}	0.6	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	1.6×10^{-7}
H	Localised failure of cutting above Morley avenue	Vehicle	ALMOST CERTAIN	10^{-1}	0.4	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.00575	May impact vehicle, not expected to be crushed or filled.	0.05	**1.2×10^{-5}**
I	Shallow translational earth slide below studio with movement up to 1m	Studio	POSSIBLE	10^{-3}	0.4	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	1.0×10^{-6}
		Vehicle			0.8	5 min exposure 2 times daily	0.00345	May impact vehicle, not expected to be crushed or filled	0.2	5.5×10^{-7}
J	Shallow rotational earth slide below studio	Studio	POSSIBLE	10^{-3}	0.2	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	5.2×10^{-7}
		Vehicle			0.2		0.00345	May impact vehicle, not expected to be crushed of filled		3.5×10^{-8}
K	Small, local failure of cutting above driveway	Vehicle	ALMOST CERTAIN	10^{-1}	0.6	5 min exposure 2 times daily	0.00345	May impact vehicle, not expected to be crushed of filled	0.05	**1.0×10^{-5}**
L	Small, localised rock slide failure of cutting beneath dwelling	Dwelling	ALMOST CERTAIN	10^{-1}	0.9	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	**2.3×10^{-4}**

Table 6: Risk Assessment for Loss of Life in Mitigated Conditions

Hazard		Element At Risk	Likelihood	P(H) Annual Probability	P(S:H) Spatial Impact Probability	Temporal Considerations	P(T:S) Temporal Probability	Vulnerability Comments	V(D:T) Vulnerability	R Loss To Life Annual Probability
A	Small, local failure of cutting behind dwelling	Dwelling	RARE	10^{-5}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	2.1×10^{-8}
A_1	Small, local failure of cutting beneath dwelling	Dwelling	RARE	10^{-5}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	2.1×10^{-8}
B_1	Shallow translational earth slide behind dwelling with 10cm of movement	Dwelling	UNLIKELY	10^{-4}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	2.1×10^{-7}
B_2	Shallow translational earth slide behind dwelling with 1m of movement	Dwelling	UNLIKELY	10^{-4}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building, not expected to collapse	0.4	1.6×10^{-5}
C	Shallow rotational earth slide beneath dwelling	Dwelling	POSSIBLE	10^{-3}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building, not expected to collapse	0.1	4.2×10^{-5}
D	Shallow translational earth slide-earth flow below dwelling	Vehicle	POSSIBLE	10^{-3}	0.8	10 sec exposure 2 times daily	0.00575	May fill or crush vehicle	0.8	3.7×10^{-6}

Hazard		Element At Risk	Likelihood	P(H) Annual Probability	P(S:H) Spatial Impact Probability	Temporal Considerations	P(T:S) Temporal Probability	Vulnerability Comments	V(D:T) Vulnerability	R Loss To Life Annual Probability
E_1	Small translational rock slide below dwelling with 1cm of movement	Dwelling	UNLIKELY	10^{-4}	0.2	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0	0
E_2	Small translational rock slide below dwelling with 10cm of movement	Dwelling	RARE	10^{-5}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building, not expected to collapse	0.1	4.2×10^{-8}
E_3	Small translational rock slide below dwelling with 1m of movement	Dwelling	BARELY CREDIBLE	10^{-6}	0.8	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building, not expected to collapse	0.1	4.2×10^{-9}
F_1	Deep seated translational rock slide beneath dwelling with 1cm of movement	Dwelling	POSSIBLE	10^{-3}	1.0	Assume 20 hrs. occupancy per day for person most at risk; whole building affected	0.1	Minor damage to the building	0	0
F_2	Deep seated translational rock slide beneath dwelling with 10cm of movement	Dwelling	UNLIKELY	10^{-4}	1.0	Assume 20 hrs. occupancy per day for person most at risk; whole building affected	0.1	Medium damage to building, not expected to collapse	0	0
F_3	Deep seated translational rock slide beneath dwelling with 1m of movement	Dwelling	RARE	10^{-5}	1.0	Assume 20 hrs. occupancy per day for person most at risk; whole building affected	0.1	Minor damage to the building, not expected to collapse	0.1	1.0×10^{-7}

Hazard		Element At Risk	Likelihood	P(H) Annual Probability	P(S:H) Spatial Impact Probability	Temporal Considerations	P(T:S) Temporal Probability	Vulnerability Comments	V(D:T) Vulnerability	R Loss To Life Annual Probability
G	Failure of fill pad beneath studio	Studio	UNLIKELY	10^{-4}	0.6	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	1.6×10^{-7}
H	Localised failure of cutting above Morley avenue	Vehicle	LIKELY	10^{-2}	0.4	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.00575	May impact vehicle, not expected to be crushed or filled.	0.05	1.2×10^{-6}
I	Shallow translational earth slide below studio with movement up to 1m	Studio	UNLIKELY	10^{-4}	0.4	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	1.0×10^{-7}
		Vehicle			0.8	5 min exposure 2 times daily	0.00345	May impact vehicle, not expected to be crushed or filled	0.2	5.5×10^{-8}
J	Shallow rotational earth slide below studio	Studio	UNLIKELY	10^{-4}	0.2	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	5.2×10^{-8}
		Vehicle			0.2		0.00345	May impact vehicle, not expected to be crushed of filled		3.5×10^{-9}
K	Small, local failure of cutting above driveway	Vehicle	RARE	10^{-5}	0.6	5 min exposure 2 times daily	0.00345	May impact vehicle, not expected to be crushed of filled	0.05	1.0×10^{-9}
L	Small, localised rock slide failure of cutting beneath dwelling	Dwelling	UNLIKELY	10^{-4}	0.9	Assume 20 hrs. occupancy per day for person most at risk; part building affected	0.052	Minor damage to the building	0.05	2.3×10^{-8}

8.0 SUMMARY OF RISKS AND CONCLUSION

Our assessment has found that there are risks to loss of life and to damage of property on the subject site due to conceivable landslide events.

The risks to property associated with developing a residential dwelling on the subject site assuming **existing conditions remain or development is unmitigated,** are considered "HIGH" (for the most at risk element). The risk to life is also above the recommended "TOLERABLE" risk limit defined as 1 x 10^{-5} by the AGS Guidelines (2007) and Schedule 1 to the Colac-Otway Shire EMO.

The risks to property can be reduced if recommended mitigation measures are adhered to.

The risks to property associated with developing a residential dwelling on the subject site assuming **risk management conditions are implemented,** can be reduced to "LOW" or "VERY LOW" for most hazards while one hazard can only be reduced to MODERATE. In quantitative terms, the risk to life can be reduced to below the recommended "TOLERABLE" risk limit for all hazard elements.

Based on our assessments of the risks, we conclude that there are no geotechnical reasons to prevent the issue of a permit to develop on this site, subject to the implementation of the following recommendations, which outline management strategies to reduce or maintain the likelihood and/or consequences of the major risk events.

9.0 RECOMMENDATIONS FOR RISK MANAGEMENT

It is not feasible to remove all of the risks of building on the site but the risks can be reduced by good engineering design, by following good hillside construction practices and by regular and frequent site maintenance. The following recommendations outline general good building practice for steep slopes and landslide prone areas.

9.1 SITE RECOMMENDATIONS

Note that an increase in landslide risk may 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.

9.2 SITE CLASSIFICATION

We have generally classified the soil profile as "Class P" in accordance with Section 2 of AS2870-2011 (Australian Standard on Residential Slabs and Footings). This classification is due to the potential risk of landslide hazards as defined by Clause 2.1.3(d) of the Standard.

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

9.3 FOOTINGS

Having all footings appropriately designed and founded will reduce the risk of damage due to soil movement or slope failures. As well as founding structures to a stable base, deep footings have the ability to provide similar root-binding effects to that of deep rooted trees, which contribute to minimising the likelihood of deep seated soil failures.

We recommend engineer-designed footings designed according to engineering principles. The designer should assume **moderate** soil profile relativity. It is also recommended that an allowance be made for lateral soil pressures on the footings due to possible soil creep and possible soil movements due to specific hazards as detailed in the previous sections.

If a raft slab is to be included in the development design then it must be fully suspended.

Footings must be founded through any fill and/or overlying residual soils, and embedded a minimum of 1000mm into the **highly weathered bedrock** or embedded a minimum of 500mm into **Competent Rock**, whichever is deeper. At this depth a maximum Allowable Bearing Pressure of 400kpa may be adopted.

Minimum foundation depths can be expected up to between 2100mm and 25000mm (from the existing surface level) to ensure proper rock socketing. Depths to rock may be shallower in areas where site cuts have been undertaken.

Our investigation revealed that in the four bore holes excavated on site within proximity of the proposed building envelope, suitable founding depths exist as follows:

Table 7: Suitable Foundation Conditions

Test Site Number	Depth below existing surface to HW rock	Minimum Founding Depth	Recommended Founding Material	Presumed Maximum Allowable Bearing Capacity	Presumed Maximum Allowable Skin Friction
1	1500mm	2500mm	Competent rock	400 kPa	40kPa
2	1100mm	2100mm	Competent rock	400 kPa	40kPa
3	1300mm	2500mm	Competent rock	400 kPa	40kPa
4	1100mm	2100mm	Competent rock	400 kPa	40kPa

Note: Competent Rock is expected to be found a **minimum** of 1000mm below the surface of highly weathered rock (refer to borehole logs in Appendix IV) and can be defined as rock which is difficult to excavate or auger with a 5 tonne excavator.

The above quoted depth to competent rock is estimated from our investigation and our previous experience, however the depth to competent rock can vary significantly. Founding depths more than twice the depths quoted above could occur due to natural soil and rock variability. Pile depths of up to 4000mm may be required where depth to less weathered bedrock naturally varies. The depth is measured from surface level at the time of testing and will vary if the site is cut and/or filled.

An experienced geotechnical professional (engineering geologist or geotechnical engineer) should be present **during** all footing excavations to ensure the appropriate foundation has been achieved.

9.4 SITE EXCAVATIONS, CUT AND FILLS AND RETAINING STRUCTURES

It is recommended any new site excavations to accommodate the sloping site should be kept to a minimum and that all site excavations should be retained regardless of height unless battered at an appropriate safe shallow angle. All excavations equal to or greater than 1000mm must be supported by engineer-designed retaining walls with appropriate drainage features or battered at an appropriate safe shallow angle.

The existing site cuttings which flank the driveway should be retained including replacement of the existing drystone retaining wall. Where the cutting is equal to or exceeds 1000mm, the retaining wall must by engineer designed. All new excavations proposed around and beneath the proposed dwelling should also be retained with engineer designed retaining walls, designed to support lateral loads relevant to specific hazards described in previous sections, either independently or as part of the building structure.

Retaining Walls

Retaining walls should be designed for active earth pressure conditions provided that some wall yield is acceptable. It is recommended that the following Active Earth Pressure Coefficients (Ka) be adopted for the wall design.

Table 8: Active Earth Pressure Coefficients

SOIL TYPE	ACTIVE EARTH PRESSURE COEFFICIENT (Ka)
silty CLAY	0.5

Table 9: Passive Earth Pressure Coefficients

SOIL TYPE	ACTIVE EARTH PRESSURE COEFFICIENT (Kp)
silty CLAY	2.15

If the retaining wall is to form part of the building structure restrained from movement above and below by the integral structure of the building, then the following At Rest Earth Pressure Coefficients (Ko) may be used.

Table 10: At Rest Earth Pressure Coefficients

SOIL TYPE	AT REST EARTH PRESSURE COEFFICIENT (Ko)
silty CLAY	0.75

The recommended parameters assume a vertical wall and an inclined backslope of 15° with granular backfill behind the wall as well as a horizontal foreslope in front of the wall of at least 2.5m wide. Wall friction between soldier piles and soil/rock is based on the assumption that piles will be founded in rock. If retaining wall conditions differ from those described, then a change in design parameters will be required.

Any retention system should be designed so that the soil behind the retaining wall is completely and permanently drained. If this cannot be achieved, hydrostatic pressure must be included in the design. Retaining wall backfill should be comprised of free draining granular material. Under no circumstances should backfill comprise of poorly compacted non-granular material. It is recommended that a non-woven geotextile filter be installed in subsurface drains to minimize silting and erosion of backfill.

Specific Retaining Wall Design

Specific retaining wall design parameters should be determined by the application of an accepted design theory (e.g.: Rankin Earth Pressure Theory or Coulomb Earth Pressure Theory). The following geotechnical parameters are judged to be typical values for the types of ground materials present on site.

Table 11: Typical Geotechnical Parameters

	silty CLAY	HW Rock[1]
Wet or total unit Weight (γ_w)	19 kN/m^3	25 kN/m^3
Effective Friction angle (Φ')	21-24°	35-39°
Effective Cohesion (c')	1-2kPa	25kPa
Undrained shear strength (c_u or S_u)[2]	25 -100kPa	400kPa
Unconfined compressive strength (q_u)		800kPa

Additional testing may be required to determine more site specific design parameters such as wet density, suction, cohesion and angle of internal friction, before the design of the retaining walls or the determination of a safe batter angle can be finalised.

Slope Stability – Short Term

In order to ensure adequate stability of filled or excavated slopes in the short term (i.e. 2 consecutive days, in fine weather) the following maximum batters should be adopted.

Table 12: Temporary Batter Angles

SOIL TYPE	MAXIMUM TEMPORARY SLOPE (To Horizontal)
Topsoil (clayey silts, silty sands, clayey sands)	45° or 1(V):1(H)
Subsoils (clay, sandy clay, silty clay)	45° or 1(V):1(H)
New or existing fill	45° or 1(V):1(H)
Highly weathered to fresh rock[3]	60° or 2(V):1(H)

All excavations should be inspected to ensure that stability is adequate and to identify any possible zone of instability e.g. unfavourable jointing, fault zones. The stability of vertically excavated slopes, e.g. for the insertion of precast panels, cannot be guaranteed.

If poor weather conditions are encountered (i.e. heavy rain, etc.) at the time of excavation or panel insertion, immediate shoring of the batters should be carried out.

[1] These strength parameters apply to failure through the rock mass and do not take into account failures controlled by geological structures such as along clay filled bedding planes, joints or faults.
[2] Not to be used for long term stability
[3] Steeper angles maybe possible in some less weathered rock depending on the nature of the geological structure, but would require site specific assessment during excavation by an experienced geotechnical professional.

Permeable soils that become inundated may lose form. If excavations are undertaken during wet periods a shoulder to shoulder pile system may be required **or** a proven diversion drainage system may need to be installed prior to site works.

Permanent Earthworks

Any fill introduced to the site should contain little or no organics and be placed in layers up to 200mm thick with each layer being well compacted at the appropriate moisture content. All permanent fill batters or cuts in natural soils must not exceed slope angels 27° or 1(V):2(H) or alternatively be retained by engineer designed retaining walls with appropriate footings and drainage works.

In order to ensure adequate stability of filled or excavated slopes in the long term the following maximum batters should be adopted.

Table 13: Permanent Batter Angles

SOIL TYPE	MAXIMUM PERMANENT SLOPE (To Horizontal)
Topsoil (clayey silts, silty sands, clayey sands)	27° or 1(V):2(H)
Subsoils (clay, sandy clay, silty clay)	27° or 1(V):2(H)
New or existing fill	27° or 1(V):2(H)
Highly weathered to fresh rock[4]	45° or 1(V):1(H)

All cut and fill batters should be revegetated with fast growing deep rooted plants as soon after construction as possible to protect the batter face.

Care must also be taken to ensure that any levelled areas have a slight fall to prevent surface water from ponding or seeping into the ground near the base of any site cut. The construction of appropriately designed walls or battered slopes will reduce the risk of soil movement and the collapse of any proposed site excavations.

9.5 VEHICLE PARKING AND ACCESS

It is recommended that suitably designed drainage accompany any design of access ways to minimise surface water run-off and overland flow. It is recommended that some consideration be given to a drainage system which may include the use of a spoon drain and culvert system as part of the overall drainage design for the site to ensure surface water is discharged away from any buildings and dispersed so that surface water cannot accumulate and infiltrate to the soil profile or run-off down slope and over any steep embankments.

9.6 SITE DRAINAGE

Many researchers identify intense rainfall and/or poor site drainage as a common trigger of landslide events. Whilst nothing can be done to reduce the likelihood of intense rainfall in the Wye River area, steps can be taken to improve site drainage and minimise saturation of the soil

[4] Steeper angles maybe possible in some less weathered rock depending on the nature of the geological structure, but would require site specific assessment during excavation by an experienced geotechnical professional.

layers which often triggers soil movement. Careful attention to drainage is essential to reduce the landslide risk and surface water must therefore be prevented from ponding anywhere on the site.

We recommend that the drainage system for the site be fully engineer designed. We expect that the roof run-off will be collected in tanks and that overflows should be connected to the site drainage system and discharge excess water in a non-destructive way to an approved point of discharge such as curb side storm water drain or municipal drainage infrastructure. Discharge must be made well away from any buildings to an area where the water can be dispersed without causing erosion or accumulating in a concentrated area. It is very important that roof run-off is not allowed to run onto the ground near the buildings or be allowed to discharge freely over the natural slopes.

As part of the overall drainage design for this site, we recommend the use of sub-surface cut off drains installed up and down slope of the proposed dwelling, designed to intercept potential groundwater seepage through the residual soils. The cut-off drains should be a minimum of 1m deep, (but may be shallower where bedrock is encountered) and contain a sub-surface drain wrapped in geofabric to minimise clogging. Inspection openings should be provided to enable periodic flushing. The drain should have sufficient fall to discharge completely into the Site's drainage infrastructure.

Surface drainage (catch drains or diversion berms) are recommended above the crest of all cut and fill embankments and within all levelled or benched areas to ensure surface water does not concentrate and pond anywhere on site or be allowed to run-off over the face of any cut or fill batters.

We recommend surface be installed along the northern property boundary to intercept stormwater run on from the northern neighbouring property. Surface drainage should also be carefully designed and installed around proposed building. The site drainage system must discharge to a legal point of discharge or connect to local government drainage infrastructure in drainage easements where available.

Where the soil surface is altered to construct vehicle parking bays, recreation areas etc., precautions must be taken to ensure excess surface water cannot pond or soak into the ground but is diverted away from the buildings.

Careful attention to site drainage will reduce the risk of slope failures or soil movements.

9.7 SITE VEGETATION

Suitable vegetation contributes greatly to the stability of a site by reducing the soil moisture content, minimizing soil erosion and binding the soil structure together. Existing trees should remain unless they interfere with the building or the minimum defendable space for fire protection in which case they should be cut off at ground level and the root structures left intact.

We recommend that a re-vegetation program be implemented for the entire development area especially down slope of the proposed dwelling. Suitable deep rooted trees, shrubs and grasses should be established an appropriate distance from the building with regard to fire risk to assist the overall slope stability.

Revegetation of the site will provide root-binding effects, help mitigate excess moisture building up in the soil profile, increase suction, assist with rainfall and surface flow interception and reduce the velocity of overland flow in turn reducing the risk of slope failures.

9.8 EFFLUENT DISPOSAL

Effluent should be disposed of offsite where reticulated mains sewer is available.

If onsite waste water treatment is required then it should, where possible, be widely dispersed by subsurface irrigation well away from the development area to minimise the likelihood of wastewater concentrating in the soil profile. Suitable vegetation will assist with evapotranspiration.

We recommend reducing the potential waste water loading as much as possible to minimise the required land application area. This could be achieved in a number of ways such as ensuring a minimum of three star water saving fixtures are installed throughout the dwelling, utilising a split blackwater/greywater treatment with minimum advanced secondary treatment, incorporating a third pipe for recycling advanced secondary treated greywater for use in toilets and laundry's or utilising incinerating toilets to reduce daily loading rates.

If an irrigation disposal field is to be constructed behind (up-slope of) the development then a cut-off drain **must** be constructed between the irrigation field and the dwelling. The cut-off drain should be a minimum of 1m deep (but may be shallower where bedrock is encountered) and contain a sub-surface drain wrapped in geofabric to minimise clogging. Inspection openings should be provided to enable periodic flushing. The drain should have sufficient fall to discharge completely to an area well away from the house.

Given that a small yet active landslide has previously been identified and recorded on No. 32 (location confirmed and dimensions interpreted during this investigation, see Figure 3), waste water disposal should be excluded from being directly applied to the landslide area in the north-eastern corner of No. 32.

9.9 EROSION

Re-vegetation of bare surface slopes is critical to minimising the effect of sheet, tunnel and rill erosion. Vegetation adds organic material back into the soil, improving soil structure and binding the topsoil layers. Surface vegetation and low shrubs also intercept surface water runoff and slow the rate of surface flow thus minimising the physical impact of surface water runoff across sloping sites.

Additional measures to help prevent erosion caused by surface water include implementing good drainage design to capture surface water runoff and using surface berms, vertical drops and energy dissipaters within the landscape design to reduce the velocity of runoff down slope.

9.10 GENERAL RECOMMENDATIONS

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

a) the design of an appropriate development for the site;

b) the provision of adequate retaining structures and drainage for all cut faces (or batter at an appropriate angle);

c) adequate site drainage is essential, surface water and excess roof water must not be allowed to pond or seep into the ground near buildings.

d) regular maintenance of open drains.

Refer also to the attached Appendices for more general advice.

DAVID J HORWOOD
BAppSc (Geology); MAusIMM CP (Geo); MAIG
SENIOR ENGINEERING GEOLOGIST

AusIMM
THE MINERALS INSTITUTE
CHARTERED PROFESSIONAL
GEOLOGY
David Horwood

10.0 REFERENCES

AS Miner Geotechnical Pty Ltd (2007) 1:25 000 Wye River Colac-Otway Landslide Susceptibility Map. Corangamite Catchment Management Authority.

AS Miner Geotechnical Pty Ltd (2007) 1:25 000 Wye River Colac-Otway Landslide Inventory Map. Corangamite Catchment Management Authority.

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

Coffey Geotechnics Pty Ltd (2016a) Wye River and Separation Creek – Geotechnical, Land Capability and Wastewater Solutions, Geotechnical Assessment. Report for Department of Environment, Land, Water and Planning.

Coffey Geotechnics Pty Ltd (2016b) Wye River and Separation Creek – Geotechnical, Land Capability and Wastewater Solutions, Main Report. Report for Department of Environment, Land, Water and Planning.

Coffey Geotechnics Pty Ltd (2011) Geotechnical Assessment, Proposed Pressure Sewer Scheme, Wye River and Separation Creek. Report for Barwon Water.

Cooney, AM., (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, (2003) Coastal Community Revitalization Project, Wye River, Separation Creek and Wye River. Report 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.

Edwards, J., Leonard, JG., Pettifer, GR. And McDonald, PA (1996). Colac 1:250 000 Map Geological Report. Geological Survey Report Victoria Report 98.

Neilson, J.L., (1992) Completion report on Slope Stability Studies at Wye River and Separation Creek, Shire of Otway. Geological Survey of Victoria, Unpublished Report No. 1992/6.

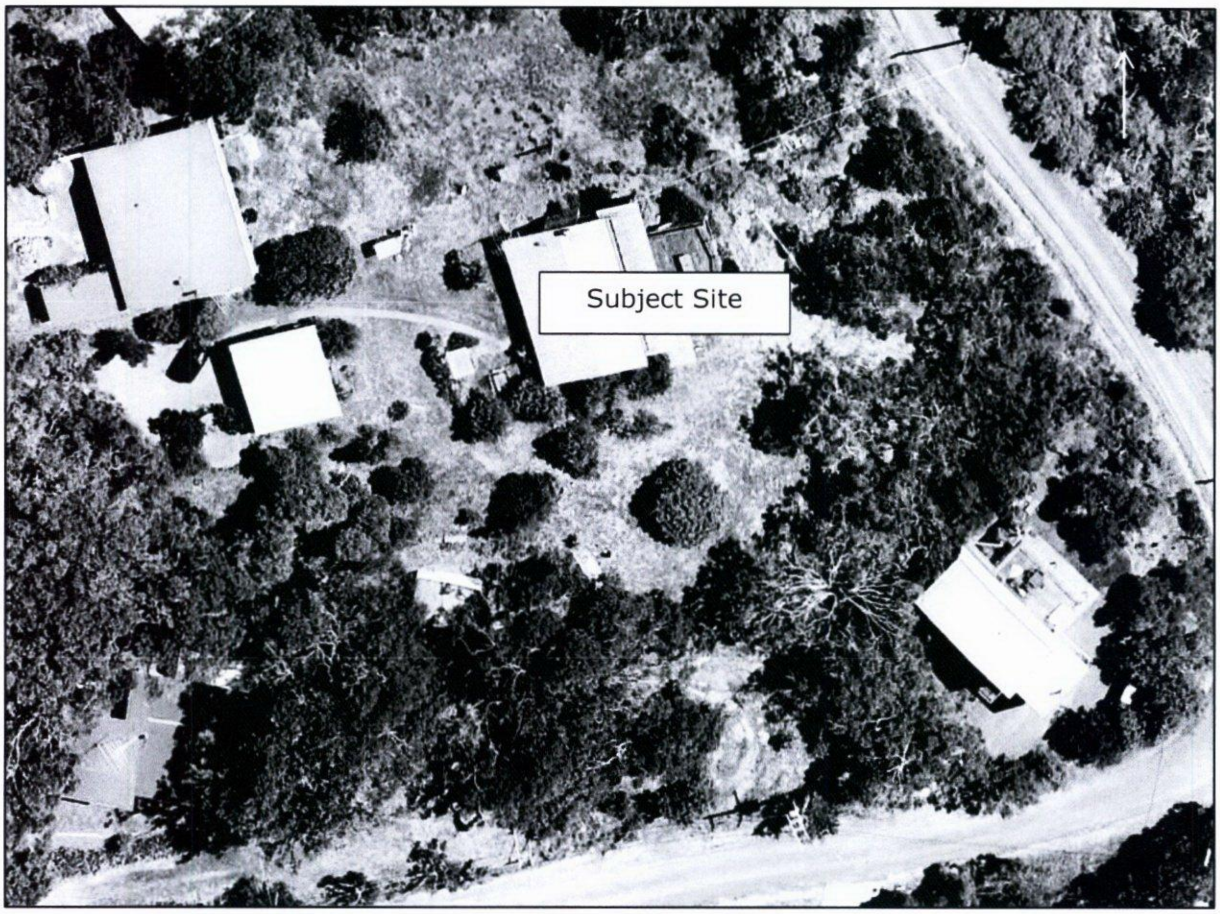
Neilson, J.L., Peck, W.A., Wood, P.D., Dahlhaus, P.G., Miner, A.S., Brumley, J.C., Kenley, P.R., Wilson, R.A., Willman, C.E. and Rowan, J.N. (2003) Geological Hazards. *In:* Birch, W.D. ed. *Geology of Victoria* pp. 573-591. Geological Society of Australia Special Publication **23**. Geological Society of Australia (Victoria Division).

Tickell, SJ., Edwards, J. and Abele, C., 1992. Port Campbell Embayment 1:100 000 map geological report. Geological Survey of Victoria Report 95.

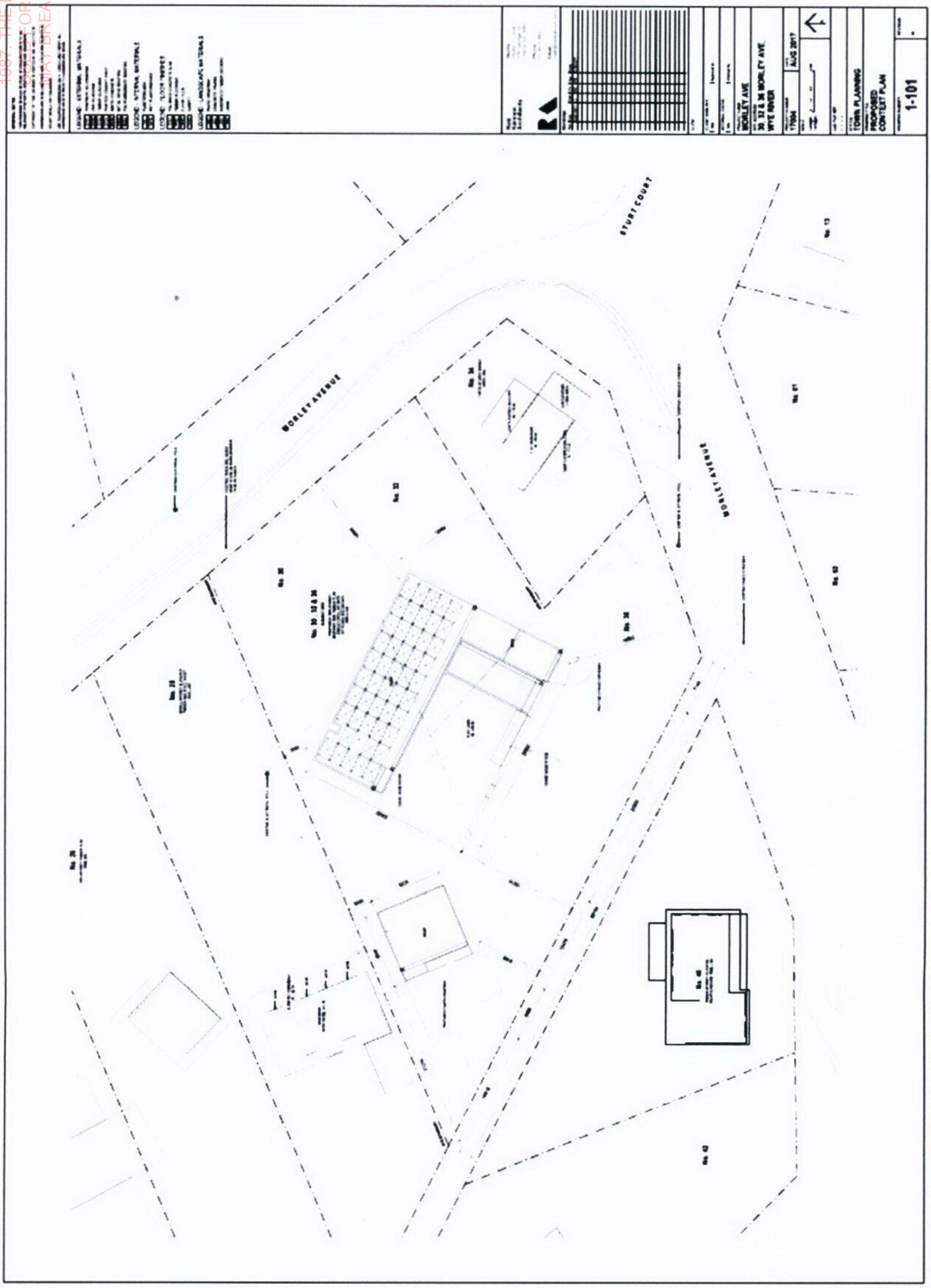
Varnes, D.J., (1978) Slope movement types and processes, in Landslides Analysis and Control Schuster and Krizek eds., Transportation Research Board Report 176.

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

Appendix I: Aerial Photograph



Appendix II: Site Plan



Appendix III: Site Photographs

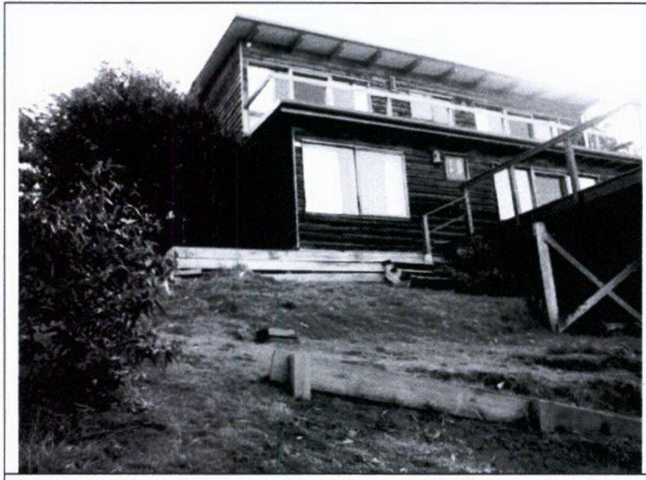


Photo 1: View of the existing dwelling overlooking the proposed building envelope.

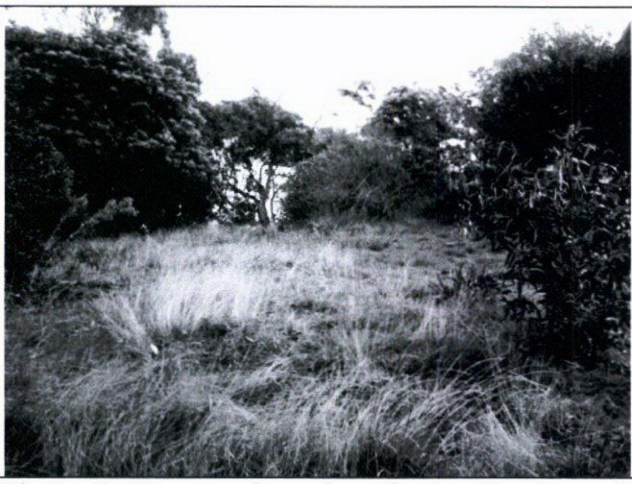


Photo 2: View upslope (west) standing in part of the proposed building envelope.

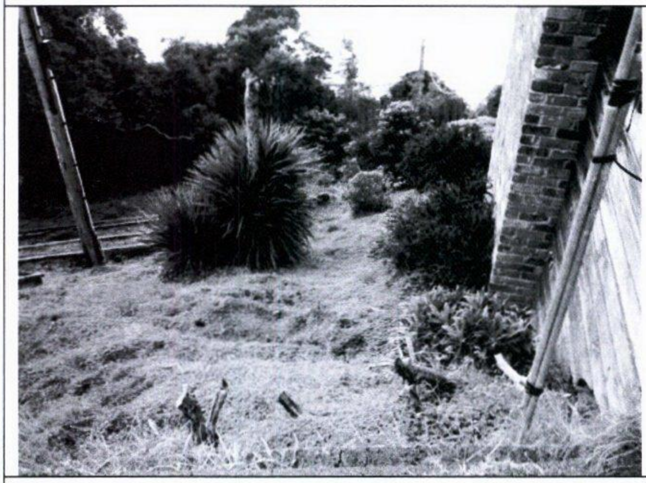


Photo 3: Looking east down the northern property boundary. Hummocky surface inside an historical landslide.

Photo 4: View to the north-east looking down the major break in slope (possible extension of historical landslide on adjoining property to north.

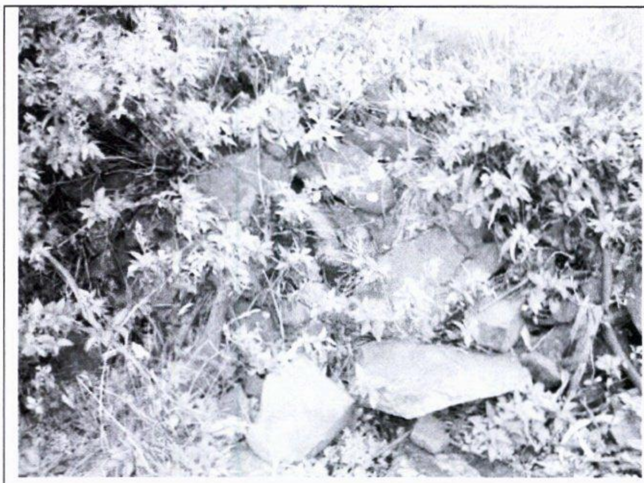


Photo 5: Groundwater seeping from stone wall above driveway.	Photo 6: View from Morley Avenue. Groundwater seeps and tree undermined by slumping in cutting.

Appendix IV: Borehole Logs

AGR GeoSciences

Client:	Rob Kennon Architects	Bore Hole	No. 1
Project Address:	30, 32, 36 Morley Ave	Field Work Completed By:	David Horwood
Reference No:	17F190LRA	Field Work Date:	20/07/2017

Depth mm	Drilling Method	Graphic Log	Group Symbol	Material Description	Shade	Colour	Mottle	Moisture	Consistency/ Density	Cu (kPa)	Field Test	Sample	Groundwater
100	Continuous Flight Auger			Fill Gravel mix	Dk	Gy		M	MC				100
200				clayey SILT	Dk	Gy		M	F				200
300				silty CLAY	Pl	Gy / Br	Or mottle	SM	St				300
400				Trace Gravels									400
500				Gravel to pebble sized									500
600				Round to Sub Angular									600
700				Plasticity Low-Medium									700
800				Mudstone	Pl	Gy		SM					800
900				Extremely Weathered									900
1000													1000
1100				Strength Very Low									1100
1200													1200
1300													1300
1400													1400
1500													1500
1600				Mudstone									1600
1700				Highly Weathered									1700
1800				Strength Low									1800
1900													1900
2000				Increased Resistance									2000
2100				Lense of carbonaceous shale	Dk	Gy / Bk							2100
2200				Strength Low									2200
2300				Mudstone	Pl	Gy							2300
2400				Highly Weathered									2400
2500				Strength Low-Med									2500
2600													2600
2700													2700
2800													2800
2900													2900
3000				Mudstone									3000
3100				Highly to Mod Weathered									3100
3200				Strength Low-Med									3200
3300													3300
3400				Decrease in Resistance									3400
3500													3500

Comment: Gravels: Mudstone fragments

Graphic Log Granular Topsoil | Cohesive Topsoil | Cohesive Subsoil | Granular Subsoil | Rock | Fill

Field Test and Sampling	Moisture:		Relative Density:		Consistency:	
SPT Standard Penetration Test (Relative density N - blows/300mm)	D	Dry	VL	Very Loose	VS	Very Soft
PP Pocket Penetrometer (Force kgf/cm^2 - Unconfined Compressive Strength q_u)	SM	Slightly Moist	L	Loose	S	Soft
VS Vane Shear (Undrained cohesive (shear) strength Cu kPa)	M	Moist	MD	Medium Dense	F	Firm
DCP Dynamic Cone Penetrometer (Penetration resistance N_p - blows/300mm)	VM	Very Moist	D	Dense	St	Stiff
Disturbed Sample D Undisturbed Sample U	W	Wet	VD	Very Dense	VSt	Very Stiff
Compaction: PC Poorly Compacted MC Moderately Compacted WC Well Compacted VC Variably Compacted			Groundwater		H	Hard
Colour: Dk Dark Lt Light Bk Black Br Brown Gy Grey Or Orange Yl Yellow Re Red Bl Blue Gn Green Pk Pink Wh White			▼			

AGR GeoSciences

Client:	Rob Kennon Architects	Bore Hole	No. 1 continued
Project Address:	30, 32, 36 Morley Ave	Field Work Completed By:	David Horwood
Reference No:	17F190LRA	Field Work Date:	20/07/2017

Depth mm	Drilling Method	Graphic Log	Group Symbol	Material Description	Shade	Colour	Mottle	Moisture	Consistency/ Density	Cu (kPa)	Field Test	Sample	Groundwater
3600	Continuous Flight Auger	Rock		Increasing Resistance	Pl	Gy							100
3700				Mudstone									200
3800				Highly to Mod Weathered									300
3900				Strength Low-Med									400
4000													500
4100													600
4200													700
4300													800
4400													900
4500				Refusal Bedrock									1000
4600				Mudstone									1100
4700				Moderately Weathered									1200
4800				Strength Medium									1300
4900													1400
5000													1500
5100													1600
5200													1700
5300													1800
5400													1900
5500													2000
5600													2100
5700													2200
5800													2300
5900													2400
6000													2500
6100													2600
6200													2700
6300													2800
6400													2900
6500													3000
6600													3100
6700													3200
6800													3300
6900													3400
7000													3500

Comment:

Graphic Log: Granular Topsoil; Cohesive Topsoil; Cohesive Subsoil; Granular Subsoil; Rock; Fill

Field Test and Sampling	Moisture:		Relative Density:		Consistency:	
SPT Standard Penetration Test (Relative density N - blows/300mm)	D	Dry	VL	Very Loose	VS	Very Soft
PP Pocket Penetrometer (Force kgf/cm^2 - Unconfined Compressive Strength q_u)	SM	Slightly Moist	L	Loose	S	Soft
VS Vane Shear (Undrained cohesive (shear) strength Cu kPa)	M	Moist	MD	Medium Dense	F	Firm
DCP Dynamic Cone Penetrometer (Penetration resistance N_p - blows/300mm)	VM	Very Moist	D	Dense	St	Stiff
Disturbed Sample D Undisturbed Sample U	W	Wet	VD	Very Dense	VSt	Very Stiff
					H	Hard

Compaction: PC Poorly Compacted MC Moderately Compacted WC Well Compacted VC Variably Compacted

Groundwater ▼

Colour: Dk Dark Lt Light Bk Black Br Brown Gy Grey Or Orange Yl Yellow Re Red Bl Blue Gn Green Pk Pink Wh White

D17/101942

AGR GeoSciences

Client:	Rob Kennon Architects	Bore Hole	No. 2
Project Address:	30, 32, 36 Morley Ave	Field Work Completed By:	David Horwood
Reference No:	17F190LRA	Field Work Date:	20/07/2017

Depth mm	Drilling Method	Graphic Log	Group Symbol	Material Description		Shade	Colour	Mottle	Moisture	Consistency/ Density	Cu (kPa)	Field Test		Sample	Groundwater
100					clayey SILT	Dk	Gy / Br		M	F					100
200				Plasticity	Very Low										200
300															300
400					CLAY	Pl	Gy / Br	Or mottle	M	F	40	VS	40		400
500	Hand Auger			Trace	HW Sandstone Rock Fragments										500
600															600
700					CLAY	Pl	Gy / Br	Or mottle	M	St	70	VS	70		700
800				with	sand						100	VS	100		800
900					Fine grained										900
1000				Plasticity	Med-High										1000
1100					Sandstone	Pl	Or / Br	Or mottle							1100
1200					Extremely Weathered										1200
1300					Mudstone		Gy								1300
1400					Extremely to Highly Weathered										1400
1500				Refusal	Bedrock										1500
1600															1600
1700															1700
1800															1800
1900															1900
2000															2000
2100															2100
2200															2200
2300															2300
2400															2400
2500															2500
2600															2600
2700															2700
2800															2800
2900															2900
3000															3000
3100															3100
3200															3200
3300															3300
3400															3400
3500															3500

Comment:

Graphic Log: Granular | Cohesive Topsoil | Cohesive Subsoil | Granular Subsoil | Rock | Fill

Field Test and Sampling	**Moisture:**	**Relative Density:**	**Consistency:**
SPT Standard Penetration Test (Relative density N - blows/300mm)	D Dry	VL Very Loose	VS Very Soft
PP Pocket Penetrometer (Force kgf/cm^2 - Unconfined Compressive Strength q_{ur})	SM Slightly Moist	L Loose	S Soft
VS Vane Shear (Undrained cohesive (shear) strength Cu kPa)	M Moist	MD Medium Dense	F Firm
DCP Dynamic Cone Penetrometer (Penetration resistance N_p - blows/300mm)	VM Very Moist	D Dense	St Stiff
Disturbed Sample D Undisturbed Sample U	W Wet	VD Very Dense	VSt Very Stiff

Compaction: PC Poorly Compacted MC Moderately Compacted WC Well Compacted VC Variably Compacted — Groundwater ▼ — H Hard

Colour: Dk Dark Lt Light Bk Black Br Brown Gy Grey Or Orange Yl Yellow Re Red Bl Blue Gn Green Pk Pink Wh White

D17/101942

AGR GeoSciences

Client:	Rob Kennon Architects	Bore Hole	No. 3
Project Address:	30, 32, 36 Morley Ave	Field Work Completed By:	David Horwood
Reference No:	17F190LRA	Field Work Date:	20/07/2017

Depth mm	Drilling Method	Graphic Log	Group Symbol	Material Description		Shade	Colour	Mottle	Moisture	Consistency/ Density	Cu (kPa)	Field Test	Sample	Groundwater
100	Continuous Flight Auger				clayey SILT	Dk	Gy		M	F	58	VS 58		100
200					silty CLAY	Pl	Gy / Br		M	St				200
300				Trace	HW Sandstone Rock Fragments									300
400				Plasticity	Med-High									400
500					CLAY	Pl	Gy / Br	Or mottle	M	St				500
600				Trace	HW Mudstone Rock Fragments									600
700				Plasticity	High									700
800				Strength	Very Low	Pl	Gy / Br	Or mottle	M	St				800
900														900
1000														1000
1100														1100
1200					CLAY		Gy	Or mottle	SM	VSt				1200
1300				with	rock									1300
1400				Refusal	Bedrock									1400
1500					Mudstone									1500
1600					Extremely Weathered									1600
1700														1700
1800														1800
1900														1900
2000														2000
2100														2100
2200														2200
2300														2300
2400														2400
2500														2500
2600														2600
2700														2700
2800														2800
2900														2900
3000														3000
3100														3100
3200														3200
3300														3300
3400														3400
3500														3500

Comment:

Graphic Log: Granular Topsoil | Cohesive Topsoil | Cohesive Subsoil | Granular Subsoil | Rock | Fill

Field Test and Sampling
SPT Standard Penetration Test (Relative density N - blows/300mm)
PP Pocket Penetrometer (Force kgf/cm² - Unconfined Compressive Strength q_u)
VS Vane Shear (Undrained cohesive (shear) strength Cu kPa)
DCP Dynamic Cone Penetrometer (Penetration resistance N_p - blows/300mm)
Disturbed Sample D Undisturbed Sample U

Moisture:		Relative Density:		Consistency:	
D	Dry	VL	Very Loose	VS	Very Soft
SM	Slightly Moist	L	Loose	S	Soft
M	Moist	MD	Medium Dense	F	Firm
VM	Very Moist	D	Dense	St	Stiff
W	Wet	VD	Very Dense	VSt	Very Stiff
				H	Hard

Compaction: PC Poorly Compacted MC Moderately Compacted WC Well Compacted VC Variably Compacted

Groundwater ▼

Colour: Dk Dark Lt Light Bk Black Br Brown Gy Grey Or Orange Yl Yellow Re Red Bl Blue Gn Green Pk Pink Wh White

D17/101942

AGR GeoSciences

Client:	Rob Kennon Architects	Bore Hole	No. 4
Project Address:	30, 32, 36 Morley Ave	Field Work Completed By:	David Horwood
Reference No:	17F190LRA	Field Work Date:	20/07/2017

Depth mm	Drilling Method	Graphic Log	Group Symbol	Material Description	Shade	Colour	Mottle	Moisture	Consistency/ Density	Cu (kPa)	Field Test	Sample	Groundwater
100	Continuous Flight Auger			clayey SILT	Dk	Gy		VM	S				100
200				Plasticity Low									200
300													300
400													400
500													500
600								VM	VS				600
700				CLAY		Or / Br	Gy mottle	M	St				700
800				Plasticity Medium									800
900				with HW Sandstone Rock Fragments									900
1000													1000
1100													1100
1200				Refusal Bedrock									1200
1300				Mudstone									1300
1400													1400
1500													1500
1600													1600
1700													1700
1800													1800
1900													1900
2000													2000
2100													2100
2200													2200
2300													2300
2400													2400
2500													2500
2600													2600
2700													2700
2800													2800
2900													2900
3000													3000
3100													3100
3200													3200
3300													3300
3400													3400
3500													3500

Comment:

Graphic Log: Granular Topsoil | Cohesive Topsoil | Cohesive Subsoil | Granular Subsoil | Rock | Fill

Field Test and Sampling	**Moisture:**	**Relative Density:**	**Consistency:**
SPT Standard Penetration Test (Relative density N - blows/300mm)	D Dry	VL Very Loose	VS Very Soft
PP Pocket Penetrometer (Force kgf/cm^2 - Unconfined Compressive Strength q_u)	SM Slightly Moist	L Loose	S Soft
VS Vane Shear (Undrained cohesive (shear) strength Cu kPa)	M Moist	MD Medium Dense	F Firm
DCP Dynamic Cone Penetrometer (Penetration resistance N_p - blows/300mm)	VM Very Moist	D Dense	St Stiff
Disturbed Sample D Undisturbed Sample U	W Wet	VD Very Dense	VSt Very Stiff
Compaction: PC Poorly Compacted MC Moderately Compacted WC Well Compacted VC Variably Compacted		Groundwater ▼	H Hard

Colour: Dk Dark Lt Light Bk Black Br Brown Gy Grey Or Orange Yl Yellow Re Red Bl Blue Gn Green Pk Pink Wh White

D17/101942

AGR GeoSciences

Client:	Rob Kennon Architects	Test Site	No. 5
Project Address:	30, 32, 36 Morley Ave	Field Work Completed By:	David Horwood
Reference No:	17F190LRA	Field Work Date:	20/07/2017

Depth mm	Drilling Method	Graphic Log	Group Symbol	Material Description		Shade	Colour	Mottle	Moisture	Consistency/ Density	Cu (kPa)	Field Test	Sample	Groundwater
100	Logged Cutting				clayey SILT	Dk	Gy		M	F				100
200				with	sand									200
300				Trace	Rock Fragments									300
400														400
500					gravelly CLAY	Lt	Br		M	F				500
600					Pebble to cobble sized									600
700					Angular to Sub Round									700
800		Rock			Sandstone	Lt	Br							800
900		Rock			Highly Weathered									900
1000		Rock		Strength	Low									1000
1100		Rock												1100
1200					Clay Seam	Lt	Gy		VM	VS				1200
1300		Rock			Sandstone									1300
1400		Rock			Thickly to thinly bedded, massive,									1400
1500		Rock			highy fractured and jointed.									1500
1600		Rock			Conjugate joints (J1-J3) tight to									1600
1700		Rock			open. Rare interbeded clay									1700
1800		Rock			weathered mudstones and									1800
1900		Rock			bedded faults up to 40mm thick.									1900
2000		Rock			Bedding 16°/137°									2000
2100		Rock			Moderately Weathered									2100
2200		Rock		Strength	Medium									2200
2300		Rock												2300
2400		Rock												2400
2500		Rock												2500
2600		Rock												2600
2700		Rock												2700
2800		Rock			Cutting Covered in soil wash									2800
2900		Rock												2900
3000		Rock			Mod to Slightly Weathered									3000
3100		Rock		Strength	Medium									3100
3200		Rock												3200
3300		Rock												3300
3400		Rock												3400
3500		Rock		EOH										3500

Comment:

Graphic Log — Granular Topsoil; Cohesive Topsoil; Cohesive Subsoil; Granular Subsoil; Rock; Fill

Field Test and Sampling	**Moisture:**		**Relative Density:**		**Consistency:**	
SPT Standard Penetration Test (Relative density N - blows/300mm)	D	Dry	VL	Very Loose	VS	Very Soft
PP Pocket Penetrometer (Force kgf/cm^2 - Unconfined Compressive Strength q_u)	SM	Slightly Moist	L	Loose	S	Soft
SV Shear Vane (Undrained cohesive (shear) strength Cu kPa)	M	Moist	MD	Medium Dense	F	Firm
DCP Dynamic Cone Penetrometer (Penetration resistance N_p - blows/300mm)	VM	Very Moist	D	Dense	St	Stiff
Disturbed Sample D Undisturbed Sample U	W	Wet	VD	Very Dense	VSt	Very Stiff

Compaction: PC Poorly Compacted MC Moderately Compacted WC Well Compacted VC Variably Compacted — Groundwater ▼ — H Hard

Colour: Dk Dark Lt Light Bk Black Br Brown Gy Grey Or Orange Yl Yellow Re Red Bl Blue Gn Green Pk Pink Wh White

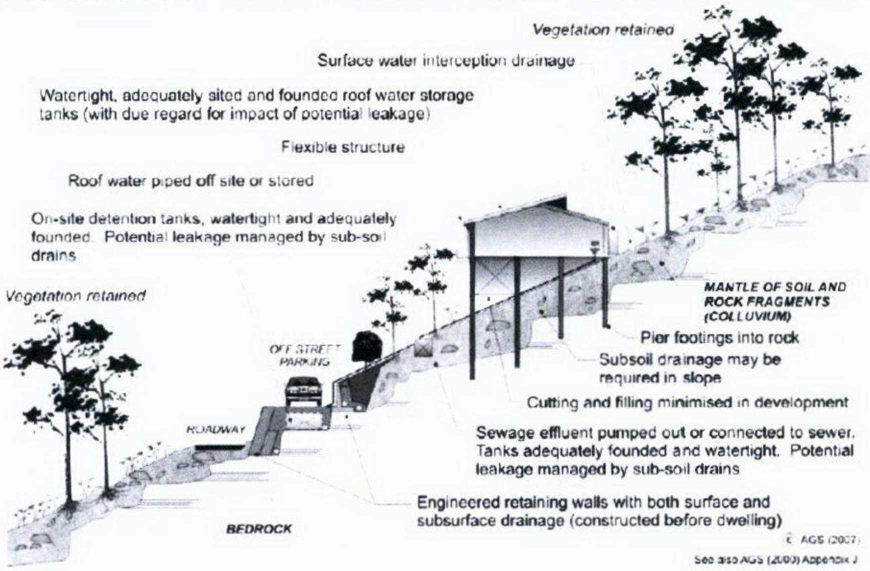
Appendix V: Hillside Construction Practice

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.

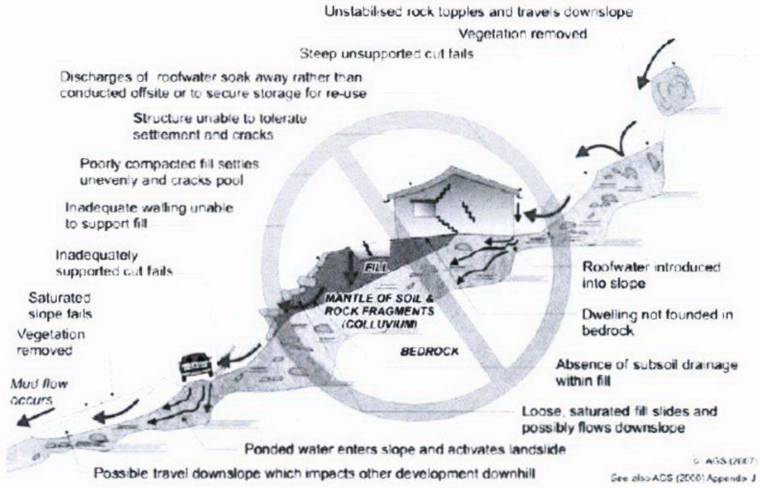
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing 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.

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF 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}		100 years		The event will probably occur under adverse conditions over the design life	LIKELY	B
10^{-3}	$5x10^{-3}$	1000 years	200 years	The event could occur under adverse conditions over the design life	POSSIBLE	C
10^{-4}	$5x10^{-4}$	10,000 years	2000 years	The event might occur under very adverse circumstances over the design life	UNLIKELY	D
10^{-5}	$5x10^{-5}$	100,000 years	20,000 years	The event is conceivable but only under exceptional circumstances over the design life	RARE	E
10^{-6}	$5x10^{-6}$	1,000,000 years	200,000 years	The event is inconceivable or fanciful over the design life	BARELY CREDIBLE	F

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

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site 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 C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

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

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

RISK LEVEL IMPLICATIONS

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

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

Appendix VII: Geotechnical Declaration

FORM A | Page 1 of 2

Geotechnical Declaration and Verification Development Application

Office Use Only		Regulator: COLAC-OTWAY SHIRE

To be submitted with a development application. If this form is not submitted with the geotechnical report the report will be refused.
This form is essential to verify that the geotechnical report has been prepared in accordance with Schedule 1 to the Erosion Management Overlay and that the author of the geotechnical report is a geotechnical engineer or engineering geologist as defined by Schedule 1 to the Erosion Management Overlay. Alternatively, where a geotechnical report has been prepared for subdivision or is greater than two years old or by a professional person not recognized by Schedule 1 to the Erosion Management Overlay, then this form may be used as technical verification of the geotechnical report if signed by a geotechnical engineer or engineering geologist as defined by Schedule 1 to the Erosion Management Overlay.

Section 1 Related Application

Reference	
DA Site Address	30, 32, 36 Morley Avenue WYE RIVER VIC
DA Applicant	Bruce Carter

Section 2 Geotechnical Report

Details	Title: Landslip Risk Assessment for 30, 32, 36 Morley Avenue	
	Author's Company/Organization Name: AGR Geosciences Pty Ltd	Report Reference No: 17F190LRA
	Author: David J Horwood	Dated: 11 / 9 / 2017

Section 3 Checklist

Geotechnical Requirements (Tick as appropriate, either Yes or No)

The following checklist covers the minimum requirements to be addressed in a geotechnical report. This checklist is to accompany the report. Each item is to be cross-referenced to the section or page of the geotechnical report which addresses that item.

Yes	No	
☒	☐	A review of readily available history of slope instability in the site or related land as per *section 4.1; 4.1.2; 4.1.3*
☒	☐	An assessment of the risk posed by all reasonably identifiable geotechnical hazards as per *Sections 4.4, 5.0, 6.0, 7.0*
☒	☐	Plans and sections of the site and related land as per *Figures 1-8, Section 4.0*
☒	☐	Presentation of a geological model as per *Figures 1-6 Section 4.1.1; Section 4.2 & Section 4.3*
☒	☐	Photographs and/or drawings of the site as per *Appendices ii-iii*
☒	☐	A conclusion as to whether the site is suitable for the development proposed to be carried out either conditionally or unconditionally as per *Section 8.0*
☐	☐	If any items above are ticked No, an explanation is to be included in the report to justify why. *<Add reference>*

Subject to recommendations and conditions relevant to:

Yes	No	
☒	☐	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 and the proposal, from a geotechnical viewpoint,
☒	☐	highlighting and detailing the inspection regime to provide the Colac-Otway Shire and builder with adequate notification for all necessary inspections.
☒	☐	State Design life adopted: 50 Years

AGR

FORM **A**

Geotechnical Declaration and Verification Development Application

Section 4 List of Drawings referenced in Geotechnical Report

Design Documents

Description	Plan or Document No.	Revision or Version No.	Date	Author
Context Plan	0-101		3/7/2017	Rob Kennon Architects
Basement plan	1-102		3/7/2017	Rob Kennon Architects
Ground floor plan	1-103		3/7/2017	Rob Kennon Architects
Elevations	2-101 – 2-102		3/7/2017	Rob Kennon Architects
Sections	3-101		3/7/2017	Rob Kennon Architects
Site Analysis Survey	1070-001SA		6/7/2017	Smith Land Surveying

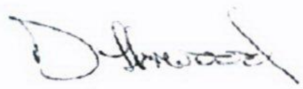
Section 5 Declaration

Declaration (Tick all that apply)

I am a geotechnical engineer or engineering geologist as defined by the Schedule 1 to the Erosion Management Overlay **and on behalf of the company below, I:**

Yes		
☒	No ☐	am aware that the geotechnical report I have either prepared or am technically verifying (referenced above) is to be submitted in a support of a development application for the proposed development site (referenced above) and its findings will be relied upon by Colac-Otway Shire in determining the development application.
☒	N/A ☐	prepared the geotechnical report referenced above in accordance with the AGS (2007c) as amended and Schedule 1 to the Erosion Management Overlay.
☒	N/A ☐	am willing to technically verify that the Geotechnical Report referenced above has been prepared in accordance with the AGS (2007c) as amended and Schedule 1 to the Erosion Management Overlay.
☒	No ☐	am willing to technically verify that the landslip risk assessment prepared for the development application for the site confirms the land will achieve the level of <*tolerable risk*> of slope instability as a result of the considerations described in Section 2.0 of Schedule 1 to the Erosion Management Overlay taking into account the total development and site disturbances proposed.
☐	N/A ☒	am willing to technically verify that the landslip risk assessment prepared for the site and related land being greater than two years old confirms the land will achieve the level of <*tolerable risk*> of slope instability as a result of the considerations described Section 2.0 of Schedule 1 to the Erosion Management Overlay *taking into account the total development and site disturbances proposed.*
☒	No ☐	have professional indemnity insurance in accordance with and Schedule 1 to the Erosion Management Overlay of not less than $1.0 million, being in force for the year in which the report is dated, with retroactive cover under this insurance policy extending back to the engineer's first submission to Colac-Otway Shire.

Section 6 Geotechnical Engineer or Engineering Geologist Details

Company/ Organization Name	AGR Geosciences Pty Ltd	
Name (Company Representative)	Surname: Horwood	Mr /Mrs /Other: Mr
	Given Names: David John	
	Chartered Professional Status: **CP (Geo)**	Registration No: **321719**
Signature		Dated: 12 / 09 / 2017

BUSHFIRE MANAGEMENT STATEMENT– 30,32 & 36 MORLEY AVE, WYE RIVER

30th October 2017

South Coast Bushfire Consultants

South Coast Bushfire Consultants

P.O. Box 721, Torquay, Vic 3228

Phone: 0401 328 757 Email: mksteel@bigpond.com

Principal Consultant – Kylie Steel

Qualifications / Accreditations:

- Accredited Bushfire Consultant (BPAD level 2) with the Fire Protection Association Australia (FPA) (2014)
- Preparing and assessing an application under the Bushfire Management Overlay – Planet (Department of Planning and Community Development) (2013)
- Postgraduate Certificate in Bushfire Planning and Management – The University of Melbourne (2013)
- Postgraduate Certificate in Business – The University of Notre Dame, Broome (2002)
- Bachelor of Science, Honours – The University of Melbourne (1998)
- Native Vegetation Planning Permit Applications – Planet (Department of Planning and Community Development) Training Seminar (2013)

Disclaimer

This report has been made with careful consideration and with the best information available to South Coast Bushfire Consultants at the time of writing. Before relying on information in this report, users should evaluate the accuracy, completeness and relevance of the information provided for their purposes. South Coast Bushfire Consultants do not guarantee that it is without flaw or omission of any kind and therefore disclaim all liability for any error, loss or other consequence that may arise from you relying on any information in this report.

Requirements detailed in this document do not guarantee survival of the buildings or the occupants. The owner of the dwelling is strongly encouraged to develop and practice a bushfire survival plan.

Version Control

	Name	Date Completed	Comments
Report Version	Kylie Steel	30/10/17	Version 2
Field Assessment	Kylie Steel	9/06/17	
Report	Kylie Steel	26/06/17	
Mapping	Kylie Steel	9/06/17	

Definitions, Abbreviations and Acronyms

AS 3959-2009 – Australian Standard AS 3959 -2009 Construction of buildings in bushfire-prone areas.

CFA – Country Fire Authority

Clause – A clause relates to a specific piece within the planning scheme.

Clause 44.06 – Bushfire Management Overlay

Clause 52.47 – Planning for Bushfire

DEPI – Department of Environment Planning and Infrastructure (now DELWP)

DELWP – Department of Environment, Land, Water and Planning

BAL – Bushfire Attack Level

BPA – Bushfire Prone Area

BMO – Bushfire Management Overlay

BMS – Bushfire Management Statement

Method 1 – refers to methodology in AS 3959-2009 for determining a BAL with a number of predetermined inputs.

Method 2 – refers to methodology in AS 3959-2009 for determining a site specific BAL

Pathway 1 – refers to an application pathway in Clause 52.47 of the planning scheme.

Pathway 2 – refers to an application pathway in Clause 52.47 of the planning scheme.

Planning Practice Note – a guide for using various sections of the planning scheme prepared by DTPI

RA – Responsible Authority

SCBC – South Coast Bushfire Consultants

Total Fire Ban Day – is declared by CFA on days when fires are likely to spread rapidly and could be difficult to control.

Bushfire Management Statement– 30,32 & 36 Morley Ave, Wye River

1 SUMMARY

This document analyses the bushfire hazards to a proposed dwelling on three lots at 30,32 and 36 Morley Avenue, Wye River and interprets how the site can meet the objectives and approval measures of *Clause 52.47 – Planning for Bushfire* and *44.06 - Bushfire Management Overlay*.

This document includes a Bushfire Hazard Site assessment, a Bushfire Landscape Assessment, Bushfire Attack Level (BAL) assessment and a Bushfire Management Plan. These requirements provide a response to the legislative requirements of the Bushfire Management Overlay (Clause 44.06 and 52.47).

The township of Wye River is located on the Great Ocean Road and is surrounded by extensive areas of unmanaged forest vegetation both on privately owned land and within the Great Otway National Park.

The site is located on the top of a ridge 130m from the ocean on the southern side of the Wye River township. It is largely surrounded by residential development and is not at the interface of large areas of unmanaged vegetation. The site is able to maintain an area of defendable space in accordance with a BAL of 29 in accordance with clause 52.47.

The site is able to meet the provisions for access and egress and will provide 10,000L of water solely for the purposes of fire fighting within the site. Access to the site and water supply will be provided for CFA.

2 INTRODUCTION

This document has been prepared for the property owners to respond to the requirements of Clause 44.06 *Bushfire Management Overlay* (known from this point on as Clause 44.06), and associated Clause 52.47 *Bushfire Protection: Planning Requirements* (known from this point on as Clause 52.47) for the construction of a new dwelling at 30,32 and 36 Morley Ave, Wye River.

The site is located in the Bushfire Management Overlay (BMO) and requires a bushfire management statement to accompany the planning permit application.

3 METHODOLOGY

The methodology used to prepare a holistic approach to assessing and mitigation the bushfire risk to the development includes the following:

- Bushfire Hazard Landscape Assessment
- Bushfire Hazard Site Assessment
- A method 1 BAL Assessment
- Bushfire Management Plan
- Bushfire Management Statement (Clause 52.47)

The site is within the township zone and requires a pathway 1 application to support the planning permit application. Due to the landscape risk associated with Wye River a modified landscape hazard has been prepared to support the application.

4 PLANNING AND BUILDING CONTROLS

4.1 Planning and building controls

Clause Number	Name
32.05	Township Zone (TZ)
	Schedule
44.06	Bushfire Management Overlay
52.17	Native Vegetation
52.47	Planning for Bushfire
52.48	Bushfire Protection: Exemptions
44.01	Erosion Management Overlay (EMO)
	Schedule 1 (EMO1)
43.02	Design and Development Overlay (DDO)
	Schedule 4 – Weather Protection (DDO4)
43.05	Neighbourhood Character Overlay
	Schedule 1
42.03	Significant Landscape Overlay (SLO)
	Schedule 2

5 BUSHFIRE HAZARD LANDSCAPE ASSESSMENT

The Bushfire Hazard Landscape Assessment includes a plan that describes the bushfire hazard of the general locality surrounding the site (Map 1).

5.1 Vegetation extent in the broader landscape

The township of Wye River is surrounded by forest to the north, west and south. The forest in all directions has extensive areas for a large landscape fire to develop and have a long run.

The forest vegetation is on steep slopes and the gullies to the north and south are characteristically wet gullies with rainforest vegetation. The high fuel loads combined with steep undulating terrain has the potential to create extreme bushfire behavior. The steep slopes increase the ability for a fire to spread and provide launch sites for embers to ignite multi spot fires ahead of the main bushfire front.

The 2015 Christmas day bushfires at Wye River have decreased the fuel load surrounding Wye River, however, the fuel loads will expected to increase over the life of the proposed development.

5.2 Surrounding Road Network

The proposed dwelling is located approximately 200m from the beach which is to the east of the property. The access roads to the beach are characteristic of Wye River and are steep and narrow. Travel to the beach is through built up residential development; however, the vegetation in the township area of Wye River cannot be considered low threat.

The closest two Neighbourhood Safer Places are located at:

1. Lorne – Point Grey (Lorne Pier)
2. Appolo Bay – Great Ocean Road between Nelson St and Moor St.

Accessing the neighbourhood safer places require travel through forested areas along the Great Ocean Road. Evacuation during a bushfire event along the Great Ocean Road is not recommended.

5.3 Bushfire History of the Area

The Barwon South West Regional Strategic Fire Management Plan: Environmental Scan lists bushfire events in the Otway Ranges. The 2015 Christmas Day Fires, the 1939 Black Friday Fires and the 1983 Ash Wednesday fires as being the most significant bushfire events in the South West region of Victoria in recent history.

The bushfires on Christmas day in 2015 showed how devastating a bushfire can be under relatively mild weather conditions in a sea side community with aging infrastructure. These bushfires has significantly lowered the fuel loads within the Wye River township and surrounding forests. These fuel loads will take a number of years to establish loads that were present pre the 2015 Bushfires.

The 1983 Ash Wednesday fires did not affect Wye River as can be seen on the bushfire history map in appendix 1 (DEPI 2014). The Black Friday (13th January 1939) burnt parts of the Otway Ranges (Appendix 1).

Since the devastating bushfires on Black Saturday in 2009 the number of prescribed burns or fuel reduction burns across the state has increased. The fuel reduction burns surrounding Wye River can be seen in Appendix 1, most of these burns have occurred in the last 5-6 years.

5.4 Bushfire Risk

The site is at an increased risk from bushfire due to its vulnerability from all directions and the distance required traveling to a safer place. This report does not consider the current state of the landscape but considers what it will be in a high fuel load state, due to the life expectancy of the proposed development.

Bushfire behavior is influenced by three key factors; climate, topography and fuel availability. The landscape surrounding Wye River has high fuel loads and the topography of the landscape is hilly and complex. Summits are generally rounded above steep and dissecting valleys. The complex forms and multiple aspects of the topography will have a significant impact on how a bushfire behaves in the area.

There are significant areas for a bushfire to become established and build in the Great Otway National Park which surrounds the township of Wye River. The extent of forest surrounding Wye River is evident in Map 1.

5.5 Landscape Type

The determination of landscape type is a requirement of a Clause 52.47 – Pathway 2 application, it is a simplified method to establish landscape context. Although the landscape type is not required for a pathway 1 it sets the scene for the risk assessment.

The surrounding landscape is characteristic of the 'Broader Landscape Type Four' as per *Planning Practice Note 65* (DTPLI 2014).

Table 4 – Broader Landscape Type Justification

Broader Landscape Type One Description	Sites Response
The broader landscape presents an extreme risk	There are heavily forested areas to the north, east and west of Wye River. The topography of the surrounding landscape is characteristic of steep slopes and is very hilly. This landscape would contribute to a fires severity.
Evacuation options are limited or not available.	The only evacuation point is to the beach. The township is located on the Great Ocean Road and evacuation along this road is only recommended prior to a day that is predicted to be of a high bushfire risk. Evacuation along the Great Ocean Road once a fire is established is not an option.

D17/101942

Map 1 – Bushfire Hazard Landscape Assessment

6 BUSHFIRE HAZARD SITE ASSESSMENT

The Bushfire Hazard Site Assessment includes a plan that describes the bushfire hazard within 150 meters of the proposed development. The description of the hazard is prepared in accordance with AS 3959-2009 Construction of buildings in bushfire prone areas (Standards Australia) excluding paragraph (a) of section 2.2.3.2 (Vegetation Exclusions).

6.1 Site Details

Address:	30,32 and 36 Morley Ave, Wye River
Lot / Plan:	Lot 1 TP160454
Municipality:	Colac Otway
Existing Dwellings:	Vacant Land
Private Bushfire Shelter:	Not Applicable
Application Pathway:	Clause 52.47-1
Directory Reference:	Vic Roads 519 S7

Map 2 – Bushfire Hazard Site Assessment.

6.2 Vegetation

The vegetation within the 150 meter assessment area was classified according to AS 3959-2009, 'Practice note 65 (DTPLI 2014) and the 'Overall fuel hazard assessment guide' (DSE 2010).

The AS 3959-2009 approach uses a generalised description of vegetation based on the AUSLIG (Australian Natural Resources Atlas: No.7 Native Vegetation) classification system. According to this method, vegetation can be classified into seven categories. Each category indicates a particular type of fire behavior and these categories or classifications are then used to determine bushfire intensity.

The vegetation identified within the 150 meter assessment zone is detailed in table 3 and the locations of these vegetation types are evident in Map 2.

Table 3 – Vegetation Assessment

Forest	**<u>AS 3959-2009 Description</u>** *Trees 10-30 meters high; 30-70% foliage cover; (may include understorey of sclerophyllous low trees and tall scrubs or grass). Typically dominated by eucalypts.* The assumed fuel load for forest in AS 3959 is 25 t/ha ground fuel and 35 t/ha overall fuel. **<u>Site Description</u>** The forest identified was in the form of Shrubby Foothill Forests (EVC 45). This forest type occurs on ridges and exposed aspects on moderately fertile soils and at a range of elevations. The over storey is a medium eucalypt forest to 25m tall over an understorey characterised by a distinctive middle stratum dominated by a diversity of narrow-leaved shrubs and a paucity of ferns, graminoids and herbs in the ground stratum. Dominant tree species are Messmate Stringybark (*Eucalyptus oblique*) and Mountain Grey-gum *(Eucalyptus cypellocarpa).*
Modified Vegetation	**<u>Modified Vegetation as described in *Planning Practice Note 65 (DPCD).*</u>** *Modified vegetation refers to vegetation that is different from other vegetation types shown in AS 3959-2009 and Table 1 and Table 2 of Clause 52.47-3. Modified vegetation arises in parts of Victoria where fuel loads are high but the vegetation is modified because of urban development, gardens, the way the vegetation is configured (for example, limited or no understorey vegetation), or because the fuel loads are different from the fuel loads assumed in AS 3959-2009.* **<u>Site Description</u>** There is evidence of modified vegetation throughout the township of Wye

	River Local home owners have modified the vegetation for the purposes of bushfire mitigation and for garden aesthetics. The vegetation in the residential gardens cannot be considered as 'low threat' given the surrounding landscape risk and the amount of large trees throughout the township. It is important to note that many of the residential gardens do have managed understorey vegetation.
Closed Scrub	**<u>AS 3959-2009 Description</u>** *Found in wet areas and / or areas affected by poor soil fertility or shallow soils; >30% foliage cover. Dry heaths occur in rocky areas. Shrubs >2m high. Typical of coastal wetlands and tall heaths.* The assumed fuel load for Scrub in AS 3959 is 25 t/ha and considered appropriate for this vegetation. **<u>Site Description</u>** The vegetation between the development and the ocean is dominated by coastal scrub vegetation. The vegetation is stunted due to the impacts from the ocean sea breezes. The vegetation still holds high fuel loads; however, the vegetation cannot reach large heights due to the impacts of coastal environments.

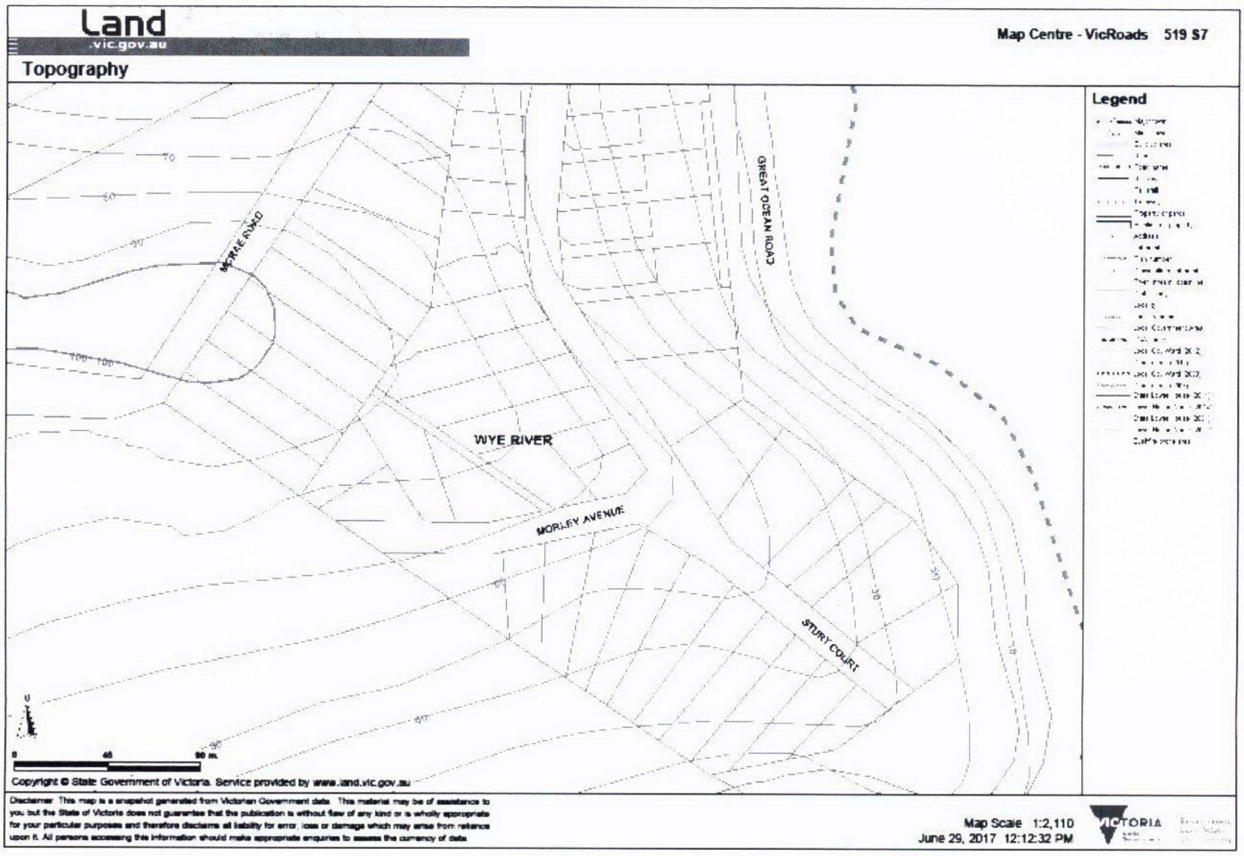
6.3 Topography

The proposed development site is located on the top of a ridge that falls way to the north east, east and south. There is a significant amount of modified vegetation in these directions, however, there is a native vegetation reserve that runs along the Great Ocean Road which is to the north, east and south of the proposed development.

The surrounding slopes in close proximity to the site are steep and would encourage the severity of a bushfires behavior, however, the availability of fuel and width of the vegetation will limit a bushfires ability to build into a fire front as assumed in AS 3959-2009.

The wider topography will enable embers to be launched into this area of the township and the surrounding vegetation in conjunction with the steep topography will enable spot fires to develop.

Map 3 – Topography of the site.



6.4 Bushfire Attack Level (BAL) for the proposed development

The bushfire attack level (BAL) is a means of measuring the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact, using increments of radiant heat expressed in kilowatts per meter squared. The BAL is also the basis for establishing the requirements for construction to improve protection of building elements from attack by bushfire.

The highest BAL determines the construction requirements for the dwelling. A reduction of one BAL level may be applied if facades of the house are shielded from the bushfire hazard. Shielding is not applicable to this site due to the classification of modified vegetation.

The BAL for this site has been calculated using a 'Forest Fire Danger Index' (FFDI) of 100 and a Flame Temperature of 1090K. The FFDI and flame temperature are in accordance with parameters that have been set as the appropriate risk parameters by the Minster for Planning.

A method 2 BAL assessment has been used to determine the BAL to the east and south to establish an accurate indication of the impacts the scrub and forest vegetation will have on the proposed development. The detailed workings of this method are detailed in table 5, 6 and 7.

The distance from the dwelling to the forest vegetation to the south west is 63m and the radiant heat exposure is calculated to be 16.70 kW/m^2. The vegetation to the south west between the forest and the proposed development has been classified as modified due to reduced fuel loads and residential style gardens with fragmented fuel arrangements.
The defendable distance for a BAL of 29 has been calculated to be 44m (Table 7) and this includes an area of 8m within the modified fuel zone. This is deemed appropriate given the radiant heat exposure calculations from the forest.

Table 4 – BAL calculations using table 1 in clause 52.47-3 and AS 3959-2009 methodology.

Orientation	Highest threat vegetation	Slope under classifiable vegetation	Distance to Classified Vegetation	Defendable Space Requirement	Bushfire Attack Level (BAL)
North	Modified Vegetation	Down slope 0-5°	3.6m	3.6m (Property Boundary)	29
East	Scrub	Down slope 5-10°	34m	27m	29
South	Forest	Down slope 10-15°	98m	44m	29
West	Modified Vegetation	Down slope 0-5°	63m	22m	29

Table 5- CSIRO BAL Calculation to the East

Shrubland, Scrub & Mallee/Mulga

Vegetation classification	Scrub			
Overall Fuel Load (t/ha)	25	*1		
Vegetation height (m)	2.5	*1		
Wind speed (km/h)	45	*4		
Effective slope under the classified vegetation (degrees)	10	Downslope		
Slope between the site and classified vegetation (degrees)	14			
Distance of the site from classified vegetation (m)	27		Rate of spread	3.775744
Flame Width (m)	100	*2	Slope ROS	2.935826
Flame Temperature (K)	1090	*3	Flame length	9.898899
Flame Emissivity	0.95	*4	Flame angle	92
Ambient Temperature (K)	308	*4	View Factor	0.170404
Relative humidity	25%	*4	Height of Receiver	0
Direction	E		Path length	27.17273
Assessment date	25/06/2017		Atmospheric Transmissivity	0.811643
Assessment Performed by	Kylie Steel		Radiant heat flux	10.52
Site Location	Morley Ave, Wye River		BUSHFIRE ATTACK LEVEL	BAL -12.5

Table 6 - CSIRO BAL Calculating from the Forest vegetation to the south.

Forest, Woodlands & Rainforest

FDI	100				
Vegetation classification	Forest				
Surface Fuel Load (t/ha)	25	*1			
Overall Fuel Load (t/ha)	35	*1			
Effective slope under the classified vegetation (degrees)	12	Downslope			
Slope between the site and classified vegetation (degrees)	9				
Distance of the site from classified vegetation (m)	63		Rate of spread	3	(km/h)
Flame Width (m)	100	*2	Slope ROS	6.86621	(km/h)
Flame Temperature (K)	1090	*3	Flame length	48.83037	(m)
Flame Emissivity	0.95	*4	Flame angle	67	
Ambient Temperature (K)	308	*4	View Factor	0.287791	
Relative humidity (%)	25%	*4	Height of Receiver	12.49607	(m)
Direction	W		Path length	53.46023	(m)
Assessment date	22/03/2017		Atmospheric Transmissivity	0.763141	
Assessment performed by	Kylie Steel		Radiant heat flux	16.70	(kW/m^2)
Site Location	30,32 and 36 Morley St, Wye River		BUSHFIRE ATTACK LEVEL	BAL -19	

Table 7 – CSIRO BAL Calculation to the south for defendable space distance of a BAL 29.

Forest, Woodlands & Rainforest

FDI	100				
Vegetation classification	Forest				
Surface Fuel Load (t/ha)	25	*1			
Overall Fuel Load (t/ha)	35	*1			
Effective slope under the classified vegetation (degrees)	12	Downslope			
Slope between the site and classified vegetation (degrees)	9				
Distance of the site from classified vegetation (m)	44		Rate of spread	3	(km/h)
Flame Width (m)	100	*2	Slope ROS	6.86621	(km/h)
Flame Temperature (K)	1090	*3	Flame length	48.83037	(m)
Flame Emissivity	0.95	*4	Flame angle	59	
Ambient Temperature (K)	308	*4	View Factor	0.475368	
Relative humidity (%)	25%	*4	Height of Receiver	13.95898	(m)
Direction	W		Path length	31.42525	(m)
Assessment date	22/03/2017		Atmospheric Transmissivity	0.801595	
Assessment performed by	Kylie Steel		Radiant heat flux	28.97	(kW/m^2)
Site Location	30,32 and 36 Morley St, Wye River		BUSHFIRE ATTACK LEVEL	BAL -29	

7 BUSHFIRE MANAGEMENT PLAN AND STANDARD PERMIT CONDITIONS

Section 7 of this document forms the complete Bushfire Management Plan. The plan must show the following bushfire mitigation measures, unless otherwise agreed in writing by the CFA and the Responsible Authority. Before development starts, a Bushfire Management Plan (BMP) must be submitted to and endorsed by the Responsible Authority.

Table 8 – Planning permit conditions to accompany the Bushfire Management Plan.

Permit Conditions
Defendable Space An area of defendable space for the designated BAL around the proposed building / or to the property boundary where vegetation (and other flammable materials) will be modified and managed in accordance with the following requirements: • Grass must be short cropped and maintained during the declared fire danger period. • All leaves and vegetation debris must be removed at regular intervals during the declared fire danger period. • Within 10 meters of a building, flammable objects must not be located close to the vulnerable parts of the building. • Plants greater than 10 cm in height must not be placed within 3m of a window or glass feature of the building. • Shrubs must not be located under the canopy of trees. • Individual and clumps of shrubs must not exceed 5sq. metres in area and must be separated by at least 5 metres. • Trees must not overhang or touch any elements of the building. • The canopy of trees must be separated by at least 5 meters. • There must be a clearance of at least 2 metres between the lowest tree branches and ground level.

Defendable space distances as calculated in section 6 of the Bushfire Management Statement.

Orientation	Highest threat vegetation	Slope under classifiable vegetation	Defendable Space Requirement	Bushfire Attack Level (BAL)
North	Modified Vegetation	Down slope 0-5°	3m Property Boundary	29
East	Scrub	Down slope 5-10°	27m	29
South	Forest	Down slope 10-15°	44m	29
West	Modified Vegetation	Down slope 0-5°	22m	29

Construction Standards

All construction works need to comply with a BAL of 29 from AS 3959-2009.

Water Supply

The site is required to have 10,000 Litres of water supply for fire fighting purposes which meets the following requirements:

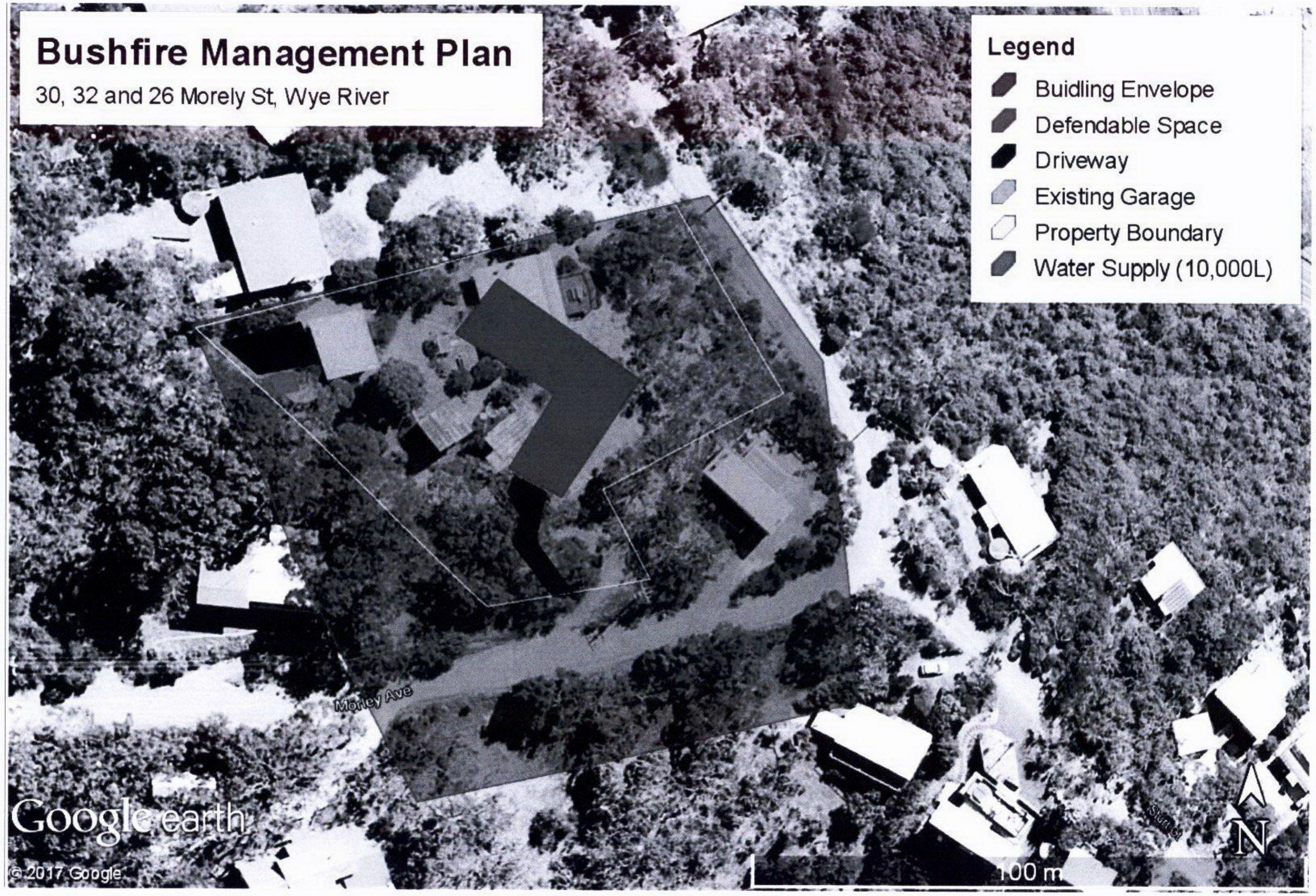
- Is stored in an above ground water tank constructed of concrete or metal.
- All fixed above-ground water pipes and fittings required for fire fighting purposes must be made of corrosive resistant metal.
- Incorporate a ball or gate valve (British Standard Pipe (BSP) 65mm) and coupling (64mm CFA 3 thread per inch male fitting).
- The outlet/s of the water tank must be within 4m of the accessway and be unobstructed.
- Be readily identifiable from the building or appropriate identification signage to the satisfaction of CFA must be provided.
- Any pipework and fittings must be a minimum of 65mm (excluding the CFA coupling).

Access

Where the access is less than 30 metres fire authority vehicles should be able to get within 4 metres of the water supply outlet.

D17/101942

Map 4 – Bushfire Management Plan – (To be read in conjunction with table 8 – Planning permit conditions).



8 BUSHFIRE MANAGEMENT STATEMENT – SITES RESPONSE TO APPLICABLE SUB CLAUSES OF 52.47

Clause 52.47 contains a range of sub clauses with objectives, approved measures (AM), alternative measures (AltM) and decision guidelines. The table below details which clauses are relevant to this application. The following section demonstrates how the requirements have been met for the relevant standards.

Table 5 - Relevant clauses and measures applicable to the proposed development.

Clause	Approved Measure	Achieved	Justification
Clause 52.47-1 – Dwellings in existing settlements – Bushfire protection objective	AM 1.1	Not Applicable	The proposed development uses an alternative assessment for establishing the BAL and therefore requires a pathway 2 application.
	AM 1.2	Not Applicable	
	AM 1.3	Not Applicable	
Clause 52.47-2.1 Landscape, siting and design objectives	AM 2.1	Applicable	This development must address this clause.
	AM 2.2	Applicable	
	AM 2.3	Applicable	
Clause 52.47-2.2 Landscape, siting and design objectives	AM 3.1	Not Applicable	This development proposes a method 2 assessment.
	AM 3.2	Not Applicable	The proposed development is a dwelling and response to this measure is not required.
	AltM 3.3	Applicable	Adjoining land will be used for defendable space
	AltM 3.4	Applicable	A method 2 assessment has been proposed.
	AltM 3.5	Not Applicable	BAL FZ is not required
	AltM 3.6	Not Applicable	
Clause 52.47-2.3 Landscape, siting and design objectives	AM 4.1	Achieved	This development must address this clause.
	AM 4.2	Not Applicable	The proposed development is a dwelling and response to this measure is not required.
Clause 52.47-2.4 Subdivision objectives	AM 5.1	Not Applicable	This application is not a subdivision.
	AM 5.2	Not Applicable	
	AM 5.3	Not Applicable	
	AM 5.4	Not Applicable	
	AM 5.5	Not Applicable	

8.1 52.47-2.1 Landscape, siting and design objectives

Development is appropriate having regard to the nature of the bushfire risk arising from the surrounding landscape.

Development is sited to minimise the risk from bushfire.

Development is sited to provide safe access for vehicles, including emergency vehicles.

Building design minimises vulnerability to bushfire attack.

Approved Measure	Requirement
AM 2.1	**The bushfire risk to the development from the landscape beyond the site can be mitigated to an acceptable level.** **Response:** This report provides a comprehensive report on the bushfire hazards associated with the development site at 30,32 and 36 Morley Ave, Wye River. The site is able to mitigate the risks to an acceptable level as it can meet a BAL of 29. The BAL of 29 can be met by using the vegetation classification of modified and Forest. The BAL of 29 has been established using the following inputs; • 'Forest Fire Danger Index'(FFDI) of 100 and • Flame Temperature of 1090K. The development site is within the township zone and is largely surrounded my residential developments. The landscape is typical of coastal townships where there is a large number of native tree species within the residential gardens and is not always managed in accordance with defendable space conditions and has thus been classified as modified fuel for the purposes of the BAL calculation.
AM 2.2	**A building is sited to ensure the site best achieves the following:** • **The maximum separation distance between the building and the bushfire hazard.** • **The building is in close proximity to a public road.** • **Access can be provided to the building for emergency service vehicles.** **Response:** The dwelling is proposed for a residential allotment and there is limited availability for siting the dwelling further away from the bushfire hazard. The greatest hazard is considered to be from the south and east as these is these

are the areas where the unmanaged native vegetation is in the closest proximity to the proposed dwelling.

Defendable space for a BAL of 29 calculated using an alternative method can be achieved to all aspects.

The vegetation surrounding the site has largely been classified as modified due to its composition and the associated high landscape risk.

Proximity to Public Road and Access

The dwelling is located on Morely Ave and there is an easement that runs along the properties western boundary that also provides access.

AM 2.3	**A building is designed to reduce the accumulation of debris and entry of embers.** **Response:** The building will be designed and constructed to a BAL of 29 in accordance with the requirements detailed in AS 3959-2009. The dwelling is proposed to be constructed from non combustible materials and will be ember resistant. Please see architectural plans and note the simple roof line for ember resistance. The window alignment and entrance / exit points of the dwelling have been proposed to be sheltered from the exposure to the south and west.

8.1.1 52.47-2.2 Defendable space and construction objective

Approved Measure	Requirement
AM 3.1	**A building used for a dwelling (including an extension or alteration to a dwelling), a dependant person's unit, industry, office or retail premises is provided with defendable space in accordance with:** • **Column A, B or C of Table 2 to Clause 52.47-3 wholly within the title boundaries of the land; or** • **If there are significant siting constraints, Column D of Table 2 to Clause 52.47-3.** **The building is constructed to the bushfire attack level that corresponds to the defendable space provided in accordance with Table 2 to Clause 52.47-3.** **Response:** The defendable space requirements have been calculated using the method 2 calculator; see assessments in section 6.4 of this document.

The dwelling will be constructed to a BAL of 29.

AltM 3.4 **Defendable space and the bushfire attack level is determined using Method 2 of AS3959-2009 *Construction of buildings in bushfire prone areas* (Standards Australia) subject to any guidance published by the relevant fire authority.**

A method 2 assessment has been undertaken and the details of this methodology are detailed in section 6.4 of this document.

AltM 3.5 **A building used for a dwelling (including an extension or alteration to a dwelling) may provide defendable space to the property boundary where it can be demonstrated that:**

- **The lot has access to urban township or other areas where:**
  - **Protection can be provided from the impact of extreme bushfire behavior.**
  - **Fuel is managed in a minimum fuel condition.**
  - **There is sufficient distance or shielding to protect people from direct flame contact or harmful levels of radiant heat.**
- **Less defendable space and a higher construction standard is appropriate having regard to the bushfire hazard landscape assessment.**
- **The dwelling is constructed to a bushfire attack level of BAL FZ. This alternative measure only applies where the requirements of AM 3.1 cannot be met.**

Defendable space is shared across property boundaries and includes; Morley Ave and the residential properties to the south of Morley Ave. The vegetation within these properties as been classified as 'modified' and as a further analysis section 6.4 of this document calculates the radiant heat exposure to the forest over 63m from the dwelling. The defendable space is shared for 8m of the required 44m and due to the radiant heat calculation from the forest being BAL 19 it is deemed appropriate to share defendable space to the south.

The vegetation within the site is classified as modified vegetation and is currently managed in accordance with the vegetation management requirements detailed in the Bushfire Management Plan, however, due to the high landscape risk surrounding the township the classification of modified is more appropriate.

8.1.2 52.47-2.3 Water supply and access objectives

Approved Measure	Requirement
AM 4.1	**A building used for a dwelling (including an extension or alteration to a dwelling), a dependant person's unit, industry, office or retail premises is provided with:** • **A static water supply for fire fighting and property protection purposes specified in Table 4 to Clause 52.47-3.** • **Vehicle access that is designed and constructed as specified in Table 5 to Clause 52.47-3.** **The water supply may be in the same tank as other water supplies provided that a separate outlet is reserved for fire fighting water supplies.** **Response:** The dwelling is able to meet the water requirements by providing 10,000 Litres of water solely for the purposes of fire fighting and will allow fire authorities to get within 4 meters of the supply. The site is able to provide access for emergency service vehicles.

9 REFERENCES

CFA (2011). FSG LUP 0003 Assessing vegetation in a bushfire management overlay (BMO. Country Fire Authority, Burwood East, Victoria.

CFA (2011). Landscaping for Bushfire: Garden design and plant selection. Country Fire Authority, Burwood East, Victoria.

CFA (2012). FSG LUP 0002 Requirements for water supply and access in the Bushfire Management Overlay (BMO). Country Fire Authority, Burwood East, Victoria.

Department of Transport, Planning and Local Infrastructure (2014) Planning Practice Note 65 – Preparing and Assessing a Planning Application under the Bushfire Provisions in Planning Schemes. Victorian Government, Melbourne

Standards Australia (2009). AS 39359-2009 Construction of Buildings in Bushfire Prone Areas. Standards Australia, North Sydney, New South Wales.

D17/101942

10 APPENDICES

Appendix 1 – Bushfire History and Prescribed Burns in the Area (DEPI – Biodiversity Interactive Map – showing bushfire history).

Figure 1 – Natural Bushfires in the area since 1970. Pink areas on the map indicate wildfires.

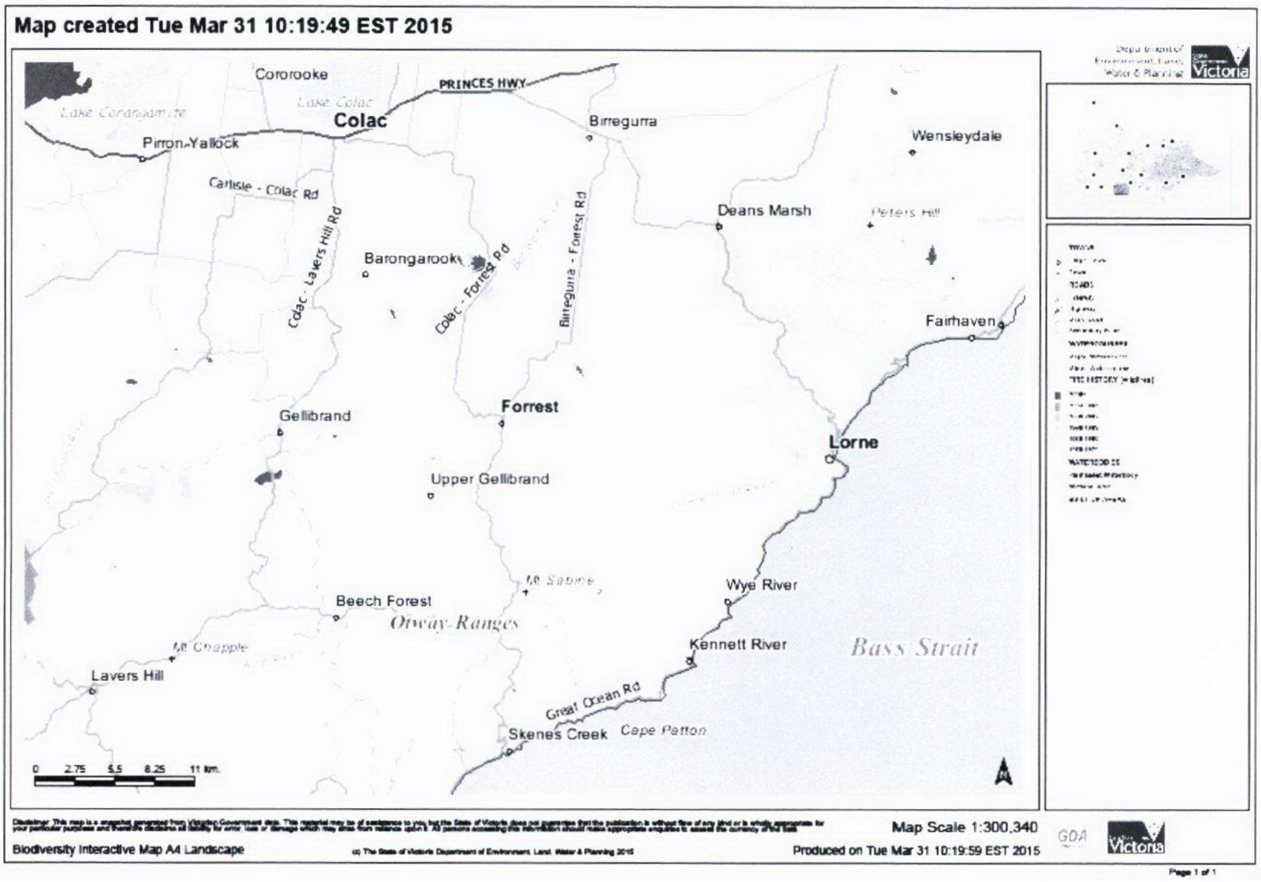
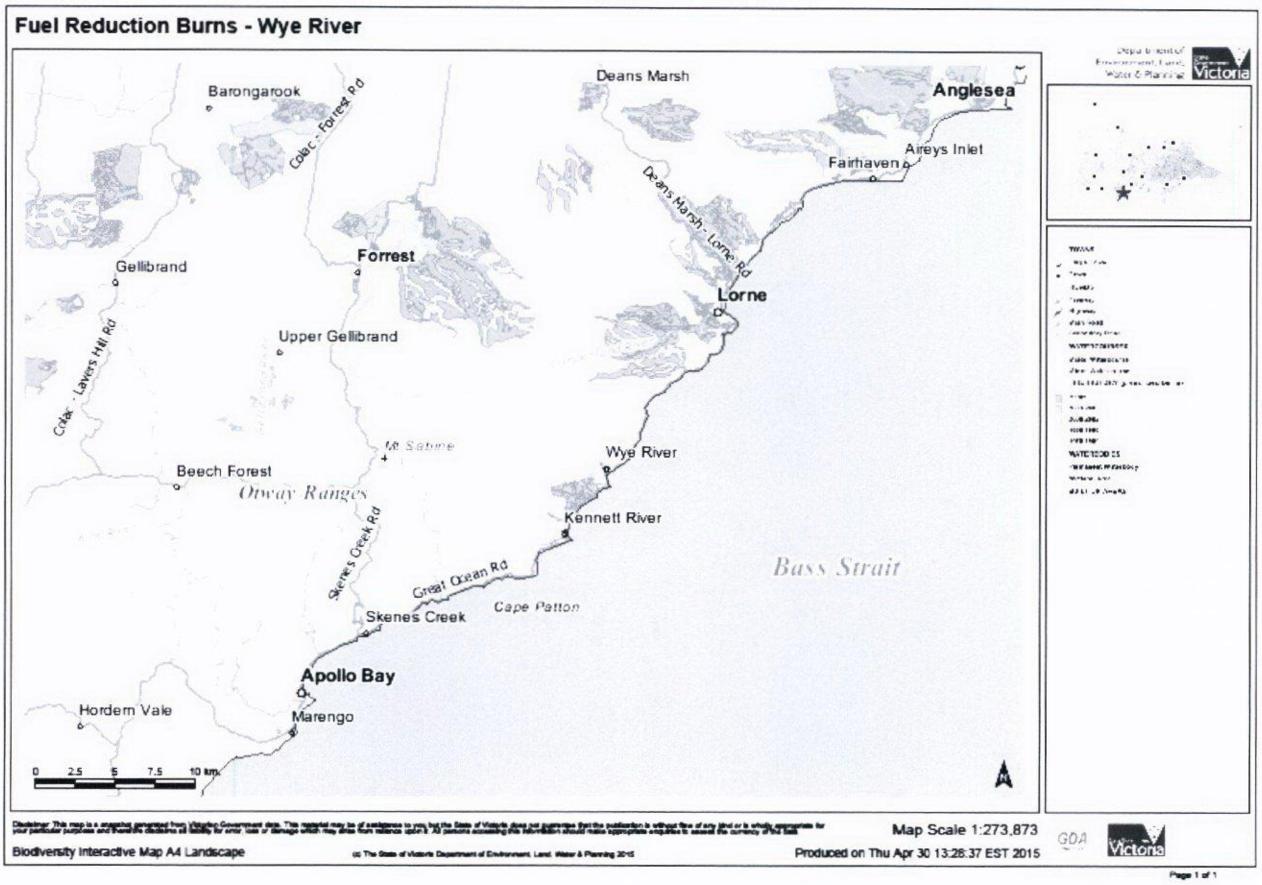


Figure 2 – Prescribed Burns in the area since 1970. Most of the prescribed burns indicated on the map shaded as areas of grey have occurred since the 2008 Black Saturday bushfires.



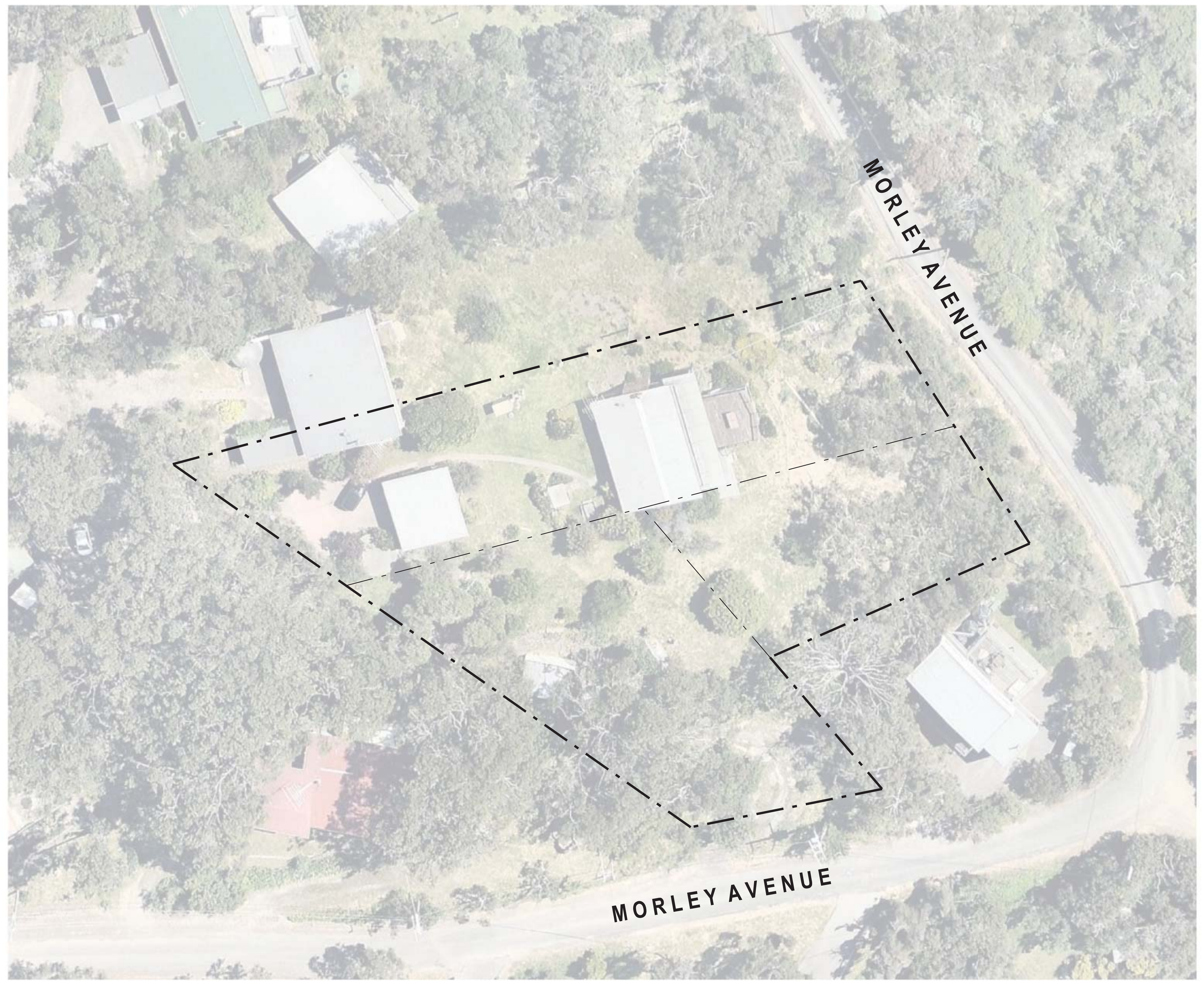
DRAWING REGISTER

DEVELOPMENT SUMMARY

SITE AREA	2848 sqm
SITE COVERAGE (BUILDING AREA)	462 sqm (16%)
SITE COVERAGE (FOOTPRINT)	323 sqm (11%)
SITE PERMEABILITY	2386 sqm (84%)

NOTE: WITH REGARDS TO SITE COVERAGE, BUILDING AREA DENOTES THE TOTAL AREA OF THE BUILT PROPOSAL, INCLUDING AREAS WHICH ARE NOT IN CONTACT WITH THE NGL, FOOTPRINT DENOTES THE BUILDING AREA WHICH IS IN CONTACT WITH OR PENETRATES THE NGL. REFER DOCUMENTATION FOR DETAIL.

30, 32 & 36 MORLEY AVE, WYE RIVER
TOWN PLANNING APPLICATION



AERIAL PHOTOGRAPH 1:500

GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
| Date | Approved By

INTERNAL CHECK
| Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE

CAD FILE REF
- - - -

STATUS
TOWN PLANNING

DRAWING TITLE
DRAWING REGISTER

DRAWING NUMBER
0-000

REVISION
A

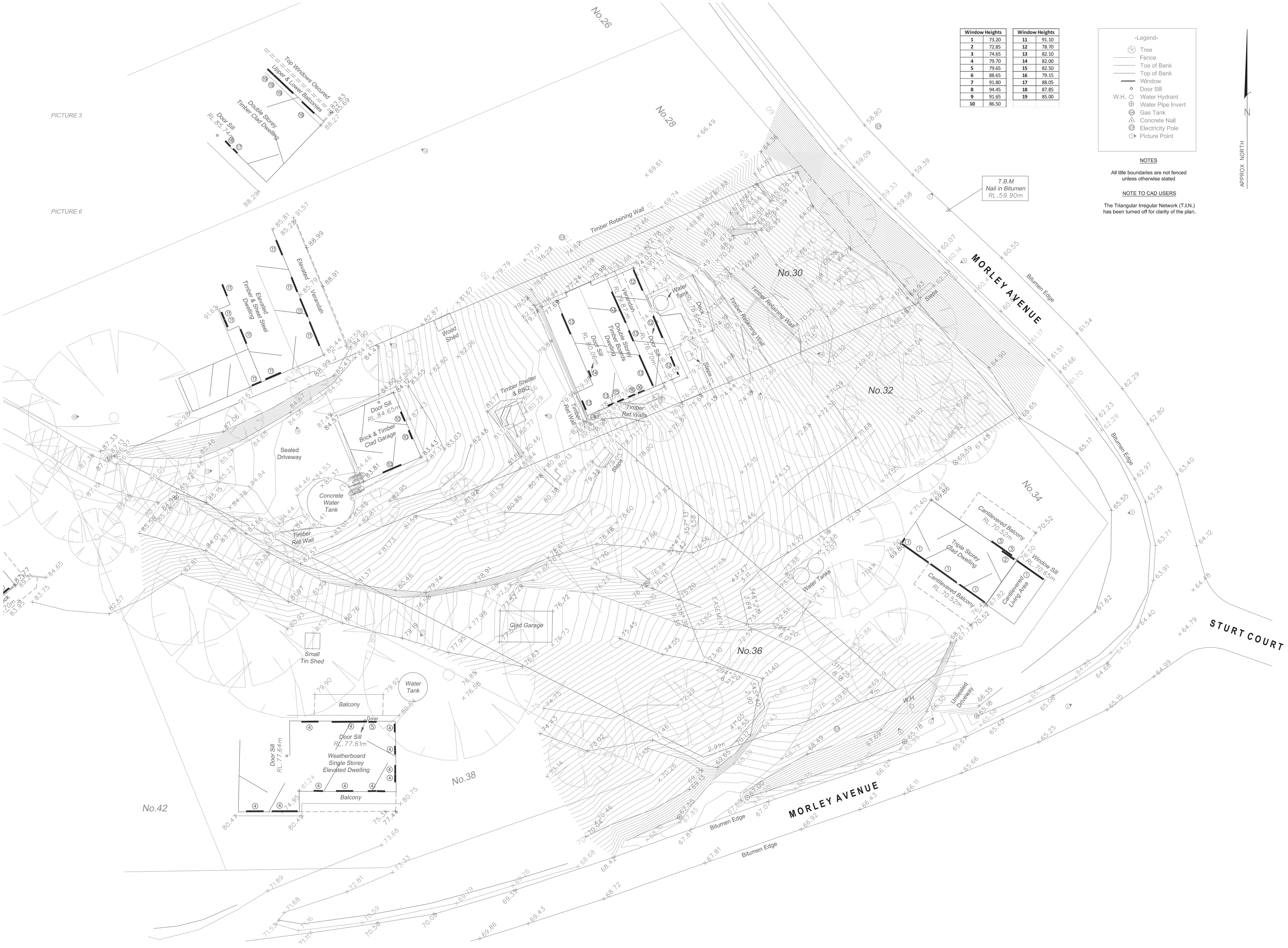
GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.



Window Heights	
1	73.20
2	72.85
3	74.65
4	79.70
5	79.65
6	88.65
7	91.80
8	94.45
9	91.65
10	86.50

Window Heights	
11	91.10
12	78.70
13	82.10
14	82.00
15	82.50
16	79.15
17	88.05
18	87.85
19	85.00

-Legend-

- Tree
- Fence
- Toe of Bank
- Top of Bank
- Window
- Door Sill
- W.H. Water Hydrant
- Water Pipe Invert
- Gas Tank
- Concrete Nail
- Electricity Pole
- Picture Point

APPROX NORTH

N

NOTES

All title boundaries are not fenced unless otherwise stated

NOTE TO CAD USERS

The Triangular Irregular Network (T.I.N.) has been turned off for clarity of the plan.

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
| Date | Approved By

INTERNAL CHECK
| Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE
1:200@A1 0 1.0 2.5 5.0M
1:400@A3

N

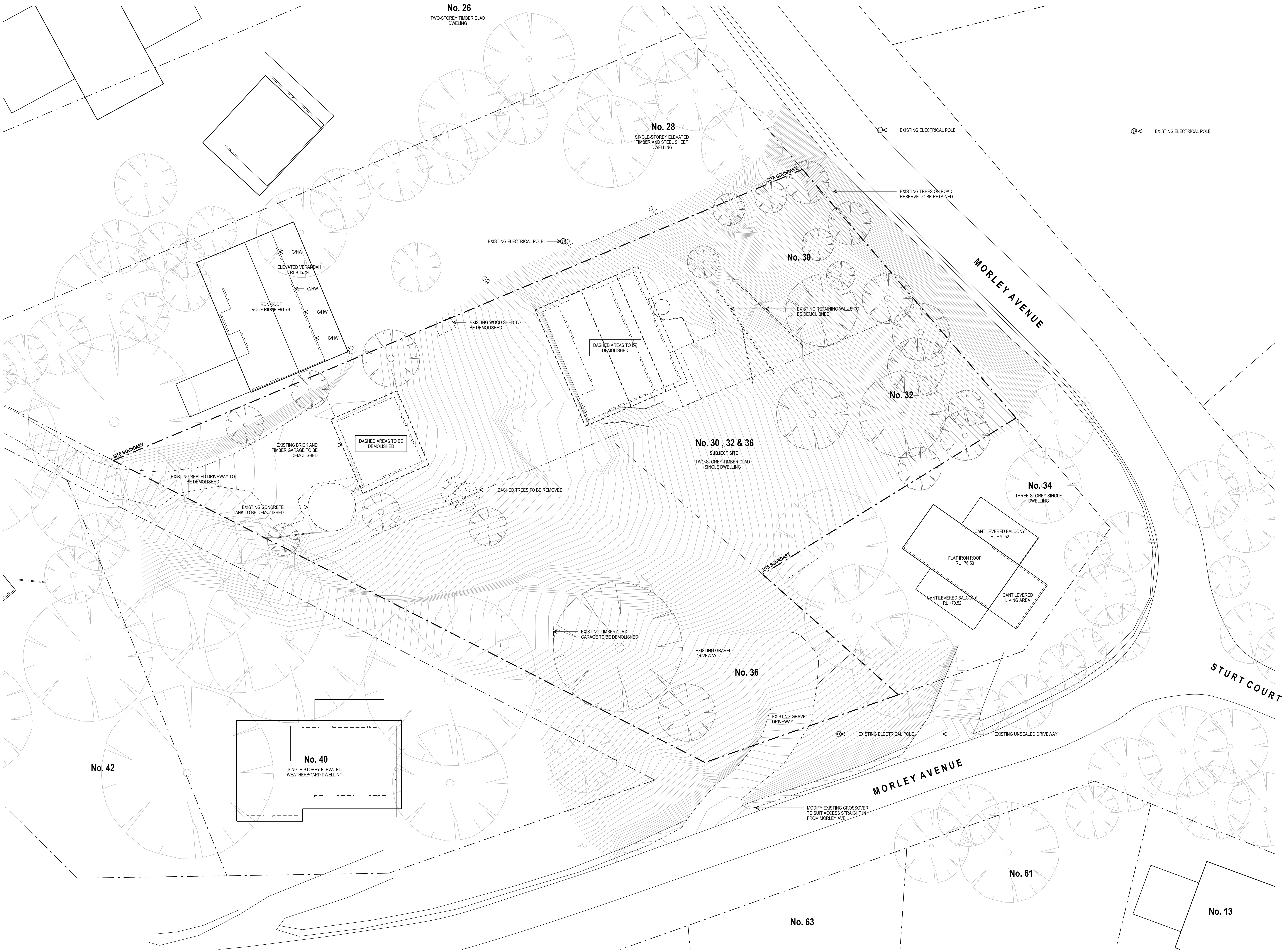
CAD FILE REF
- - - -

STATUS
TOWN PLANNING

DRAWING TITLE
EXISTING & DEMOLITION SURVEY PLAN

DRAWING NUMBER
0-101

REVISION
-



GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
Date | Approved By

INTERNAL CHECK
Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE
1:200@A1 0 1.0 2.5 5.0M
1:400@A3

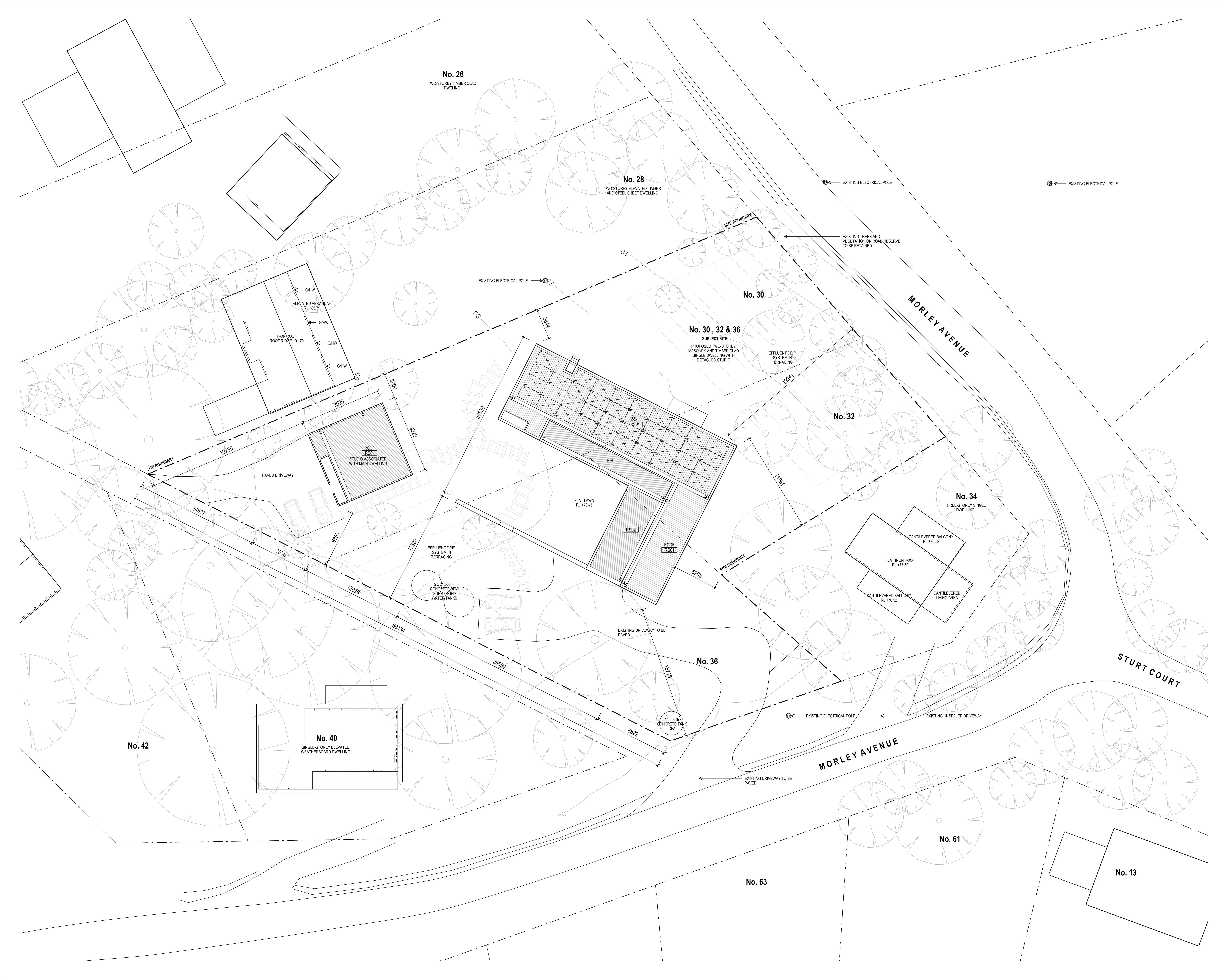
CAD FILE REF
- - - -

STATUS
TOWN PLANNING

DRAWING TITLE
EXISTING & DEMOLITION CONTEXT & ROOF PLAN

DRAWING NUMBER
0-201

REVISION
A



GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

LEGEND - EXTERNAL MATERIALS

- EF01 CONCRETE BLOCKWORK
- EF02 GREY CLADDING
- EF03 TIMBER CLADDING
- EF04 STEEL CLADDING
- RS01 METAL DECK ROOFING
- RS02 POLYCARBONATE ROOFING

LEGEND - INTERNAL MATERIALS

- PB PLASTERBOARD
- WPB WET PLASTERBOARD

LEGEND - FLOOR FINISHES

- FF01 POLISHED CONCRETE SLAB
- FF02 TIMBER FLOORING
- FF03 FLOOR TILES
- FF04 CARPET

LEGEND - LANDSCAPE MATERIALS

- LS01 PAVED DRIVEWAY
- LS02 CONCRETE PAVING
- LS03 HARDWOOD TIMBER DECKING
- LS04 LAWN

FG FIXED GLAZING
OG OPERABLE GLAZING
S/L SKYLIGHT

HW HABITABLE WINDOW
NON HW NON HABITABLE WINDOW
HGD HABITABLE GLAZED DOOR

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
Date | Approved By

INTERNAL CHECK
Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE
1:200@A1 0 1.0 2.5 5.0M
1:400@A3

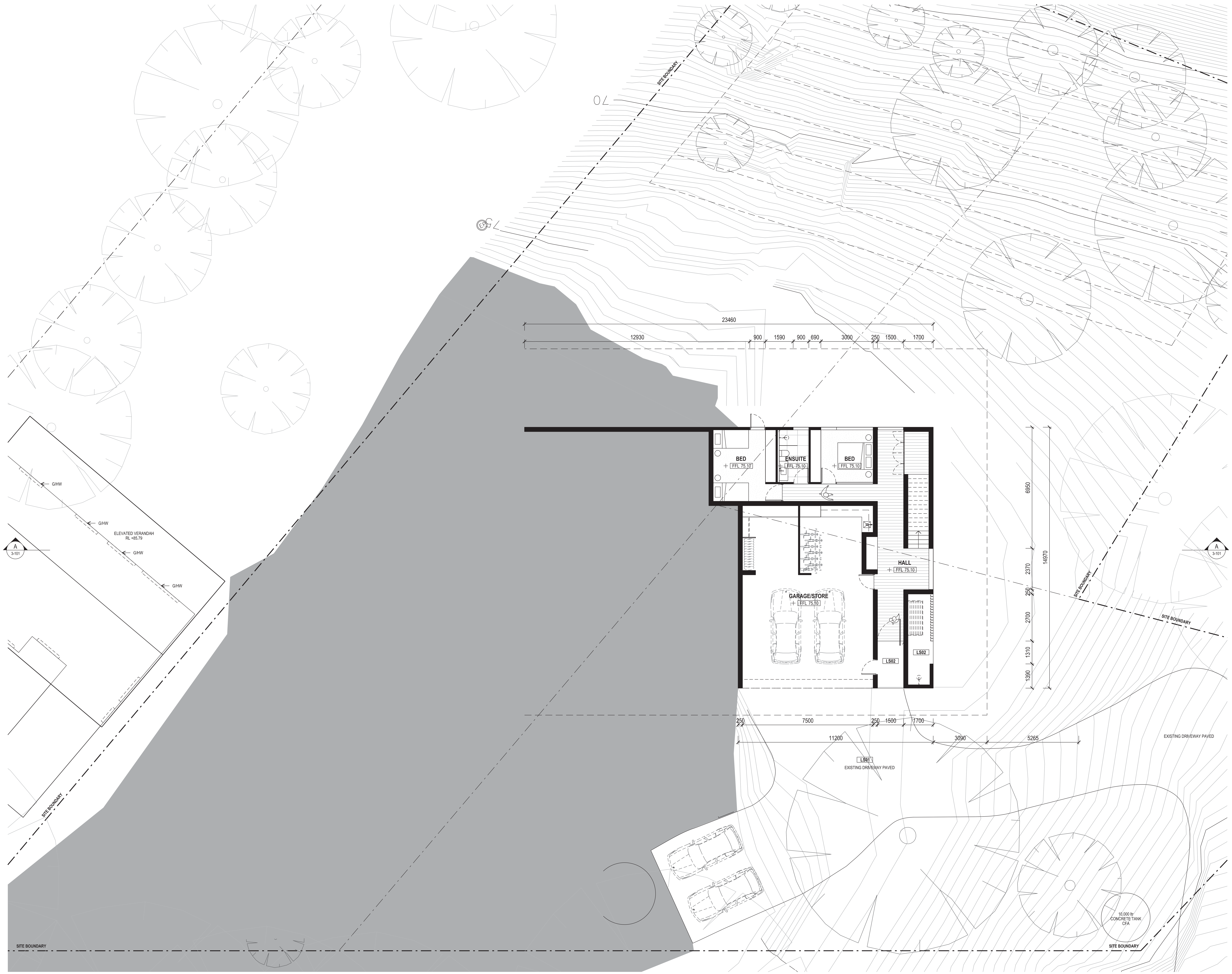
CAD FILE REF
- - - -

STATUS
TOWN PLANNING

DRAWING TITLE
PROPOSED CONTEXT, ROOF & LANDSCAPE PLAN

DRAWING NUMBER
1-101

REVISION
A



GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

LEGEND - EXTERNAL MATERIALS

- EF01 CONCRETE BLOCKWORK
- EF02 GREY CLADDING
- EF03 TIMBER CLADDING
- EF04 STEEL CLADDING
- RS01 METAL DECK ROOFING
- RS02 POLYCARBONATE ROOFING

LEGEND - INTERNAL MATERIALS

- PB PLASTERBOARD
- WPB WET PLASTERBOARD

LEGEND - FLOOR FINISHES

- FF01 POLISHED CONCRETE SLAB
- FF02 TIMBER FLOORING
- FF03 FLOOR TILES
- FF04 CARPET

LEGEND - LANDSCAPE MATERIALS

- LS01 PAVED DRIVEWAY
- LS02 CONCRETE PAVING
- LS03 HARDWOOD TIMBER DECKING
- LS04 LAWN

FG FIXED GLAZING
OG OPERABLE GLAZING
S/L SKYLIGHT

HW HABITABLE WINDOW
NON HW NON HABITABLE WINDOW
HGD HABITABLE GLAZED DOOR

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
Date | Approved By

INTERNAL CHECK
Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER **17004**
DATE **NOV 2017**

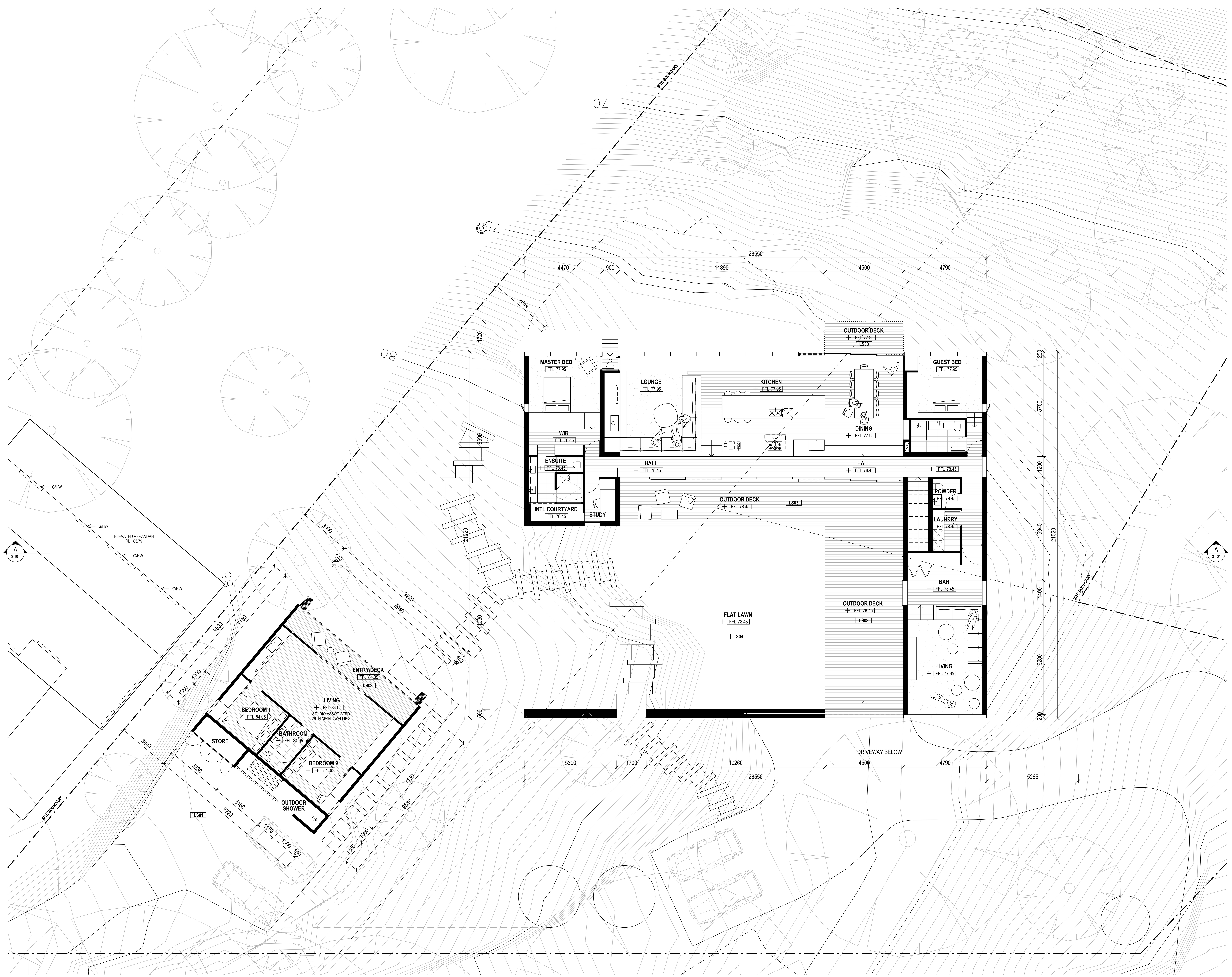
SCALE
1:100@A1 0 0.5 1 2 3M
1:200@A3

CAD FILE REF
- - - -

STATUS
TOWN PLANNING

DRAWING TITLE
PROPOSED BASEMENT PLAN

DRAWING NUMBER **1-102**
REVISION **A**



GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

COPYRIGHT OF THIS DRAWING IS VESTED IN THE ARCHITECTS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

LEGEND - EXTERNAL MATERIALS

EF01	CONCRETE BLOCKWORK
EF02	GREY CLADDING
EF03	TIMBER CLADDING
EF04	STEEL CLADDING
RS01	METAL DECK ROOFING
RS02	POLYCARBONATE ROOFING

LEGEND - INTERNAL MATERIALS

PB	PLASTERBOARD
WPB	WET PLASTERBOARD

LEGEND - FLOOR FINISHES

FF01	POLISHED CONCRETE SLAB
FF02	TIMBER FLOORING
FF03	FLOOR TILES
FF04	CARPET

LEGEND - LANDSCAPE MATERIALS

LS01	PAVED DRIVEWAY
LS02	CONCRETE PAVING
LS03	HARDWOOD TIMBER DECKING
LS04	LAWN

FG	FIXED GLAZING
OG	OPERABLE GLAZING
S/L	SKYLIGHT

HW	HABITABLE WINDOW
NON HW	NON HABITABLE WINDOW
HGD	HABITABLE GLAZED DOOR

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
Date | Approved By

INTERNAL CHECK
Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE
1:100@A1 0 0.5 1 2 3M
1:200@A3

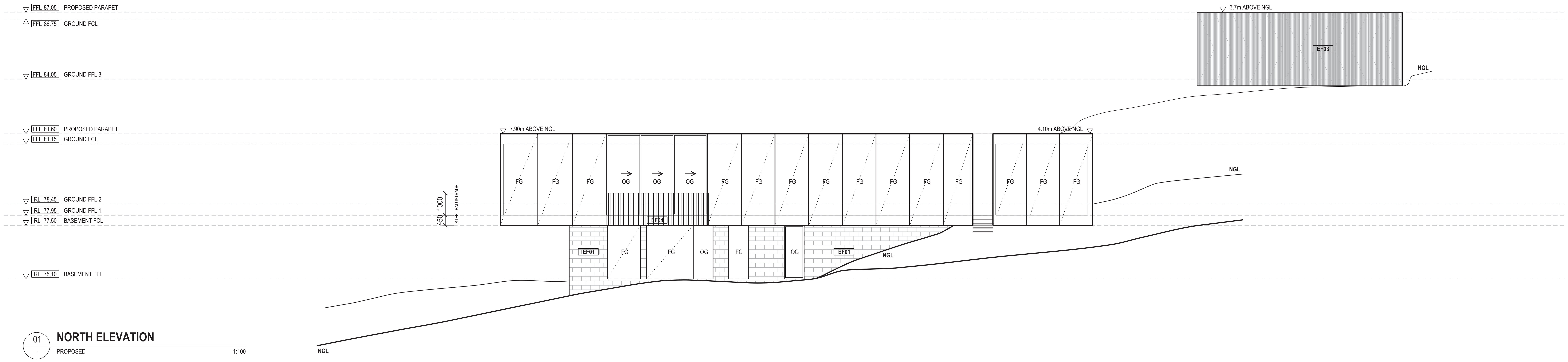
CAD FILE REF
- - - -

STATUS
TOWN PLANNING

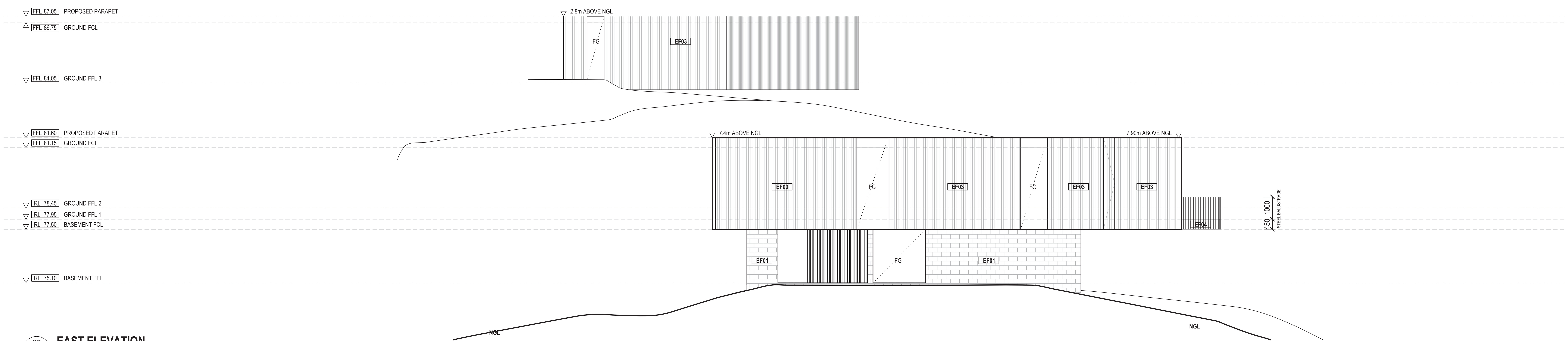
DRAWING TITLE
PROPOSED GROUND FLOOR PLAN

DRAWING NUMBER
1-103

REVISION
A



01 **NORTH ELEVATION**
- PROPOSED 1:100



02 **EAST ELEVATION**
- PROPOSED 1:100

GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

LEGEND - EXTERNAL MATERIALS

EF01	CONCRETE BLOCKWORK
EF02	GREY CLADDING
EF03	TIMBER CLADDING
EF04	STEEL CLADDING
RS01	METAL DECK ROOFING
RS02	POLYCARBONATE ROOFING

LEGEND - INTERNAL MATERIALS

PB	PLASTERBOARD
WPB	WET PLASTERBOARD

LEGEND - FLOOR FINISHES

FF01	POLISHED CONCRETE SLAB
FF02	TIMBER FLOORING
FF03	FLOOR TILES
FF04	CARPET

LEGEND - LANDSCAPE MATERIALS

LS01	PAVED DRIVEWAY
LS02	CONCRETE PAVING
LS03	HARDWOOD TIMBER DECKING
LS04	LAWN

FG	FIXED GLAZING
OG	OPERABLE GLAZING
S/L	SKYLIGHT

HW	HABITABLE WINDOW
NON HW	NON HABITABLE WINDOW
HGD	HABITABLE GLAZED DOOR

Rob
Kennon
Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
| Date | Approved By

INTERNAL CHECK
| Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE
1:100@A1 1:200@A3 0 0.5 1 2 3M

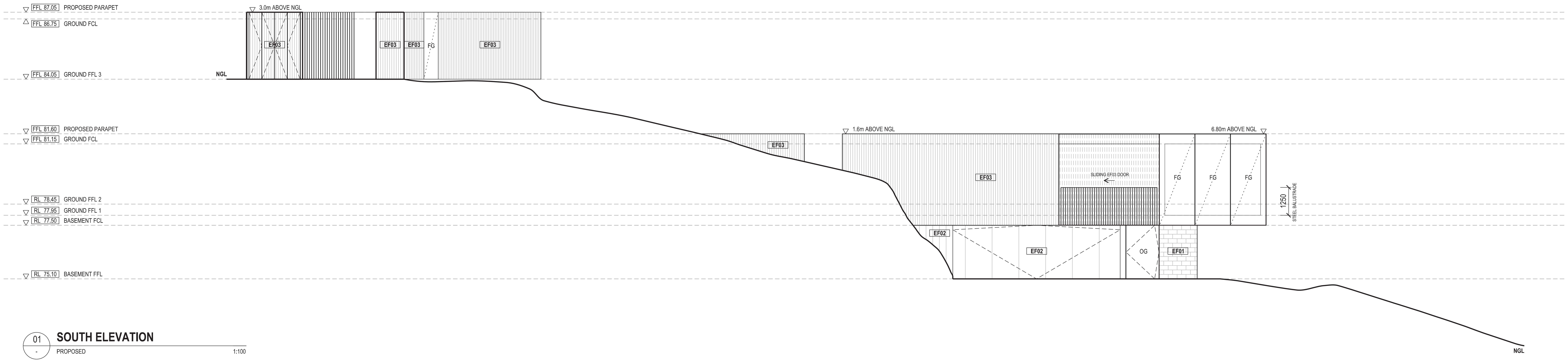
CAD FILE REF
- - - -

STATUS
TOWN PLANNING

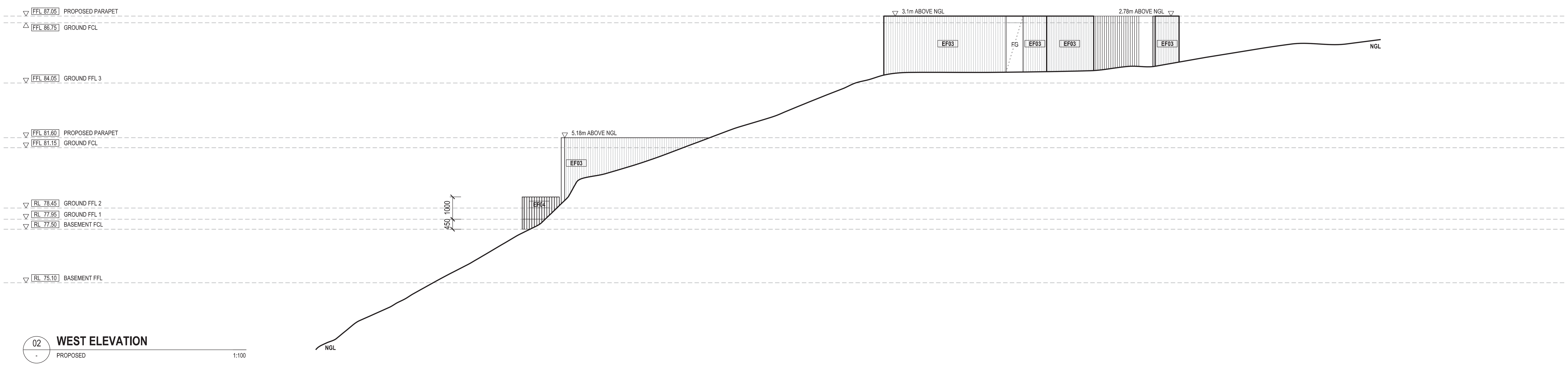
DRAWING TITLE
PROPOSED ELEVATIONS

DRAWING NUMBER
2-101

REVISION
A



01 **SOUTH ELEVATION**
PROPOSED 1:100



02 **WEST ELEVATION**
PROPOSED 1:100

GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

LEGEND - EXTERNAL MATERIALS

EF01 CONCRETE BLOCKWORK
EF02 GREY CLADDING
EF03 TIMBER CLADDING
EF04 STEEL CLADDING
RS01 METAL DECK ROOFING
RS02 POLYCARBONATE ROOFING

LEGEND - INTERNAL MATERIALS

PB PLASTERBOARD
WPB WET PLASTERBOARD

LEGEND - FLOOR FINISHES

FF01 POLISHED CONCRETE SLAB
FF02 TIMBER FLOORING
FF03 FLOOR TILES
FF04 CARPET

LEGEND - LANDSCAPE MATERIALS

LS01 PAVED DRIVEWAY
LS02 CONCRETE PAVING
LS03 HARDWOOD TIMBER DECKING
LS04 LAWN

FG FIXED GLAZING
OG OPERABLE GLAZING
S/L SKYLIGHT

HW HABITABLE WINDOW
NON HW NON HABITABLE WINDOW
HGD HABITABLE GLAZED DOOR
NON HGD NON HABITABLE GLAZED DOOR

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
Date | Approved By

INTERNAL CHECK
Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE
1:100@A1 1:200@A3 0 0.5 1 2 3M

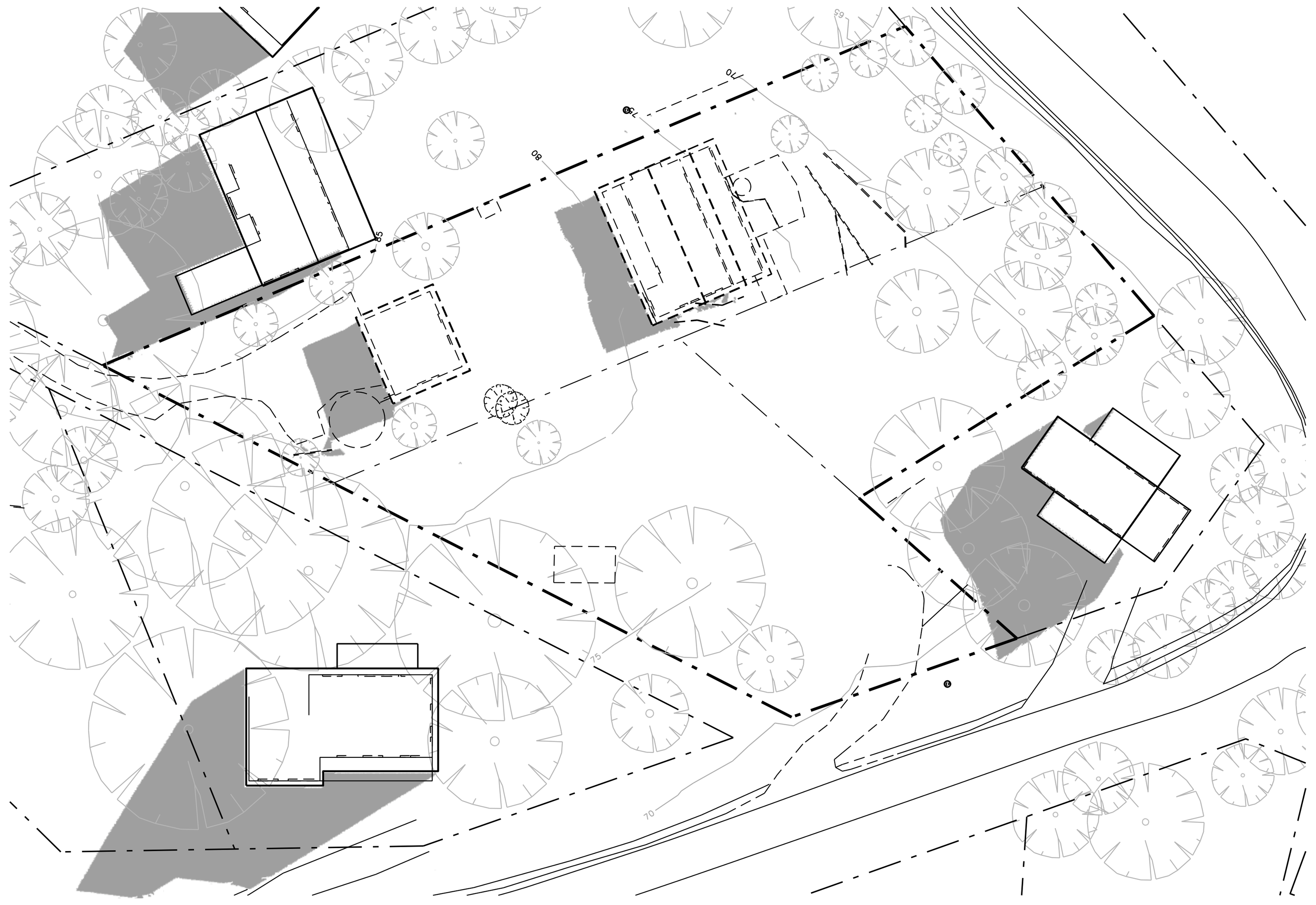
CAD FILE REF
- - - -

STATUS
TOWN PLANNING

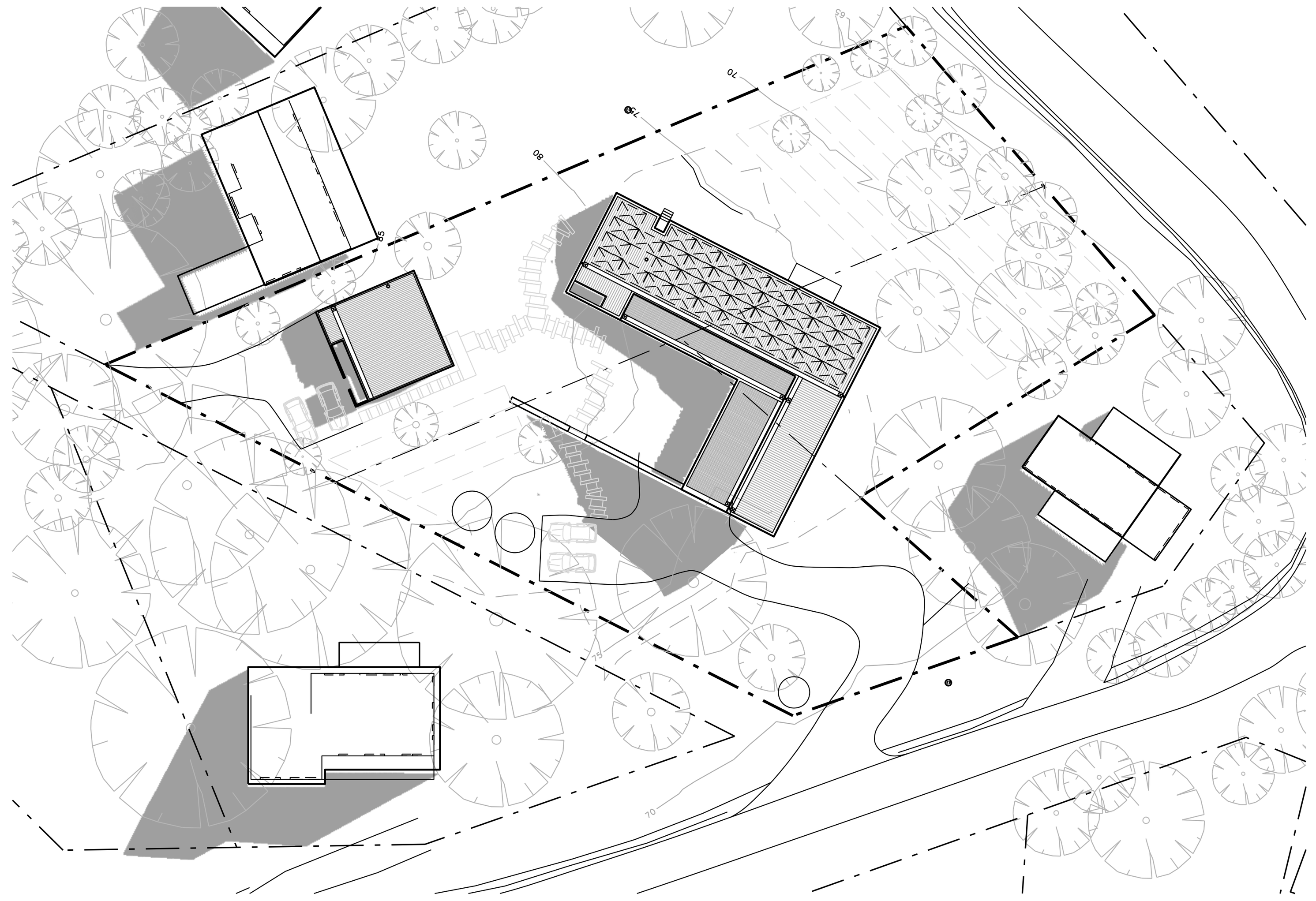
DRAWING TITLE
PROPOSED ELEVATIONS

DRAWING NUMBER
2-102

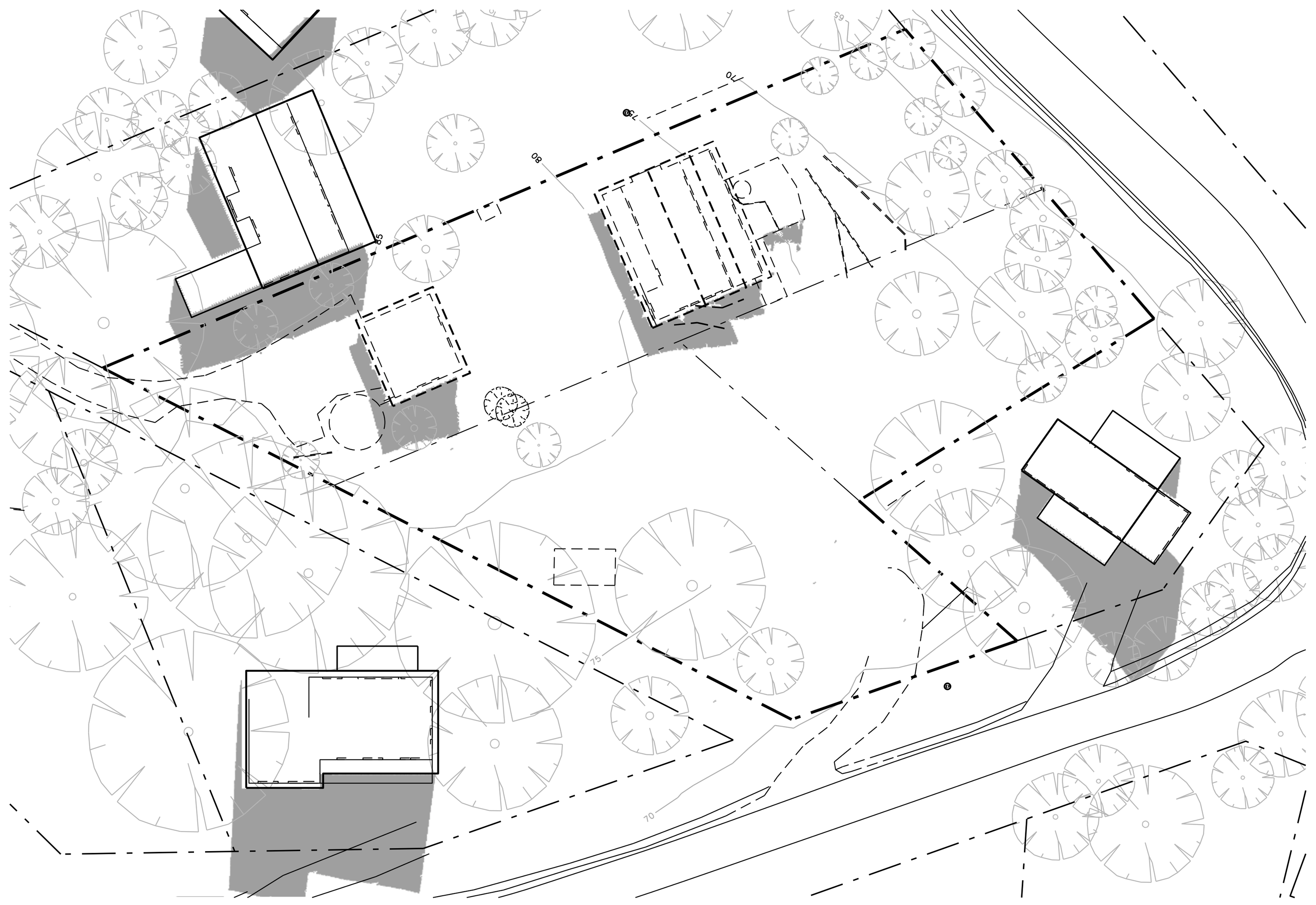
REVISION
A



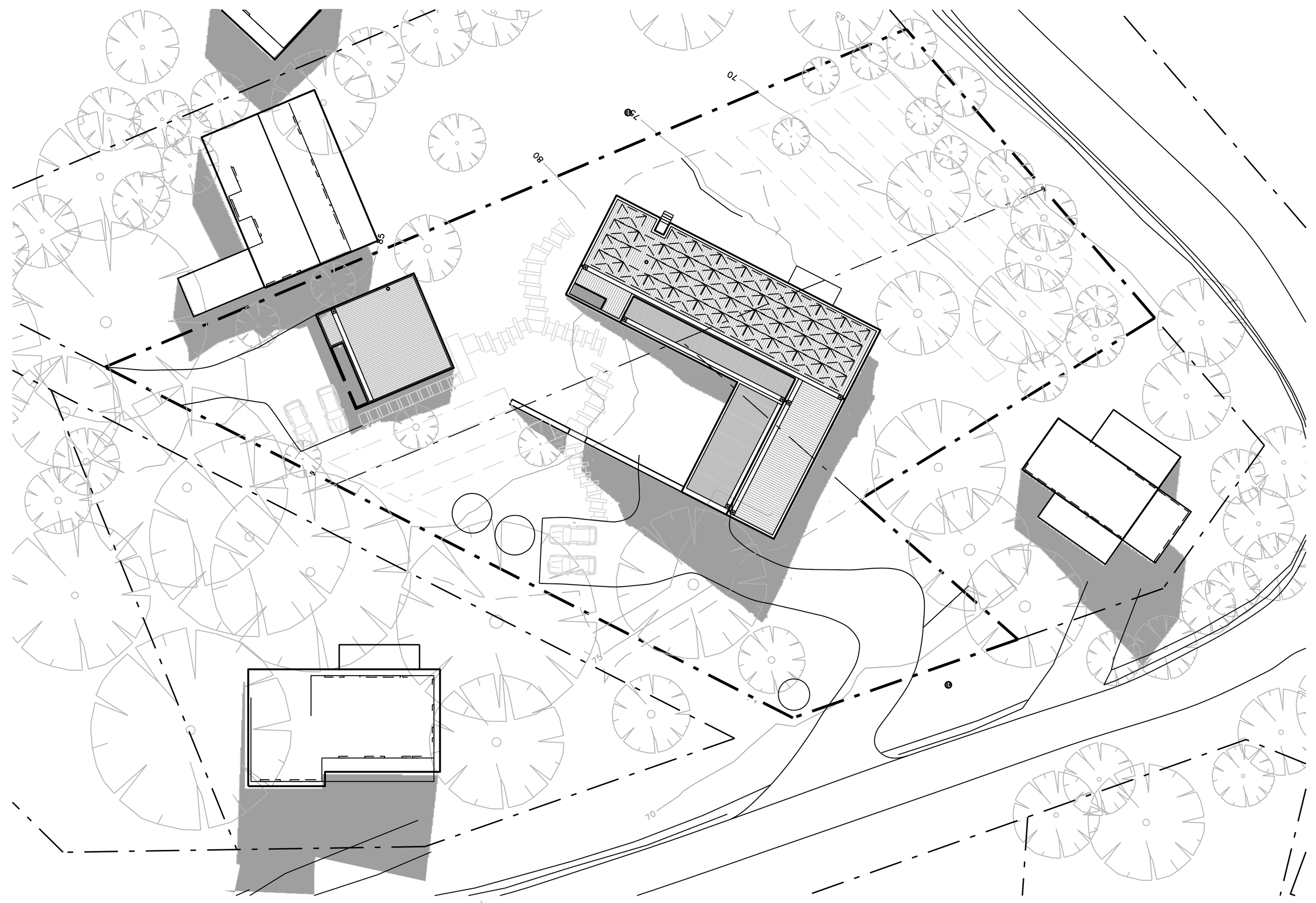
01 22 SEPTEMBER 9am
EXISTING 1:500



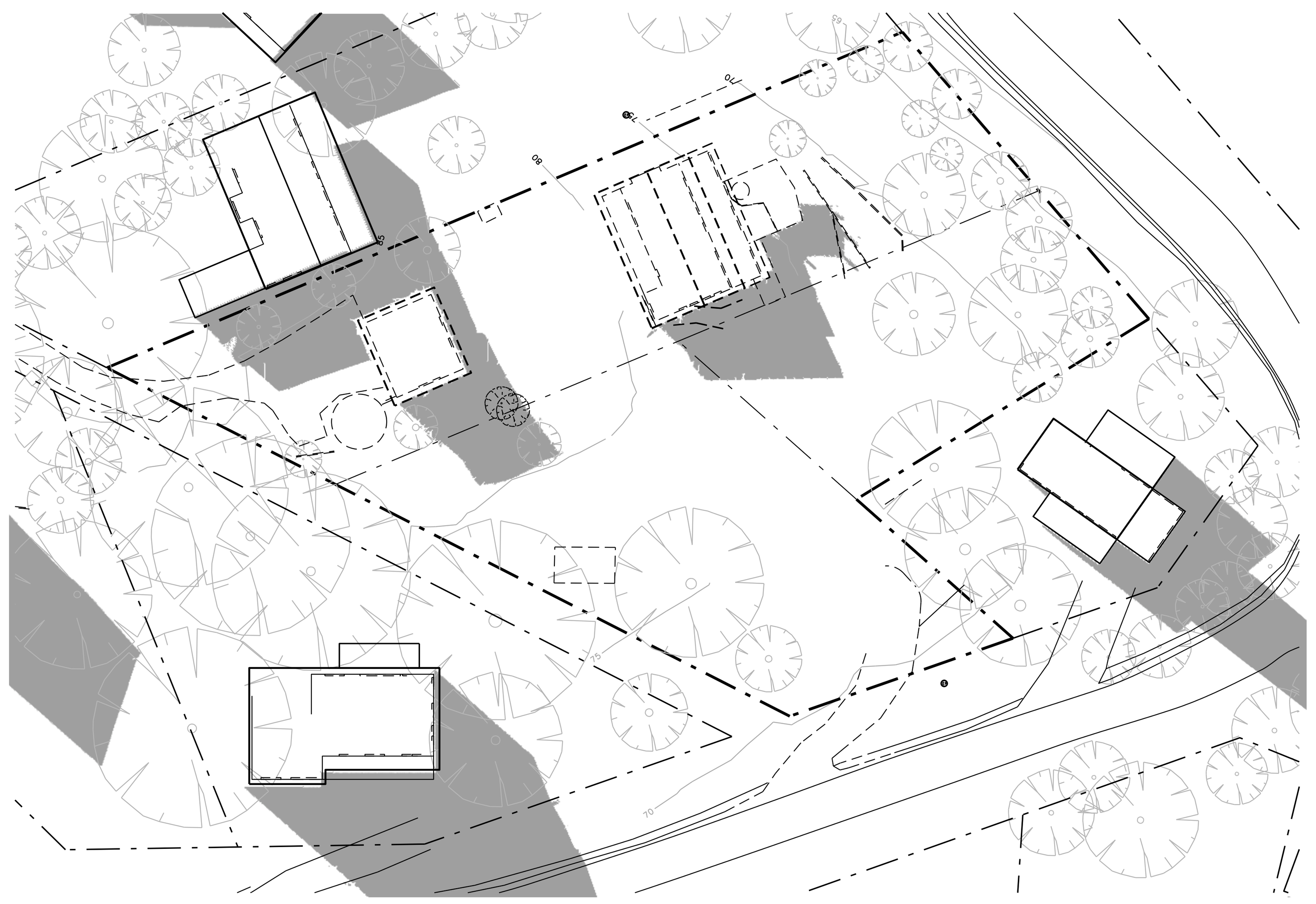
02 22 SEPTEMBER 9am
PROPOSED 1:500
NO OVERSHADOWING TO PRIVATE OPEN SPACE



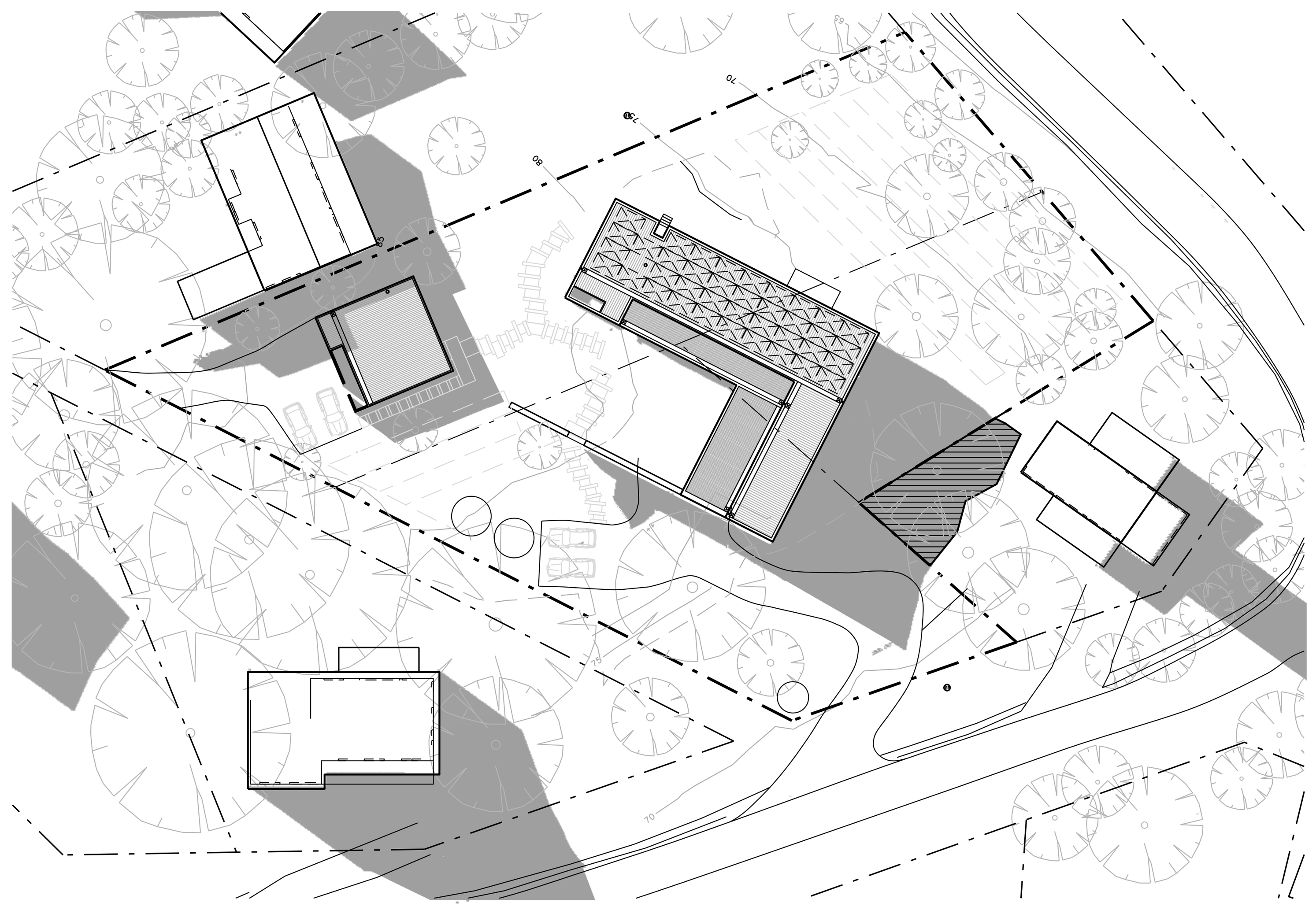
03 22 SEPTEMBER 12pm
EXISTING 1:500



04 22 SEPTEMBER 12pm
PROPOSED 1:500
NO OVERSHADOWING TO PRIVATE OPEN SPACE



05 22 SEPTEMBER 3pm
EXISTING 1:500



06 22 SEPTEMBER 3pm
PROPOSED 1:500
OVERSHADOWING TO PRIVATE OPEN SPACE NOMINALLY 80sqm

GENERAL NOTES

THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS AND DRAWINGS.

DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.

DO NOT SCALE OFF DRAWINGS.

USE FIGURED DIMENSIONS ONLY. CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.

LEGEND - EXTERNAL MATERIALS

- EF01 CONCRETE BLOCKWORK
- EF02 GREY CLADDING
- EF03 TIMBER CLADDING
- EF04 STEEL CLADDING
- RS01 METAL DECK ROOFING
- RS02 POLYCARBONATE ROOFING

LEGEND - INTERNAL MATERIALS

- PB PLASTERBOARD
- WPB WET PLASTERBOARD

LEGEND - FLOOR FINISHES

- FF01 POLISHED CONCRETE SLAB
- FF02 TIMBER FLOORING
- FF03 FLOOR TILES
- FF04 CARPET

LEGEND - LANDSCAPE MATERIALS

- LS01 PAVED DRIVEWAY
- LS02 CONCRETE PAVING
- LS03 HARDWOOD TIMBER DECKING
- LS04 LAWN

FG FIXED GLAZING
OG OPERABLE GLAZING
S/L SKYLIGHT

HW HABITABLE WINDOW
NON HW NON HABITABLE WINDOW
HGD HABITABLE GLAZED DOOR

Rob Kennon Architects

Studio
Studio 1, Level 1
156 George St
Fitzroy Vic 3065

Phone
03 9015 8621

Email
mail@robkennon.com

REVISIONS

Rev	Date	Dwn	Chk	App	Notes
-	28/11/2017	JL	RK	RK	TOWN PLANNING APPLICATION
A	02/03/2018	JL	RK	RK	TOWN PLANNING APPLICATION - RFI

CLIENT

CLIENT SIGN-OFF
Date | Approved By

INTERNAL CHECK
Date | Checked By

PROJECT NAME
MORLEY AVE

SITE ADDRESS
30, 32 & 36 MORLEY AVE, WYE RIVER

PROJECT NUMBER
17004

DATE
NOV 2017

SCALE

CAD FILE REF
- - - -

STATUS
TOWN PLANNING

DRAWING TITLE
SHADOW DIAGRAMS

DRAWING NUMBER
10-101

REVISION
A