LIMITED GEOTECHNICAL INVESTIGATION

Lots 303, 304 & 306 No.3-7 Oakland Close, Bolwarra

for

Unicomb

Ref: 2021562

30 August 2021

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1. INTRODUCTION

At your request Agility Engineering have carried out a Limited Geotechnical Investigation at Lots 303, 304 & 306 No.3-7 Oakland Close, Bolwarra. This report should be read in conjunction with the attached "General Notes".

The purpose of this investigation was to:

- determine the type and nature of the existing subsurface soil/rock profile across the site.
- undertake a slope stability risk assessment for the site in accordance with the methodology set out in the Australian Geomechanics Society Landslide Taskforce "Practice Note Guidelines for Landslide Risk Management" March 2007 and Lake Macquarie City Councils "Development Control Plan".
- determine the site classification for the proposed building envelope/site in accordance with AS2870 - 2011 "Residential Slabs and Footings" and provide general recommendations for suitable footing systems and allowable bearing pressures.
- Provide recommendations for proposed site cuts and retaining wall design parameters.

2. PROPOSED DEVELOPMENT

Agility Engineering was provided with architectural drawings prepared by Sorensen Design and Planning project no: 2103113, sheets 1-10, dated 18 June 2021 and DRB Consulting Engineers project no: 210695, sheets CIV01-CIV05, Rev B, dated 7 June 2021.

It is understood that the site is to be subdivided and seven dwellings be construction within the proposed subdivision. A copy of the provided documentation can be found attached to this report.

3. SITE DESCRIPTION

The subject site is identified as a 5630m^2 lot located on the north-eastern side of Oakland Close. The site was bordered by developed residential lots with dwellings to the north, by an undeveloped residential lot to the east and by vacant land to the south. The location of the site is illustrated in the attached drawing 2021562-SIT-01.

The following observations were made during the visual assessment and are approximately located on drawing 2021562-SIT-01 and in the attached photographs:

- The slopes in the vicinity of the site generally inclined down from the north to the south approximately 0–17°. Site cutting and filling in the northern portion of the site had reduced slopes to 0–2°.
- Existing development at the site comprised a concrete internal road pavement which runs in a west to east from the end of Oakland Close.
- Site vegetation to the northern side of the access drive generally comprised unvegetated earth with vegetation to the south of the access drive generally comprising unkept grass.
- Site drainage primarily comprised infiltration and surface runoff.
- A batter slope with an approximate maximum height of 3.0m is located along the northern site boundary (Photograph 3). Localised batter slopes were constructed between lots and along the access drive.
- Outcropping rock was observed in several batter slopes across the site area to the north of the access drive (Photograph 4).
- No soil instability was observed during the site investigation.

4. GEOLOGICAL SETTING

The NSW Seamless Geology online mapping tool (MinView) indicates that the site lies within the Branxton Formation of the Maitland Group. The Branxton Formation underlies the Muree Sandstone and overlies the Shoalhaven Group. The Branxton Formation consists of conglomerate, sandstone and mudstone. The Branxton Formation is part of the non-coal bearing marine sequence of the Maitland Group.

5. FIELDWORK AND SUBSURFACE CONDITIONS

Fieldwork was undertaken on the 26 August 2021 and consisted of the excavation of six boreholes to assess the typical subsurface conditions of the site. Boreholes were excavated using 115mm diameter solid flight auger hydraulically powered by a purpose-built trailer mounted drill rig. Drawing 2021562-SIT-01 shows the borehole locations. The subsurface profiles encountered in the boreholes are presented on engineering logs in the attachment section of this report. Table 1 and Table 2 summarise the identified subsurface profiles and their distribution within the excavated boreholes.

Table 1 – Summary of geotechnical units

Geotechnical Unit	Material Type	Material Description
Unit 1	FILL	Silty Sandy CLAY / Silty CLAY / Gravelly SAND
Unit 2	Residual soil	CLAY, high plasticity
Unit 3	Extremely weathered sandstone	Remoulds to SAND

Table 2 – Summary of units at borehole locations

Borehole	Unit 1	Unit 2	Unit 3
BH1	–	0.0 – 0.4m	0.4 – 1.5m*
BH2	0.0 – 0.3m	0.3 – 1.2m	1.2 – 1.6m*
BH3	0.0 – 0.1m	–	0.1 – 0.8m*
BH4	0.0 – 0.8m	0.8 – 2.2m	2.2 – 2.6m*
BH5	0.0 – 0.2m	0.2 – 0.4m	0.4 – 1.8m*
BH6	0.0 – 0.8m	0.8 – 2.6m	2.6 – 3.0m*

Note – * denotes borehole terminated in layer

It is unknown whether the existing fill materials were placed under controlled conditions in accordance with AS3798 (Guidelines on Earthworks for Commercial & Residential Developments). Evidence of oversize material and water ingress indicating that fill material may have been compromised.

Groundwater was not encountered during the investigation. Surface water ponding was noted on lots to the north of the constructed access drive at the site.

6. LABORATORY TESTING

Agility Engineering undertook laboratory shrink swell index testing on one undisturbed 50mm diameter (U50) soil sample. Results are summarised in Table 3.

Table 3 – Summary of shrink swell index test results

Borehole	Depth	Soil type	I_{SS} (%)
BH1	0.2 – 0.4	Residual Soil – CLAY, high plasticity	2.6
BH4	0.8 – 1.1	Residual Soil – CLAY, high plasticity	4.4

Note – I_{SS} = shrink swell index

7. SLOPE STABILITY RISK ASSESSMENT

7.1 RISK ASSESSMENT

An assessment of the risk to both property and life as a result of failure mechanisms on the site has been undertaken with reference to the Australian Geomechanics Society Landslide Taskforce “Practice Note Guidelines for Landslide Risk Management” March 2007.

7.2 RISK TO PROPERTY

A summary of the results of Agility Engineering site assessment, together with a qualitative assessment of the likelihood of occurrence of a landslide (following construction) or mass ground movements and its consequence and risk to post construction structures on the site and neighbouring lots is presented in Table 4.

Table 4 – Assessment of risk to property

Hazard		**Likelihood**	**Consequence**	**Risk**
North of the Access Drive				
1	Creep failure of soils	Barely Credible	Medium	Very Low
2	Rotational or translational failure of soils	Rare	Medium	Low
3	Failure of existing batters in unretained weathered sandstone bedrock	Rare	Medium	Low
4	Failure of proposed batters/retaining walls	Rare	Medium	Low
South of the Access Drive				
5	Creep failure of soils	Unlikely	Medium	Low
6	Rotational or translational failure of soils	Rare	Medium	Low
7	Failure of existing/proposed batters or retaining walls	Rare	Medium	Low

Reference to the Australian Geomechanics Society guidelines indicates that sites which have been deemed to have a Low Risk level or less are usually acceptable to regulators provided measures are undertaken to ensure ongoing monitoring and maintenance of the hazard. In this instance, this would involve regular inspection (each couple of months) of the site by the owner. If any further signs of instability are identified, further advice should be sought from a geotechnical engineer and additional stabilisation measures may be required.

7.3 RISK TO LIFE

The Australian Geomechanics Society Practice Note Guidelines also provides a framework for landslide risk management, guidance on risk analysis methods and information on acceptable or tolerable risks for loss of life.

Risk analysis can be broken up into four components, namely:

- Hazard identification
- Frequency analysis
- Consequence analysis, and
- Risk estimation.

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

$$R_{LOL} = P_{H} \text{ x } P_{S:H} \text{ x } P_{T:S} \text{ x } V_{D:T}$$

Where,

R_{LOL} is the risk, or annual probability of death of an individual

P_{H} is the annual probability of the hazardous event

$P_{S:H}$ is the probability of spatial impact by the hazard given the event

$P_{T:S}$ is the temporal probability given the spatial impact, and

$V_{D:T}$ is the vulnerability of the individual

A summary of the results of the assessment undertaken in relation to risk to life of the hazards identified at this site is presented in Table 5.

Table 5 – Assessment of risk to life

Hazard		**P(H)**	**P(S:H)**	**P(T:S)**	**V(D:T)**	**Risk R(LOL)**
Upslope of the Access Drive						
1	Creep failure of soils	1 x 10^{-6}	0.5	0.5 (person onsite)	1 x 10^{-3} (evacuation possible)	2.5 x 10^{-10}
2	Rotational or translational failure of soils	1 x 10^{-5}	0.5	0.5 (person onsite)	0.1 (person struck)	2.5 x 10^{-7}
3	Failure of existing batters in unretained weathered sandstone bedrock	1 x 10^{-5}	0.1	0.1 (person in area)	1 x 10^{-3} (evacuation possible)	1 x 10^{-10}
4	Failure of proposed batters/retaining walls	1 x 10^{-5}	0.1	0.1 (person in area)	1 x 10^{-3} (evacuation possible)	1 x 10^{-10}
Downslope of the Access Drive						
5	Creep failure of soils	1 x 10^{-4}	0.5	0.5 (person onsite)	1 x 10^{-3} (evacuation possible)	2.5 x 10^{-8}
6	Rotational or translational failure of soils	1 x 10^{-5}	0.5	0.5 (person onsite)	0.1 (person struck)	2.5 x 10^{-7}
7	Failure of existing/ proposed batters or retaining walls	1 x 10^{-5}	0.1	0.1 (person in area)	1 x 10^{-3} (evacuation possible)	1 x 10^{-9}

The Australian Geomechanics Society's "Practice Note Guidelines" details tolerable risk levels for loss of life. Table 6 shows tolerable risk levels for existing and new developments.

Table 6 – Australian Geomechanics Society tolerable risk for loss of life

Situation	**Suggested Tolerable Loss of Life Risk for the person most at risk**
Existing Slope[1] / Existing Development[2]	10^{-4} / annum
New Constructed Slope[3] /New Development[4] /Existing Landslide[5]	10^{-5} / annum

Notes:
1. "Existing Slopes" in this context are slopes that are not part of a recognizable landslide and have demonstrated nonfailure performance over at least several seasons or events of extended adverse weather, usually being a period of at least 10 to 20 years.

2. “Existing Development” includes existing structures, and slopes that have been modified by cut and fill, that are not located on or part of a recognizable landslide and have demonstrated non-failure performance over at least several seasons or events of extended adverse weather, usually being a period of at least 10 to 20 years.
3. “New Constructed Slope” includes any change to existing slopes by cut or fill or changes to existing slopes by new stabilisation works (including replacement of existing retaining walls or replacement of existing stabilization measures, such as rock bolts or catch fences).
4. “New Development” includes any new structure or change to an existing slope or structure. Where changes to an existing structure or slope result in any cut or fill of less than 1.0m vertical height from the toe to the crest and this change does not increase the risk, then the Existing Slope / Existing Structure criterion may be adopted. Where changes to an existing structure do not increase the building footprint or do not result in an overall change in footing loads, then the Existing Development criterion may be adopted.
5. “Existing Landslides” have been considered likely to require remedial works and hence would become a New Constructed Slope and require the lower risk. Even where remedial works are not required per se, it would be reasonable expectation of the public for a known landslide to be assessed to the lower risk category as a matter of “public safety”.

There are no established individual or societal risk acceptance criteria for the loss of life due to a hazardous event such as a landslide or rock fall. Australian Geoguide LR7 discusses “acceptable” and “tolerable” levels of risk which have been proposed by several authorities including the ANCOLD Guidelines for Risks from Large Dams.

7.4 RISK CONCLUSIONS

With respect to both property and life, slope stability hazards identified during this investigation were assessed to comply with minimum tolerable risk levels. Agility Engineering considers that from a geotechnical point of view, the proposed development may proceed in accordance with the development guidelines provided in Section 9 below. No further geotechnical investigation is required for the proposed development to proceed in relation to slope stability.

8. SITE CLASSIFICATION

8.1 GENERAL

Site classification is a method adopted in residential development for quantifying the anticipated surface movements that may occur on a site, generally due to soil reactivity. Soil reactivity is an appreciable change in soil volume due to a change in the moisture content of the soil. The extent of ground movement due to a reactive clay soil depends on the degree of reactivity of the clay, depth of clay in the soil profile, the depth of potential moisture variation in the soil and the change in soil suction that occurs from dry to wet soil conditions. Chapter 2 of AS2870 – 2011 “Residential Slabs and Footings” classifies soil profiles in terms of their potential for shrink/swell movement due to changes in moisture content, to be slight (Class S), moderate (Class M), high (Class H1 or H2) or extreme (Class E). Sites with little or no reactivity are classified rock or sand (Class A).

Sites which include soft soils such as soft clay, silt or loose sands, landslip, mine subsidence, collapsing soils, soils subject to coastal erosion, reactive sites subject to abnormal moisture conditions, soil bearing capacities less than 100kPa under strip and pad footings and 50kPa under beam and slab panels, soils where excessive foundations settlement may occur due to loading on the foundation, soils where other factors may result in foundation movement, soils subject to abnormal moisture conditions or controlled or uncontrolled fill greater than 0.8m for sand and 0.4m for material other than sand are classified as Class P sites.

8.2 SITE CLASSIFICATION

The site was classified as **Class P** as defined in AS2870 - 2011 “Residential Slabs and Footings”. This site classification was based upon the presence of greater than 0.4m of uncontrolled fill material.

The classification presented above assumes that:

- All footings are founded on residual soil or underlying bedrock below all non-controlled fill, topsoil and slopewash material.
- Root zones and fill under slab panels meets the requirements of AS2870, in particular, the root zone must be removed prior to the placement of fill materials beneath slabs.
- The performance expectations set out in AS2870 are acceptable.
- Site maintenance complies with the provisions of CSIRO Sheet BTF 18, Foundation Maintenance and Footing Performance: A Homeowner’s Guide, a copy of which is attached.
- The constructional and architectural requirements for reactive clay sites set out in AS2870 - 2011 ‘Residential Slabs and Footings’ are followed.

9. DEVELOPMENT GUIDELINES

9.1 FOOTING DESIGN

The site would be suitable for development provided the footing system by designed by a structural engineer in accordance with engineering principles and AS 2870 - 2011 “Residential Slabs and Footings”. Based on the findings of the site investigations and laboratory testing, site classification for each lot is shown in Table 7 below.

Table 7 – Site Classification to AS 2870-2011

Proposed Lot	Site Classification to AS 2879-2011
Lots 2 – 5, Lot 8	M
Lots 6 – 7	H1

Due to existing site conditions, all footings must be either founded on or piered/piled to extremely weathered sandstone. Footings and piers/piles founded on extremely weathered sandstone should be designed using a maximum allowable soil bearing pressure of 400kPa.

9.2 EXCAVATIONS AND FILLING

Cut and fill in excess of 1.0m must be retained by an engineer designed retaining wall. Unretained fill less than 1.0m in depth should be battered in accordance with the requirements of the Building Code of Australia. Recommended short and long term batter slopes are detailed in Table 8 below.

Table 8 – Recommended short and long term batter slopes

Stratum	Short Term Excavations	Long Term Excavations
Fill materials	2H:1V	4H:1V
Residual CLAYS	1H:1V	2H:1V
Highly Weathered Sandstone	1V:1H to 2V:1H*	1V:1V to 4V:1H*

* - Unretained cuts in Highly Weathered Sandstone to be confirmed

Where applicable, the excavation design should incorporate surcharge loads from slopes, retaining walls and structures within the vicinity of the excavation. Drainage measures should be implemented above and behind all excavations to intercept both surface and subsurface water movement. All unretained cuts and fills must be protected from erosion.

9.3 GEOTECHNICAL ENGINEER INSPECTIONS

Temporary unsupported cuts in weathered sandstone bedrock must be inspected by a suitably qualified geotechnical engineer to determine whether the cut is suitable to remain unretained or whether temporary retaining/support is required as potential fracturing of the weathered rock is unknown. It is understood there are no proposed long term unretained cuts in the weathered sandstone bedrock.

9.4 COUNCIL'S DEVELOPMENT GUIDELINES

Council's development guidelines should be reviewed during site planning as development guidelines may impose height limitations on site cuts and fills.

9.5 RETAINING WALLS

Engineer designed retaining walls should be designed in accordance with the requirements of AS4678 "Earth-retaining Structures" to support, where appropriate, surcharge loading due to the upslope battered surface level above the retaining walls and the depth of cut or fill material. Retaining walls should be constructed with adequate surface and subsurface drainage to the Engineer's and Council's requirements.

Based on the subsurface materials detailed in Section 5 above, recommended retaining wall design parameters have been detailed in Table 9 below. These earth pressure coefficients apply for well drained retaining materials.

Table 9 - Retaining wall design parameters

Stratum	Bulk Density (kN/m^3)	K_a	K_o	K_p
Fill and residual materials	22	0.36	0.53	2.8
Extremely weathered sandstone	20	.25	.4	400kPa

9.6 SITE DRAINAGE

The effective drainage from the site of surface and subsurface water is important to ensure the stability of the surface soil and the long-term performance of any footing system and retaining walls. The property should be developed and maintained in accordance with the guidelines set out in Section 3 of the BCA and Appendix B of AS 2870.

The following measures are recommended:

- Catch/dish drains formed at the top of all batters.
- Dish and rubble drains installed at the toe of all batters.
- Subsoil drains installed behind new retaining walls.
- Cut areas sloped to fall away from buildings and water not allowed to pond around buildings.
- The site graded to prevent water from ponding on any compacted fills.
- Surface stormwater and subsoil water collected and disposed of to Council's requirements.
- Erosion control measures to be undertaken during construction to Council's requirements.
- It is recommended that a subsoil drain be constructed immediately upslope of any proposed residence to intercept and dispose of any groundwater seepage.

10. LIMITATIONS

Agility Engineering have performed investigation and consulting services for this project in general accordance with current professional and industry standards. The findings contained within this report are the result of site observations and field investigation. The extent of testing was limited to discrete test locations and variations that cannot be inferred or predicted may occur in ground conditions between test locations.

To the best of our knowledge, information presented in this report represents a reasonable interpretation of the general condition of the site. Under no circumstances, however, do these findings represent the actual state of the site at all points.

The programme of field sampling and interpretations presented within this report are limited in nature and Agility Engineering, or any other reputable consultant, cannot provide unqualified warranties, nor does Agility Engineering assume liability for site conditions not accessible during the time of the investigation.

Agility Engineering should be contacted immediately should subsurface conditions be found to differ from those described in this report.

Agility Engineering Pty Ltd

Mark Sth

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Geo-Environmental Scientist

Mark Smith
Geotechnical Engineer
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ATTACHMENTS

Photograph 1 – Looking east towards the site from Oakland Close

Photograph 2 – Looking east across the northern portion of the site (proposed lots above the access drive) along the northern site boundary

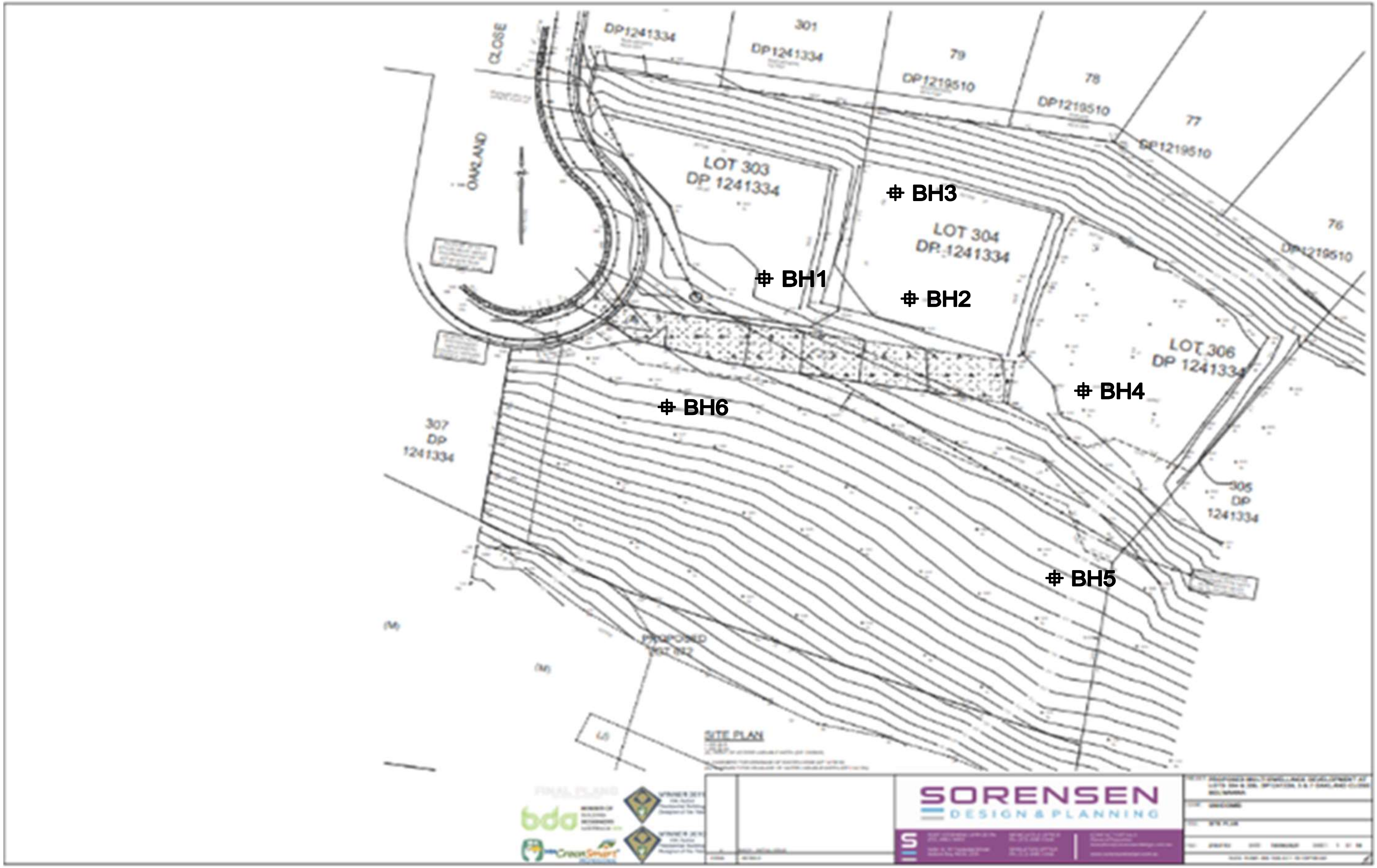
Photograph 3 – Example of outcropping bedrock on the batter slope in the northern portion of the site

Photograph 4 – Looking west across the southern portion of the site (proposed lots south of the access drive)

Photograph 5 – Looking southeast across the southern portion of the site

Photograph 6 – Looking example of oversize observed in fill material at the site

Photograph 7 – Looking northwest across an example of surface water ponding in the northern portion of the site



AGILITY
ENGINEERING

TITLE: **Approximate Test Location Plan (Not To Scale)** DRAWN BY: **MC**
CLIENT: **Unicomb**
ADDRESS: **No.5 Oakland Close, Bolwarra**
AGILITY JOB No: **2021562** DRAWING No: **2021562-SIT-01** DATE: **26.08.21**

ENGINEERING BOREHOLE LOG

AGILITY ENGINEERING

Client: Unicomb
Site Address: 5 Oakland Drive, Bolwarra
Location: See site plan
Surface RL: Existing ground surface level
Equipment: Trailer mounted drill-rig with 115mmø solid flight auger

Borehole No: BH1
Job No: 2021562
Date: 26.08.21
Logged By: MC

Drilling Information			Profile Description							Soil Origin and Additional Comments
						Material Description			DCP Blows per 100mm	
Depth in metres	Progress	Sample type	Water	Graphic Log	USC	SOIL TYPE, primary soil component characteristics, colour, secondary and minor soil component characteristics ROCK TYPE, grain size, colour, fabric and texture, weathering	Consistancy Rel. Density Rock Str.	Moisture	0 5 10 15 20 25	
		U50	NE	▨		CLAY, high plasticity, red mottled grey and orange, trace fine to coarse subangular to rounded gravel (residual soil)	-	M		RESIDUAL SOIL
0.50						SAND, fine to medium grained, pale brown/yellow, with silt, trace f-c subrounded to rounded gravel (xw sandstone)	VD	D		EXTREMELY WEATHERED SANDSTONE
1.00										
1.50						Terminated, slow auger progression				
2.00										
2.50										
3.00										
3.50										
4.00										
4.50										
5.00										
5.50										
6.00										

Key

Water

NE	not encountered
NO	not observed
—	seepage
▽	free standing

Cohesive Soil Consistancy

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fr	friable

Non-Cohesive Soil Relative Density

VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Rock Strength

VLow	very low
Low	low
Med	medium
High	high
VHigh	very high
EHigh	extremely high

Moisture

D	dry
SM	slightly moist
M	moist
W	wet

DCP Termination

R	Refusal
T	Terminated

Sampling Data

U50	undisturbed 50mm diameter sample
D	disturbed sample
B	bulk sample

ENGINEERING BOREHOLE LOG

AGILITY ENGINEERING

Client:	Unicomb	**Borehole No:**	BH2
Site Address:	5 Oakland Drive, Bolwarra	**Job No:**	2021562
Location:	See site plan	**Date:**	26.08.21
Surface RL:	Existing ground surface level	**Logged By:**	MC
Equipment:	Trailer mounted drill-rig with 115mmø solid flight auger		

Drilling Information			Profile Description							Soil Origin and Additional Comments
Depth in metres	Progress	Sample type	Water	Graphic Log	USC	Material Description SOIL TYPE, primary soil component characteristics, colour, secondary and minor soil component characteristics ROCK TYPE, grain size, colour, fabric and texture, weathering	Consistancy Rel. Density Rock Str.	Moisture	DCP Blows per 100mm 0 5 10 15 20 25	
			NE	▩		FILL: Silty Sandy CLAY, low plasticity, dark grey, trace fine to coarse subangular to rounded gravel and cobbles	-	M		FILL
0.50				▨		CLAY, high plasticity, red mottled grey and orange, trace fine to coarse subangular to rounded gravel (residual soil)	St			RESIDUAL SOIL
1.00				▨		CLAY, high plasticity, pale brown/yellow mottled grey, with silt, trace fine sand (residual soil)	VSt			
1.50						SAND, fine to medium grained, pale brown/yellow, with silt, trace fine to coarse subrounded to rounded gravel (xw sandstone)	VD	D		EXTREMELY WEATHERED SANDSTONE
2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 6.00						Terminated, slow auger progression				

Key

Water	
NE	not encountered
NO	not observed
—	seepage
▽	free standing

Cohesive Soil Consistancy	
VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fr	friable

Non-Cohesive Soil Relative Density	
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Rock Strength	
VLow	very low
Low	low
Med	medium
High	high
VHigh	very high
EHigh	extremely high

Moisture	
D	dry
SM	slightly moist
M	moist
W	wet

DCP Termination	
R	Refusal
T	Terminated

Sampling Data	
U50	undisturbed 50mm diameter sample
D	disturbed sample
B	bulk sample

ENGINEERING BOREHOLE LOG

AGILITY ENGINEERING

Client:	Unicomb	**Borehole No:**	BH3
Site Address:	5 Oakland Drive, Bolwarra	**Job No:**	2021562
Location:	See site plan	**Date:**	26.08.21
Surface RL:	Existing ground surface level	**Logged By:**	MC
Equipment:	Trailer mounted drill-rig with 115mmø solid flight auger		

Drilling Information			Profile Description							Soil Origin and Additional Comments
Depth in metres	Progress	Sample type	Water	Graphic Log	USC	Material Description SOIL TYPE, primary soil component characteristics, colour, secondary and minor soil component characteristics ROCK TYPE, grain size, colour, fabric and texture, weathering	Consistancy Rel. Density Rock Str.	Moisture	DCP Blows per 100mm 0 5 10 15 20 25	
			NE	☒		FILL: Silty Sandy CLAY, low plasticity, dark grey, trace fine to coarse subangular to rounded gravel and cobbles	-	M/W		FILL
						SAND, fine to medium grained, pale brown/yellow, with silt, trace f-c subrounded to rounded gravel (xw sandstone)	VD	D		EXTREMELY WEATHERED SANDSTONE
0.50										
						Terminated, slow auger progression				
1.00										
1.50										
2.00										
2.50										
3.00										
3.50										
4.00										
4.50										
5.00										
5.50										
6.00										

Key

Water

NE	not encountered
NO	not observed
—	seepage
▽	free standing

Cohesive Soil Consistancy

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fr	friable

Non-Cohesive Soil Relative Density

VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Rock Strength

VLow	very low
Low	low
Med	medium
High	high
VHigh	very high
EHigh	extremely high

Moisture

D	dry
SM	slightly moist
M	moist
W	wet

DCP Termination

R	Refusal
T	Terminated

Sampling Data

U50	undisturbed 50mm diameter sample
D	disturbed sample
B	bulk sample

ENGINEERING BOREHOLE LOG

Client:	Unicomb	**Borehole No:**	BH4
Site Address:	5 Oakland Drive, Bolwarra	**Job No:**	2021562
Location:	See site plan	**Date:**	26.08.21
Surface RL:	Existing ground surface level	**Logged By:**	MC
Equipment:	Trailer mounted drill-rig with 115mmø solid flight auger		

Drilling Information			Profile Description							Soil Origin and Additional Comments
Depth in metres	Progress	Sample type	Water	Graphic Log	USC	Material Description SOIL TYPE, primary soil component characteristics, colour, secondary and minor soil component characteristics ROCK TYPE, grain size, colour, fabric and texture, weathering	Consistancy Rel. Density Rock Str.	Moisture	DCP Blows per 100mm 0 5 10 15 20 25	
0.50			NE	▩		FILL: Gravelly SAND, fine to coarse grained, brown, fine to coarse subangular to rounded gravel and cobbles	-	D		FILL
1.00 1.50		U50		▨		CLAY, high plasticity, red mottled grey and orange, trace fine to coarse subangular to rounded gravel (residual soil) becoming grey mottled brown/orange at 1.2m	St	M		RESIDUAL SOIL
2.00				▨		CLAY, high plasticity, pale brown/yellow mottled grey,with silt, trace fine sand (residual soil)	VSt			
2.50						SAND, fine to medium grained, pale brown/yellow, with silt, trace f-c subrounded to rounded gravel (xw sandstone)	VD	D		EXTREMELY WEATHERED SANDSTONE
3.00 3.50 4.00 4.50 5.00 5.50 6.00						Practical auger refusal on xw sandstone				

Key

Water

NE	not encountered
NO	not observed
—	seepage
▽	free standing

Cohesive Soil Consistancy

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fr	friable

Non-Cohesive Soil Relative Density

VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Rock Strength

VLow	very low
Low	low
Med	medium
High	high
VHigh	very high
EHigh	extremely high

Moisture

D	dry
SM	slightly moist
M	moist
W	wet

DCP Termination

R	Refusal
T	Terminated

Sampling Data

U50	undisturbed 50mm diameter sample
D	disturbed sample
B	bulk sample

ENGINEERING BOREHOLE LOG

AGILITY ENGINEERING

Client:	Unicomb	**Borehole No:**	BH5
Site Address:	5 Oakland Drive, Bolwarra	**Job No:**	2021562
Location:	See site plan	**Date:**	26.08.21
Surface RL:	Existing ground surface level	**Logged By:**	MC
Equipment:	Trailer mounted drill-rig with 115mmø solid flight auger		

Drilling Information			Profile Description							Soil Origin and Additional Comments
Depth in metres	Progress	Sample type	Water	Graphic Log	USC	Material Description SOIL TYPE, primary soil component characteristics, colour, secondary and minor soil component characteristics ROCK TYPE, grain size, colour, fabric and texture, weathering	Consistancy Rel. Density Rock Str.	Moisture	DCP Blows per 100mm 0 5 10 15 20 25	
			NE	▨		FILL: Gravelly SAND, fine to coarse grained, brown, fine to coarse subangular to rounded gravel and cobbles, with clay	-	W		FILL
				▧		CLAY, high plasticity, red mottled grey and orange, trace fine to coarse subangular to rounded gravel (residual soil)	St	M		RESDIUAL SOIL
0.50						SAND, fine to medium grained, pale brown/yellow, with silt, trace f-c subrounded to rounded gravel (xw sandstone)	VD	D		EXTREMELY WEATHERED SANDSTONE
1.00										
1.50										
						Terminated, slow auger progression				
2.00										
2.50										
3.00										
3.50										
4.00										
4.50										
5.00										
5.50										
6.00										

Key

Water

NE	not encountered
NO	not observed
—	seepage
▽	free standing

Cohesive Soil Consistancy

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fr	friable

Non-Cohesive Soil Relative Density

VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Rock Strength

VLow	very low
Low	low
Med	medium
High	high
VHigh	very high
EHigh	extremely high

Moisture

D	dry
SM	slightly moist
M	moist
W	wet

DCP Termination

R	Refusal
T	Terminated

Sampling Data

U50	undisturbed 50mm diameter sample
D	disturbed sample
B	bulk sample

ENGINEERING BOREHOLE LOG

Client: Unicomb
Site Address: 5 Oakland Drive, Bolwarra
Location: See site plan
Surface RL: Existing ground surface level
Equipment: Trailer mounted drill-rig with 115mmø solid flight auger

Borehole No: BH6
Job No: 2021562
Date: 26.08.21
Logged By: MC

Drilling Information			Profile Description							Soil Origin and Additional Comments
Depth in metres	Progress	Sample type	Water	Graphic Log	USC	Material Description SOIL TYPE, primary soil component characteristics, colour, secondary and minor soil component characteristics ROCK TYPE, grain size, colour, fabric and texture, weathering	Consistancy Rel. Density Rock Str.	Moisture	DCP Blows per 100mm 0 5 10 15 20 25	
0.50			NE			FILL: Silty CLAY, low to medium pasticity, dark grey mottled orange and red, with fine to medium grained sand, trace fine to coarse subangular to rounded gravel	-	W		FILL
1.00 1.50 2.00						CLAY, high plasticity, pale brown/yellow mottled grey,with silt, trace fine sand and fine to medium subrounded to rounded gravel (residual soil)	St	M/W		RESIDUAL SOIL
						CLAY, high plasticity, red mottled grey and orange, trace fine to coarse subangular to rounded gravel (residual soil)	VSt	M		
2.50						Tuffaceous Silty CLAY, low plasticity, pale yellow mottled orange, trace fine grained sand (residual soil)				
3.00						SAND, fine to medium grained, pale brown/yellow, with silt, trace f-c subrounded to rounded gravel (xw sandstone)	VD	D		EXTREMELY WEATHERED SANDSTONE
3.50 4.00 4.50 5.00 5.50 6.00						Practical auger refusal on xw sandstone				

Key

Water

NE	not encountered
NO	not observed
—	seepage
▽	free standing

Cohesive Soil Consistancy

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fr	friable

Non-Cohesive Soil Relative Density

VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

Rock Strength

VLow	very low
Low	low
Med	medium
High	high
VHigh	very high
EHigh	extremely high

Moisture

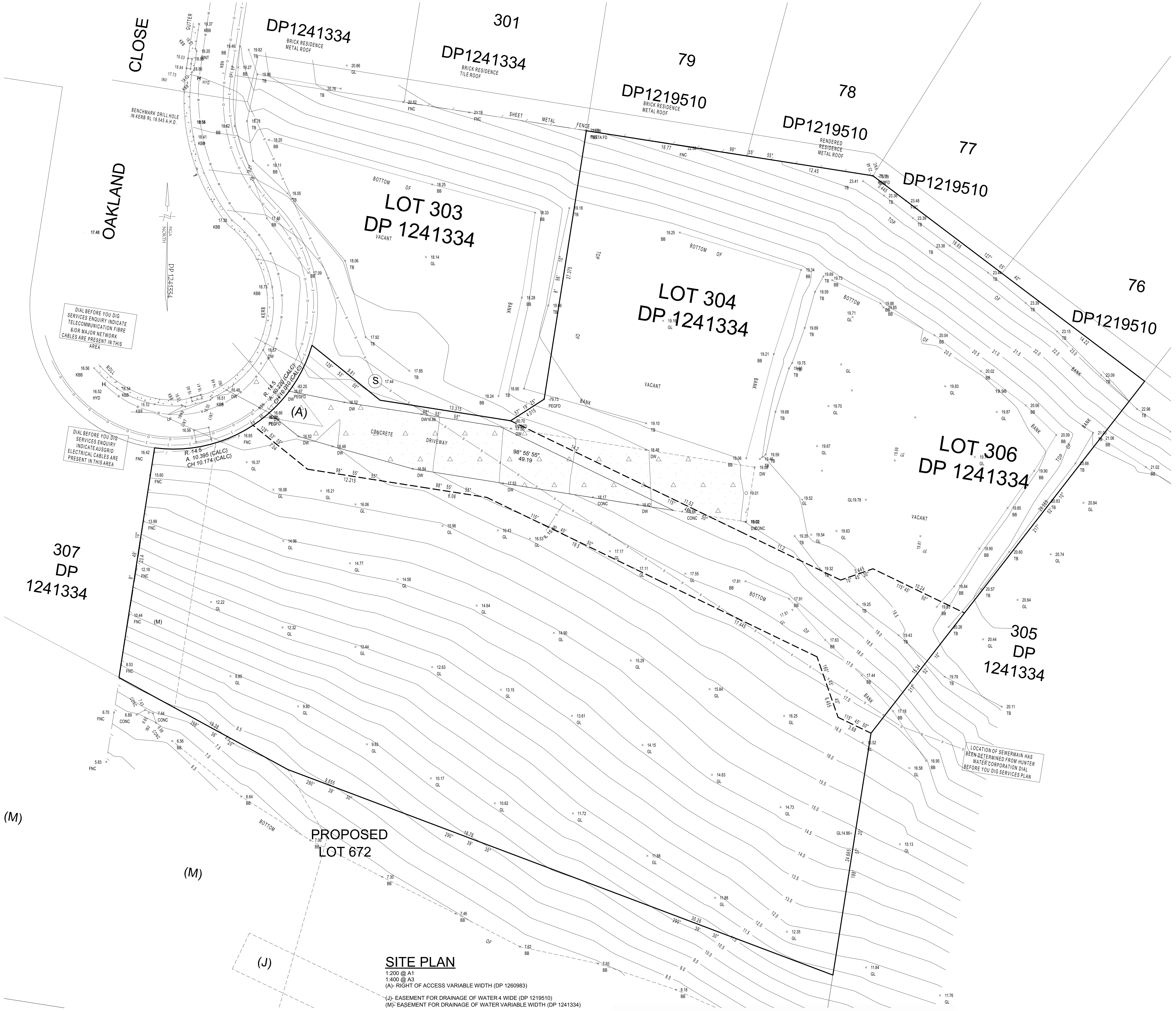
D	dry
SM	slightly moist
M	moist
W	wet

DCP Termination

R	Refusal
T	Terminated

Sampling Data

U50	undisturbed 50mm diameter sample
D	disturbed sample
B	bulk sample



SITE PLAN

1:200 @ A1
1:400 @ A3
(A)- RIGHT OF ACCESS VARIABLE WIDTH (DP 1260983)

(J)- EASEMENT FOR DRAINAGE OF WATER 4 WIDE (DP 1219510)
(M)- EASEMENT FOR DRAINAGE OF WATER VARIABLE WIDTH (DP 1241334)

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PROJECT: **PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA**

CLIENT: **UNICOMB**

TITLE: **SITE PLAN**

FILE: **2103113** DATE: **18/06/2021** SHEET: **1** OF **10**

A1

GENERAL NOTES

1 ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH THE REQUIREMENTS OF LOCAL GOVERNMENT AUTHORITY (LGA), THE BUILDING CODE OF AUSTRALIA AND CURRENT AUSTRALIAN STANDARDS.

2 ALL DIMENSIONS AND LEVELS TO BE CONFIRMED PRIOR TO CONSTRUCTION.

3 REPORT ANY DISCREPANCIES TO THE DESIGNER.

4 DO NOT SCALE OFF THESE DRAWINGS.

5 THESE PLANS ARE TO BE READ TOGETHER WITH THE ENGINEERS DRAWINGS AND SPECIFICATIONS.

6 SCALES APPLY TO SHEET SIZE IN TITLE.

7 THE BUILDER IS TO CHECK ALL FLOOR, CEILING AND ROOF LEVELS TO ENSURE THAT THE FINISHED ROOF HEIGHT DOES NOT EXCEED THE DA APPROVED RL & HEIGHT LIMIT.

8 A REGISTERED SURVEYOR IS TO SET OUT THE BUILDINGS, & CONFIRM ALL LEVELS.

9 ALL STORMWATER TO BE PIPED TO TUNNEL TRENCHES WITH OVERFLOW TO STREET AS PER LGA REQUIREMENTS.

LEGEND

AW	AWNING WINDOW
BFD	BI-FOLD DOOR
DH	DOUBLE-HUNG WINDOW
□DP	DOWNPIPE
CONC	CONCRETE
CPT	CARPET
CW	CASEMENT WINDOW
CSD	CAVITY SLIDING DOOR
FG	FIXED GLASS
f.w.	FLOOR WASTE
GB	GLASS BLOCKS
HWS	HOT WATER SYSTEM
LV	LOUVRE WINDOW
PLD	PANEL LIFT DOOR
REF	REFRIGERATOR
RD	ROLLER DOOR
SH	SHOWER
SD	SLIDING DOOR
SW	SLIDING WINDOW
S.D.	SMOKE DETECTOR
VA	VANITY BASIN
WM	WASHING MACHINE
WC	WATER CLOSET

SITE PLAN PROPOSED

1:200 @ A1
1:400 @ A3
(A)- RIGHT OF ACCESS VARIABLE WIDTH (DP 1260983)
(ED) - PROPOSED EASEMENT FOR DRAINAGE OF WATER
(J)- EASEMENT FOR DRAINAGE OF WATER 4 WIDE (DP 1219510)
(M)- EASEMENT FOR DRAINAGE OF WATER VARIABLE WIDTH (DP 1241334)

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PROJECT: PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA

CLIENT: UNICOMB

TITLE: SITE PLAN PROPOSED

FILE: 2103113 DATE: 18/06/2021 SHEET: 2 OF 10

A1

SITE ANALYSIS

R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	4791.6 m²
PROPOSED LOT 8	
LEVEL 1	146.8 m²
PROPOSED LOT 2	
LEVEL 1	146.8 m²
PROPOSED LOT 3	
LEVEL 1	146.8 m²
PROPOSED LOT 4	
LEVEL 1	146.8 m²
PROPOSED LOT 5	
LEVEL 2	145.9 m²
LEVEL 1	9.0 m²
PROPOSED LOT 6	
LEVEL 2	145.9 m²
LEVEL 1	9.0 m²
PROPOSED LOT 7	
LEVEL 2	145.9 m²
LEVEL 1	9.0 m²
COMBINED GROSS FLOOR AREA (EXCLUDING STAIR VOIDS & GARAGE AREAS)	1051.87 m²
FLOOR SPACE RATIO	0.22:1
BUILDING FOOTPRINTS	1610.5 m²
ROADWAY & GUTTERS	392.3 m²
CROSSOVERS	38.6 m²
DRIVEWAYS	176.8 m²
TOTAL	2218.2 m²
SITE COVERAGE	46.3%

LOT 8 SITE ANALYSIS

R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	455.64 m²
FLOOR AREA (EXCLUDING GARAGE AREA)	146.80 m²
FLOOR SPACE RATIO	0.32:1
BUILDING FOOTPRINT	224.96 m²
DRIVEWAY	25.73 m²
TOTAL	250.69 m²
SITE COVERAGE	55.0%
PRIVATE OPEN SPACE	
YARD	204.95 m²
PORCH & PATIO	26.07 m²
CAR PARKS PROVIDED	

LOT 2 SITE ANALYSIS

R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	495.15 m²
FLOOR AREA (EXCLUDING GARAGE AREA)	146.80 m²
FLOOR SPACE RATIO	0.30:1
BUILDING FOOTPRINT	224.96 m²
DRIVEWAY	29.23 m²
TOTAL	254.19 m²
SITE COVERAGE	51.3%
PRIVATE OPEN SPACE	
YARD	271.23 m²
PORCH & PATIO	26.07 m²
CAR PARKS PROVIDED	

LOT 3 SITE ANALYSIS

R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	496.21 m²
FLOOR AREA (EXCLUDING GARAGE AREA)	146.80 m²
FLOOR SPACE RATIO	0.30:1
BUILDING FOOTPRINT	224.96 m²
DRIVEWAY	28.89 m²
TOTAL	253.85 m²
SITE COVERAGE	51.2%
PRIVATE OPEN SPACE	
YARD	242.36 m²
PORCH & PATIO	26.07 m²
CAR PARKS PROVIDED	

LOT 4 SITE ANALYSIS

R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	408.03 m²
FLOOR AREA (EXCLUDING GARAGE AREA)	146.80 m²
FLOOR SPACE RATIO	0.36:1
BUILDING FOOTPRINT	224.96 m²
DRIVEWAY	15.34 m²
TOTAL	240.30 m²
SITE COVERAGE	58.9%
PRIVATE OPEN SPACE	
YARD	167.73 m²
PORCH & PATIO	26.07 m²
CAR PARKS PROVIDED	

LOT 5 SITE ANALYSIS

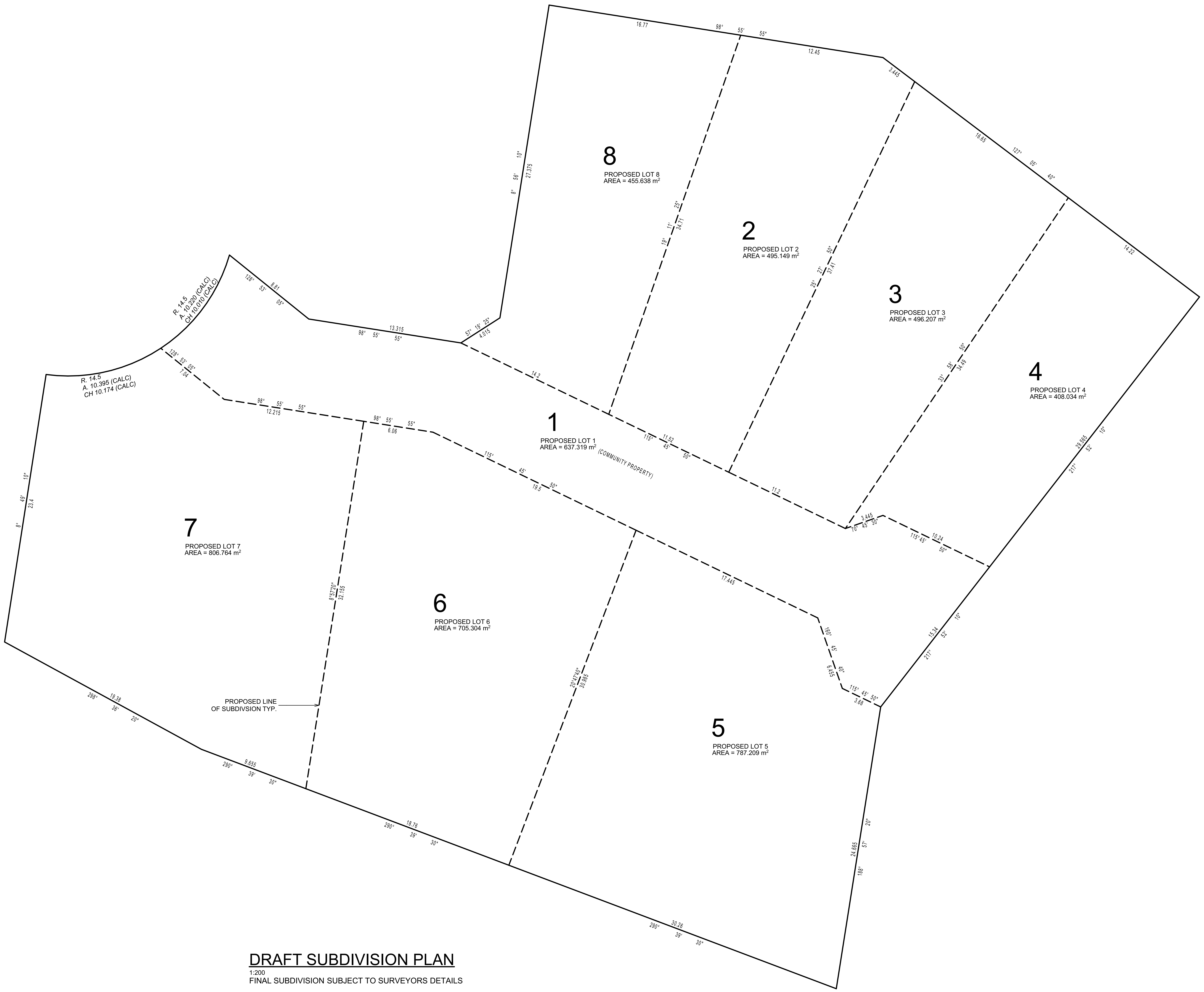
R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	787.21 m²
LEVEL 2	145.90 m²
LEVEL 1	66.56 m²
TOTAL (EXCLUDING VOIDS & GARAGE AREAS)	236.88 m²
FLOOR SPACE RATIO	0.27:1
BUILDING FOOTPRINT	236.88 m²
DRIVEWAY	25.57 m²
TOTAL	262.45 m²
SITE COVERAGE	33.3%
PRIVATE OPEN SPACE	
YARD	524.76 m²
PORCH & PATIO	33.88 m²
CAR PARKS PROVIDED	

LOT 6 SITE ANALYSIS

R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	705.30 m²
LEVEL 2	145.90 m²
LEVEL 1	66.56 m²
TOTAL (EXCLUDING VOIDS & GARAGE AREAS)	236.88 m²
FLOOR SPACE RATIO	0.30:1
BUILDING FOOTPRINT	236.88 m²
DRIVEWAY	26.42 m²
TOTAL	263.30 m²
SITE COVERAGE	37.3%
PRIVATE OPEN SPACE	
YARD	442.00 m²
PORCH & PATIO	33.88 m²
CAR PARKS PROVIDED	

LOT 7 SITE ANALYSIS

R1 GENERAL RESIDENTIAL ZONE	
SITE AREA	806.76 m²
LEVEL 2	145.90 m²
LEVEL 1	9.00 m²
TOTAL (EXCLUDING VOIDS & GARAGE AREAS)	236.88 m²
FLOOR SPACE RATIO	0.26:1
BUILDING FOOTPRINT	236.88 m²
DRIVEWAY	25.60 m²
TOTAL	262.48 m²
SITE COVERAGE	32.5%
PRIVATE OPEN SPACE	
YARD	544.28 m²
PORCH & PATIO	33.88 m²
CAR PARKS PROVIDED	



DRAFT SUBDIVISION PLAN

1:200
FINAL SUBDIVISION SUBJECT TO SURVEYORS DETAILS

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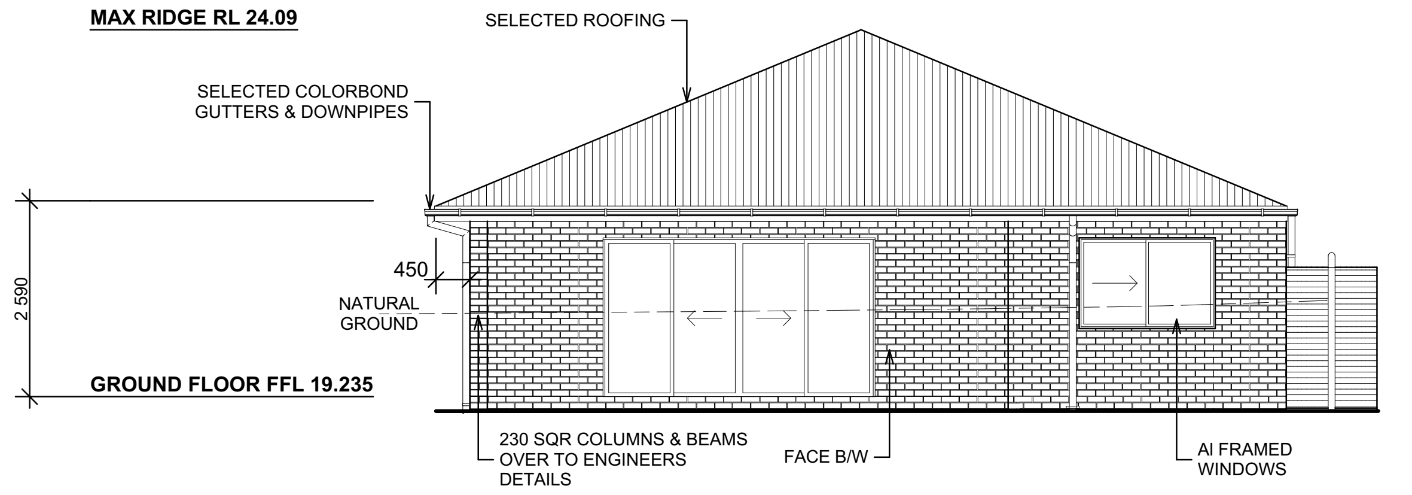
PROJECT: PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA

CLIENT: UNICOMB

TITLE: DRAFT BOUNDARY REALIGNMENT & SUBDIVISION PLAN

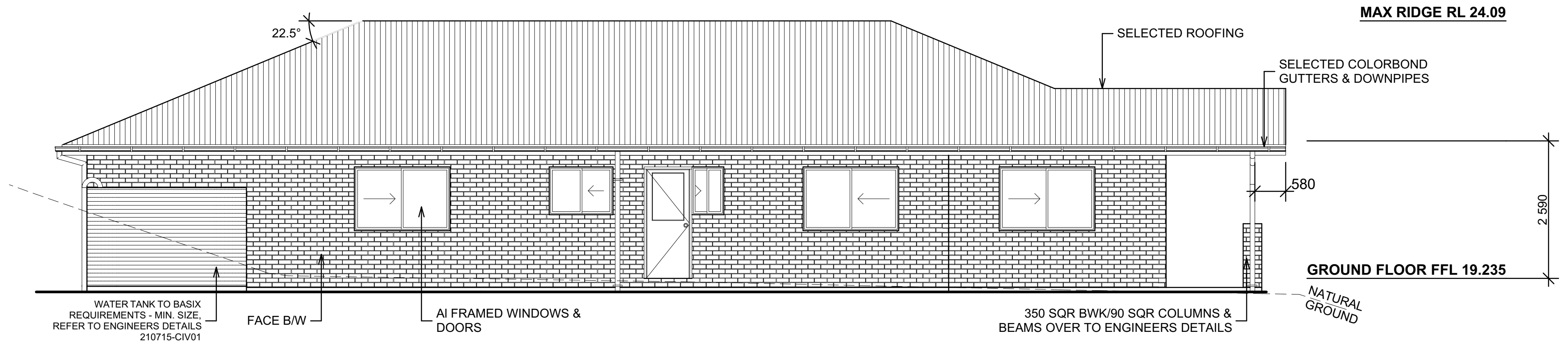
FILE: 2103113 DATE: 18/06/2021 SHEET: 3 OF 10

A1



NORTH ELEVATION

1:100
DWELLING 1



WEST ELEVATION

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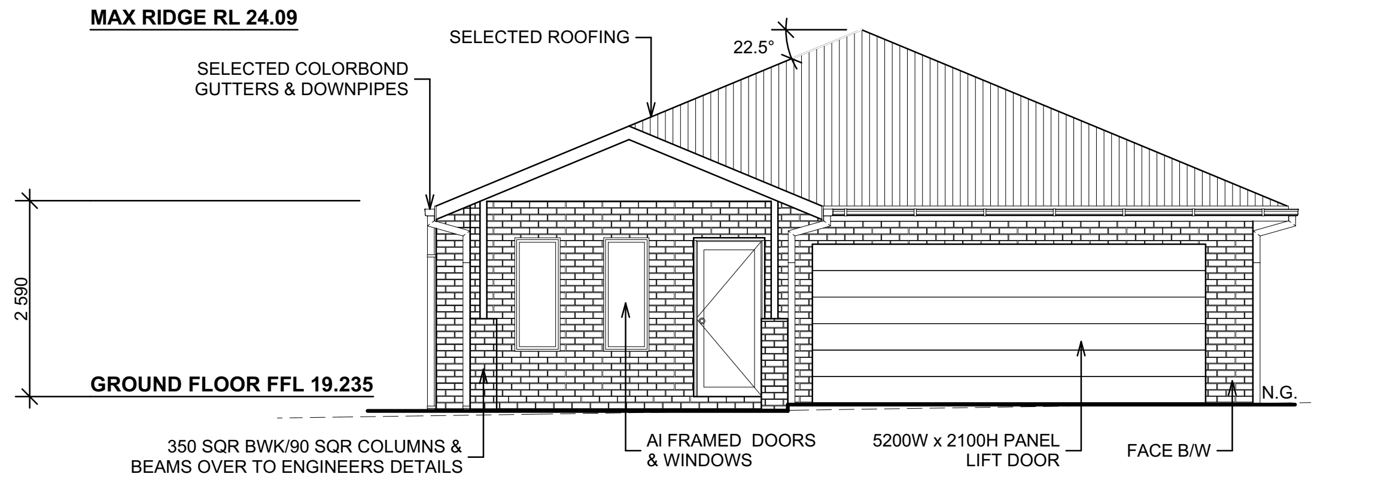
DWELLING 1



SOUTH ELEVATION

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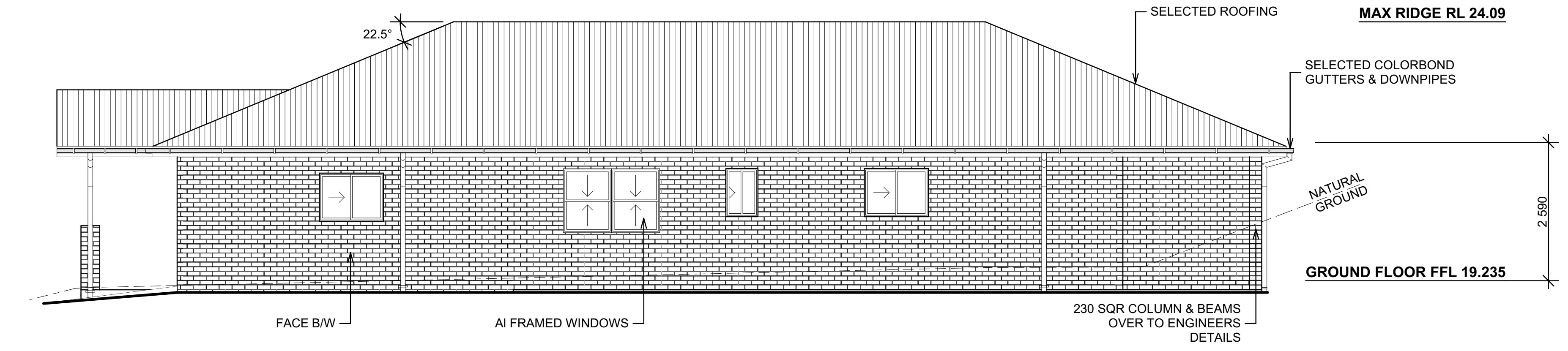
DWELLING 1



EAST ELEVATION

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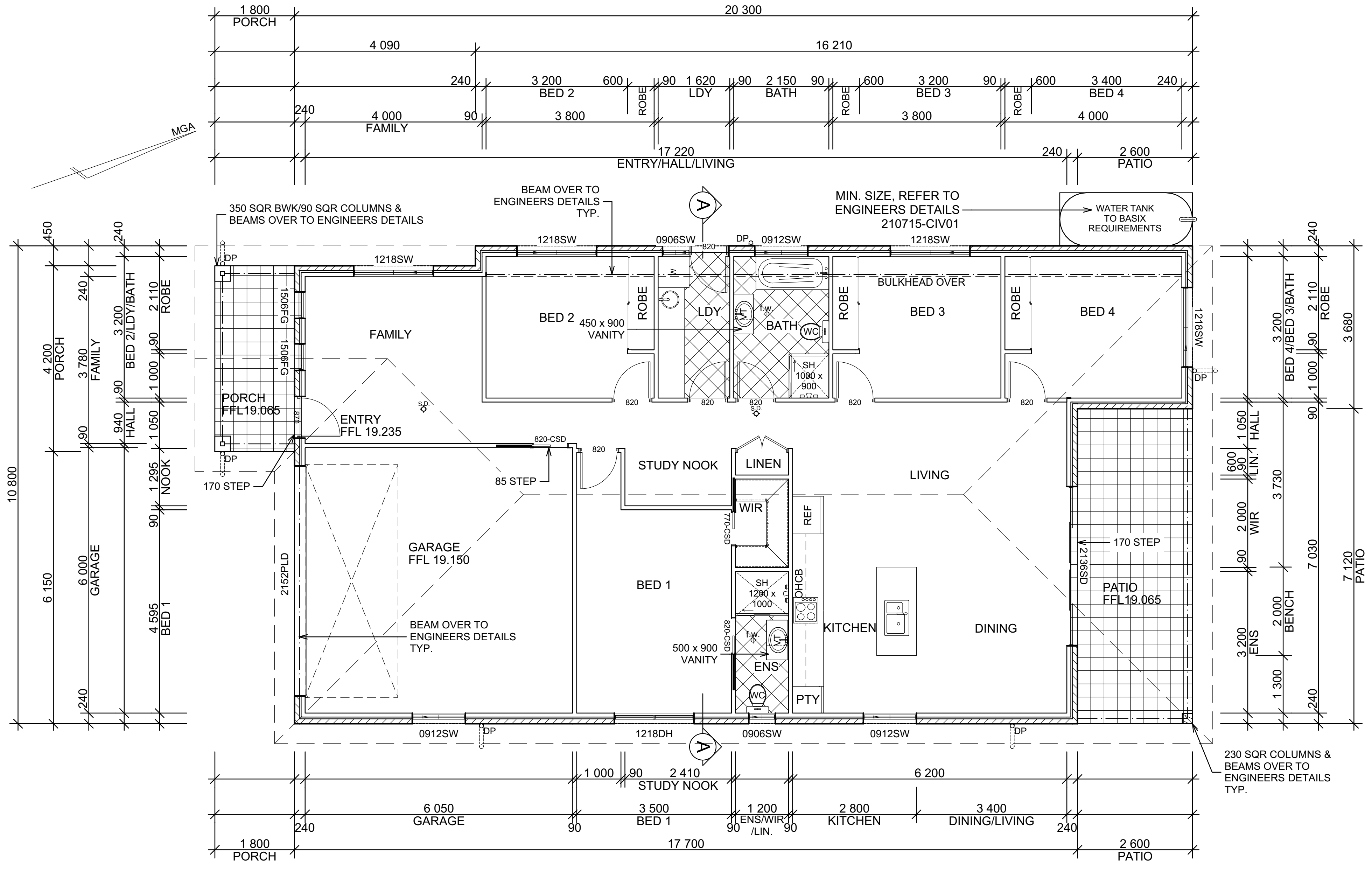
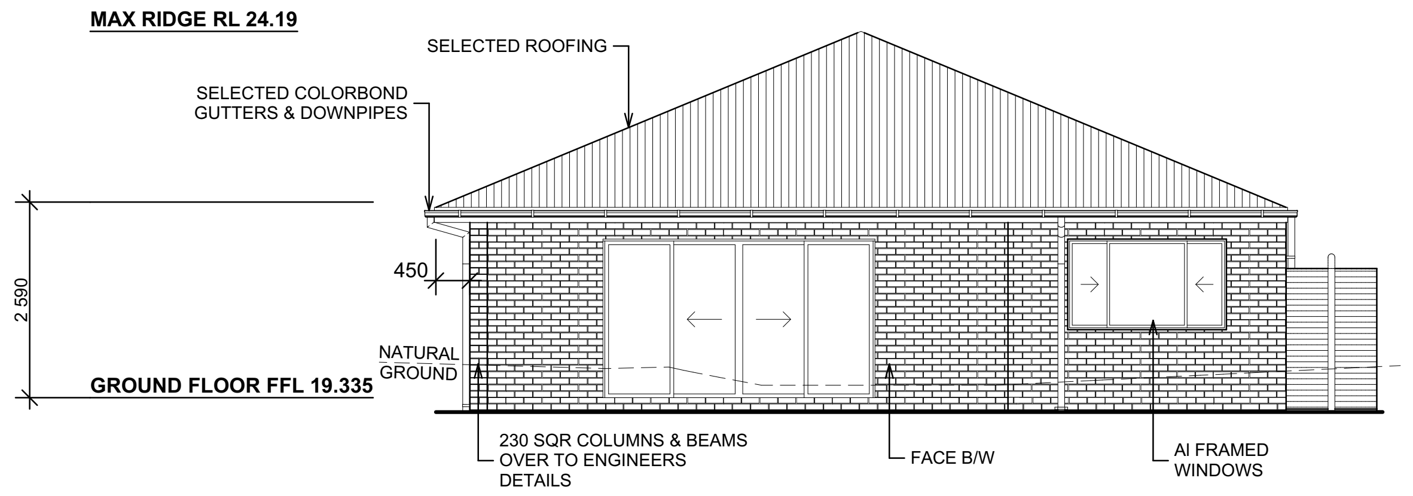
DWELLING 1



DWELLING 1 FLOOR PLAN

1:100



NORTHEAST ELEVATION

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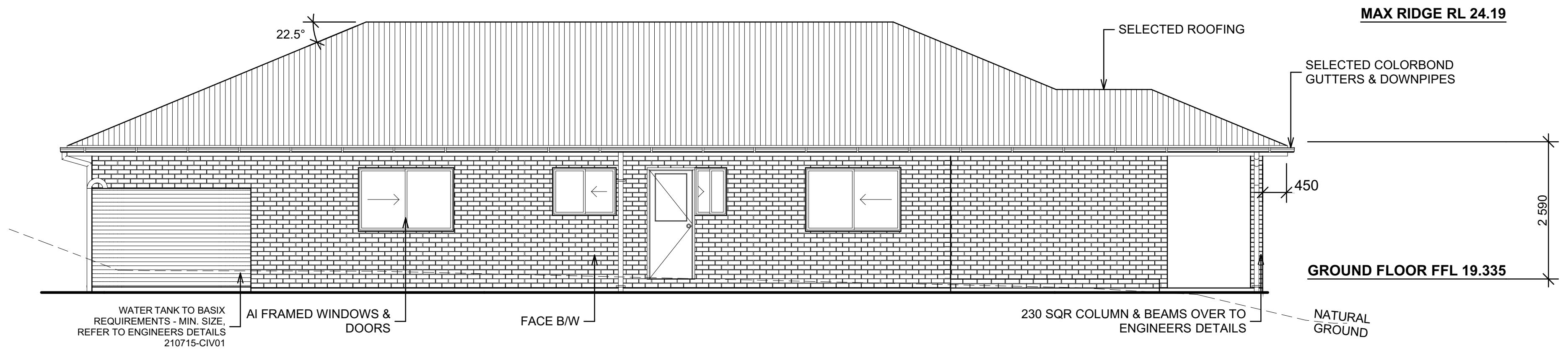
DWELLING 2



NORTHWEST ELEVATION

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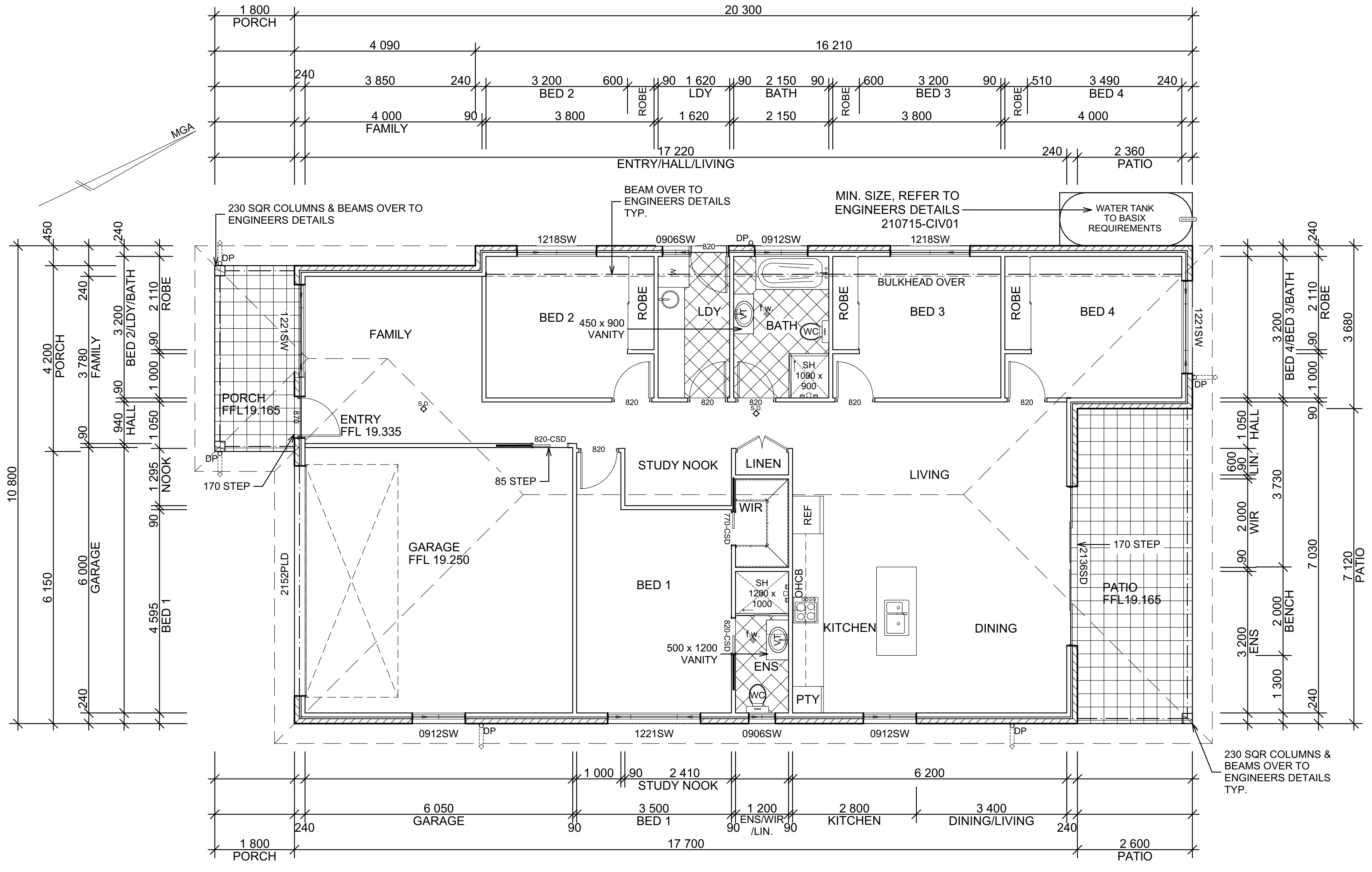
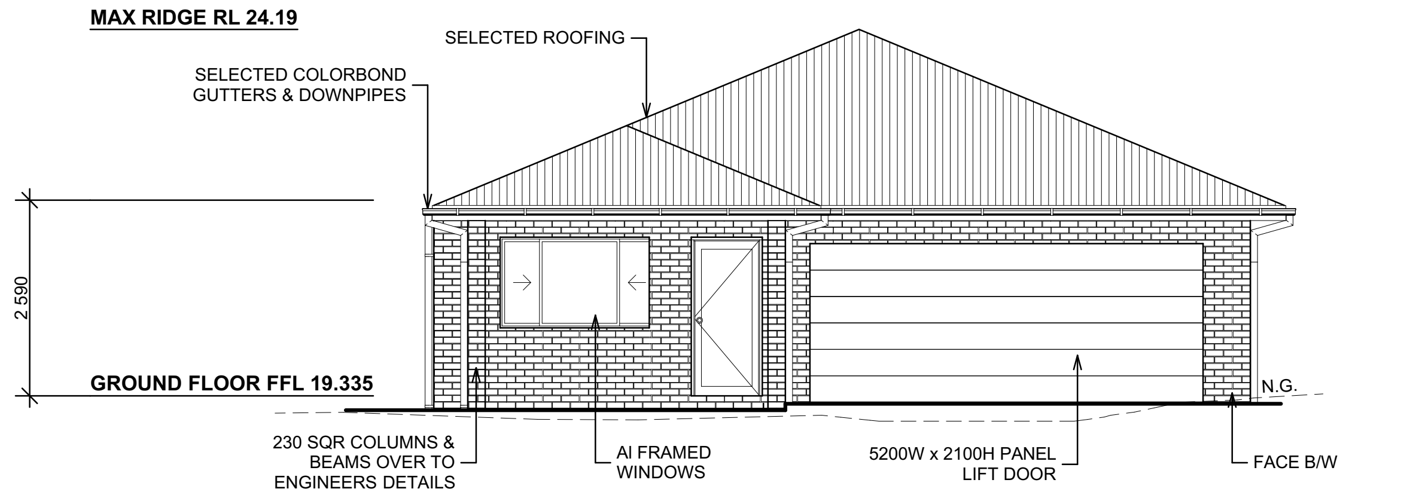
DWELLING 2



DWELLING 2 FLOOR PLAN

1:100



SOUTHWEST ELEVATION

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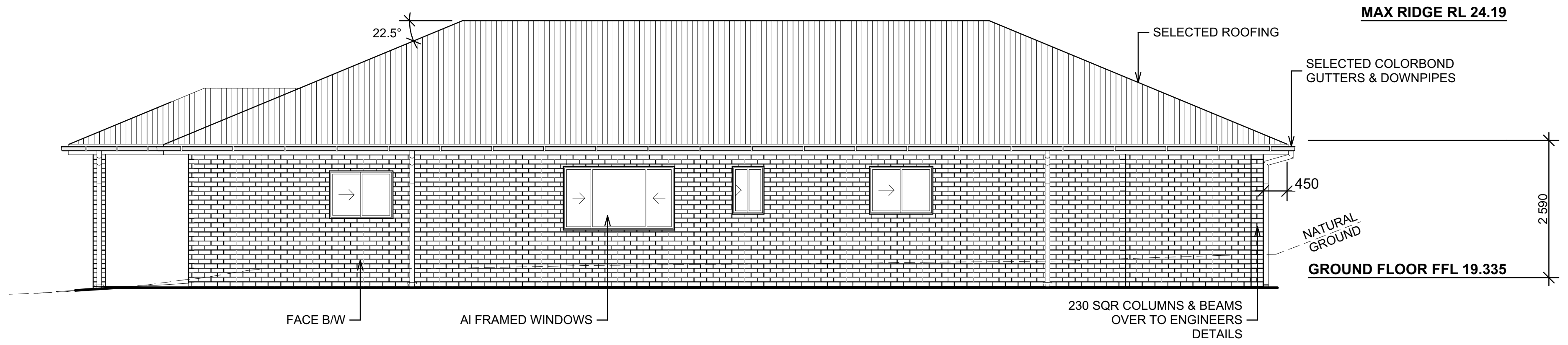
DWELLING 2



SOUTHEAST ELEVATION

1:100
DWELLING 2

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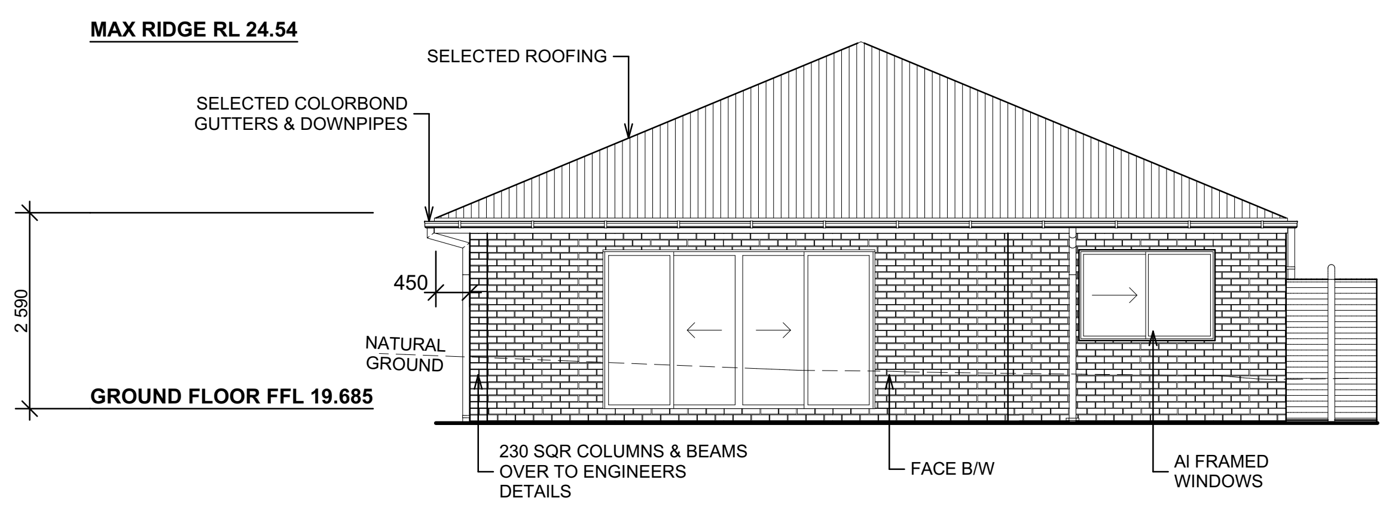
PROJECT: **PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA**

CLIENT: **UNICOMB**

TITLE: **DWELLINGS 1 & 2 FLOOR PLANS & ELEVATIONS**

FILE: **2103113** DATE: **18/06/2021** SHEET: **4** OF **10**

A1



NORTHEAST ELEVATION

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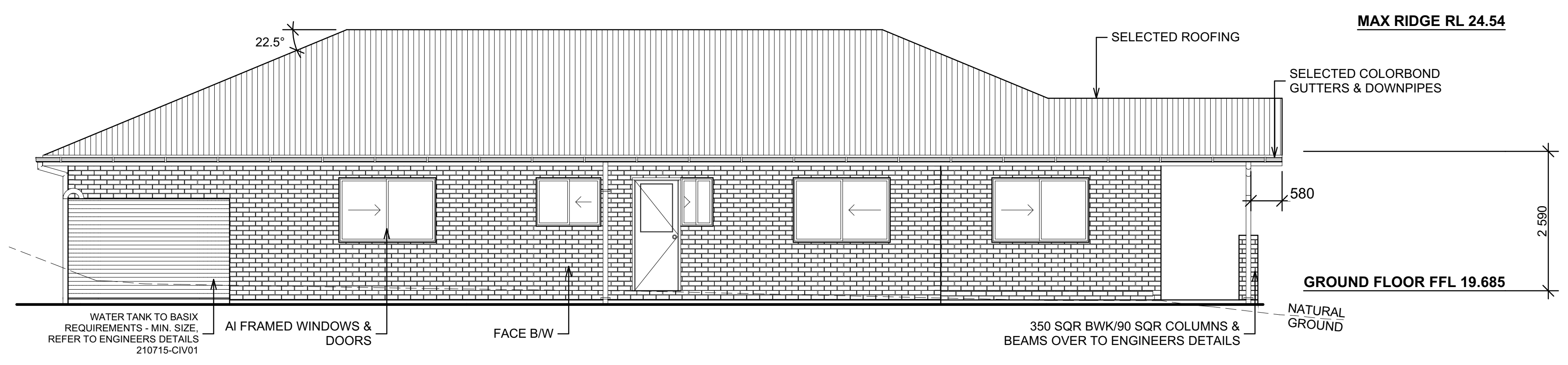
DWELLING 3



NORTHWEST ELEVATION

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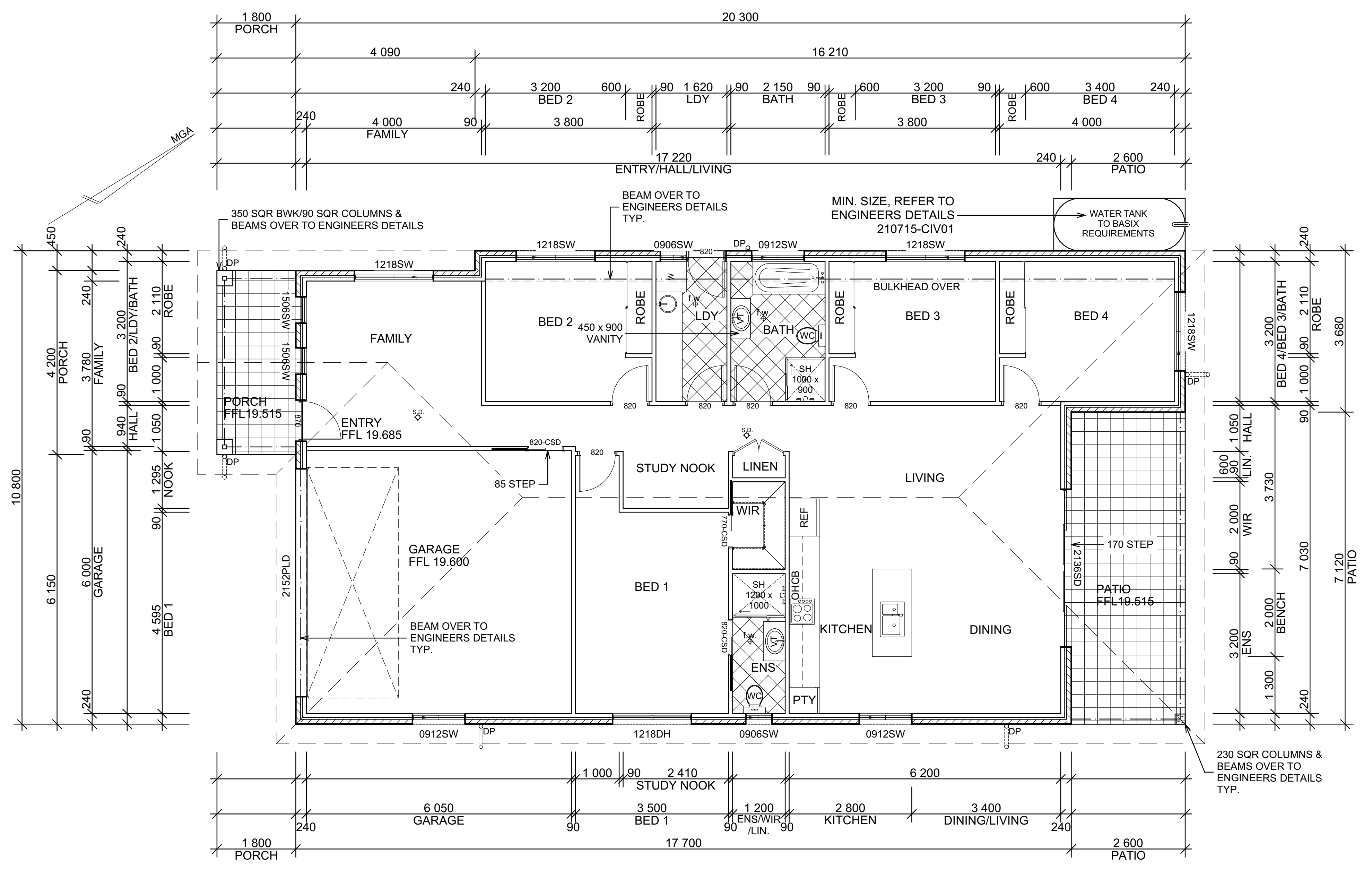
DWELLING 3



DWELLING 3 FLOOR PLAN

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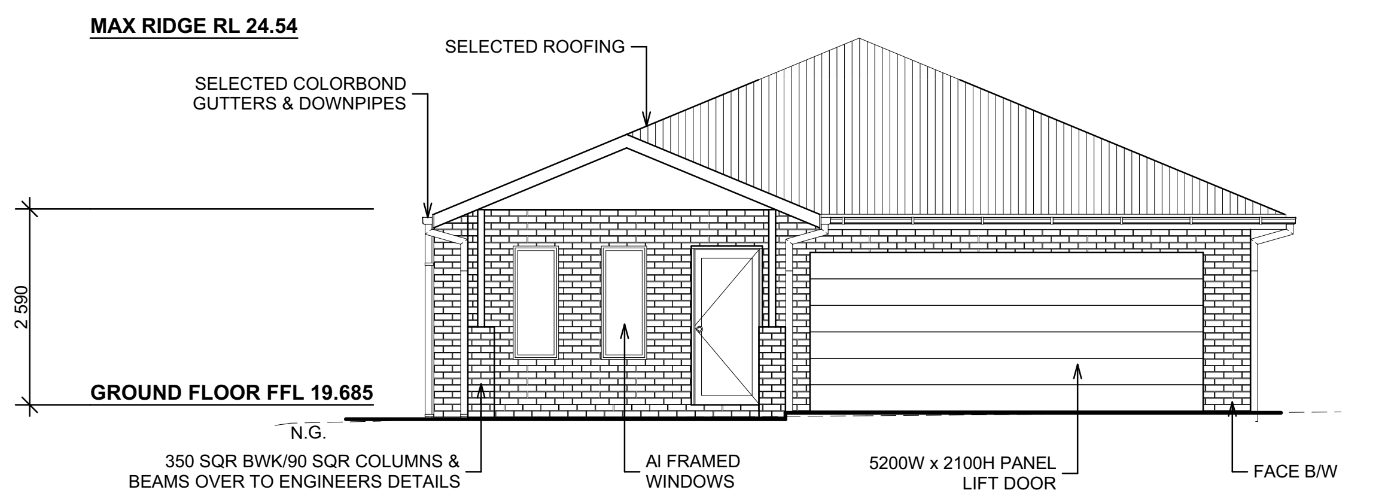
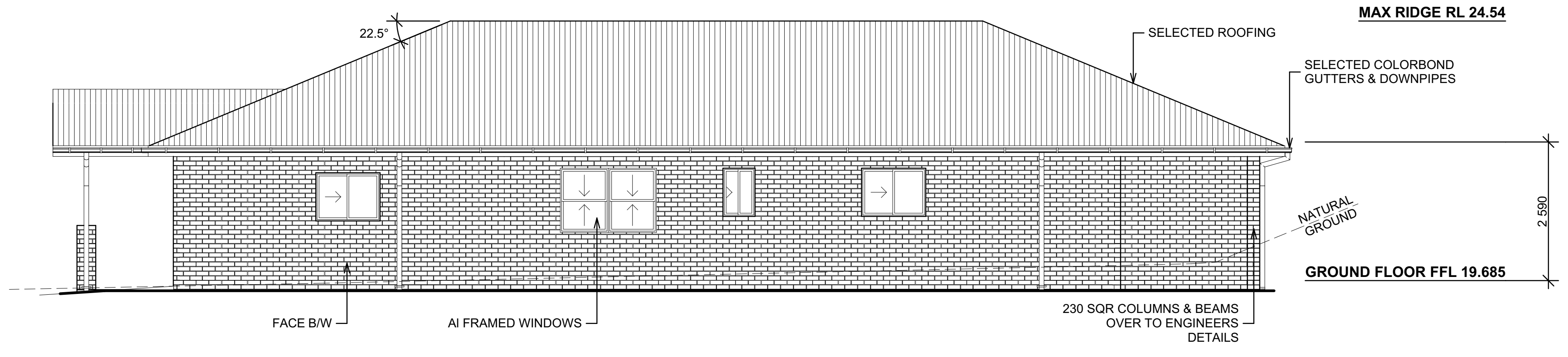


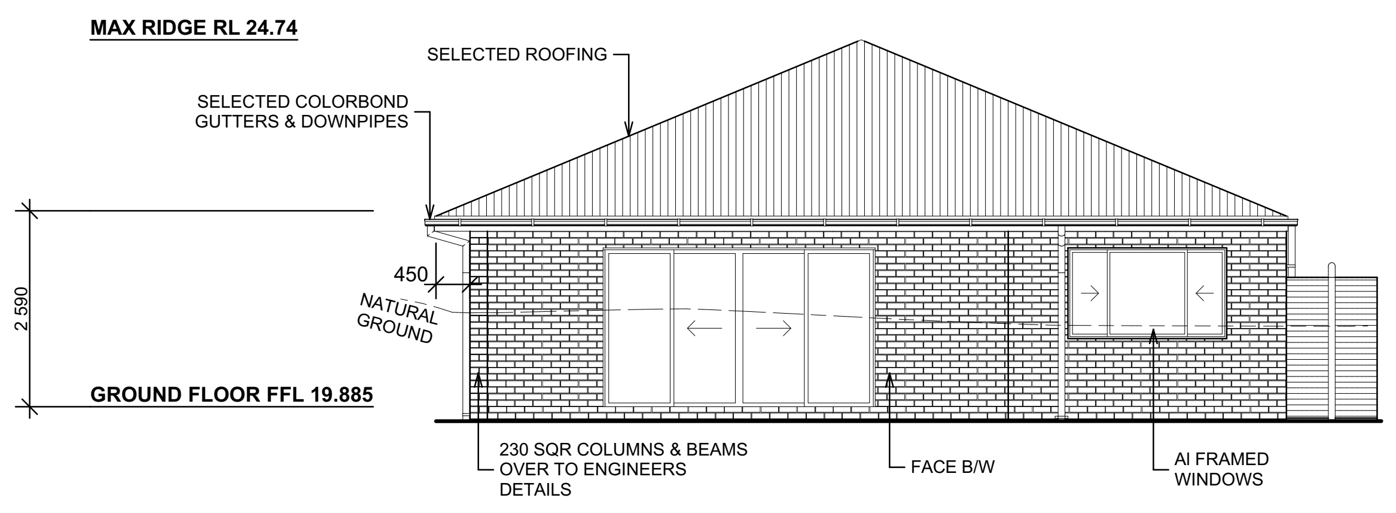
SOUTHWEST ELEVATION

1:100
DWELLING 3



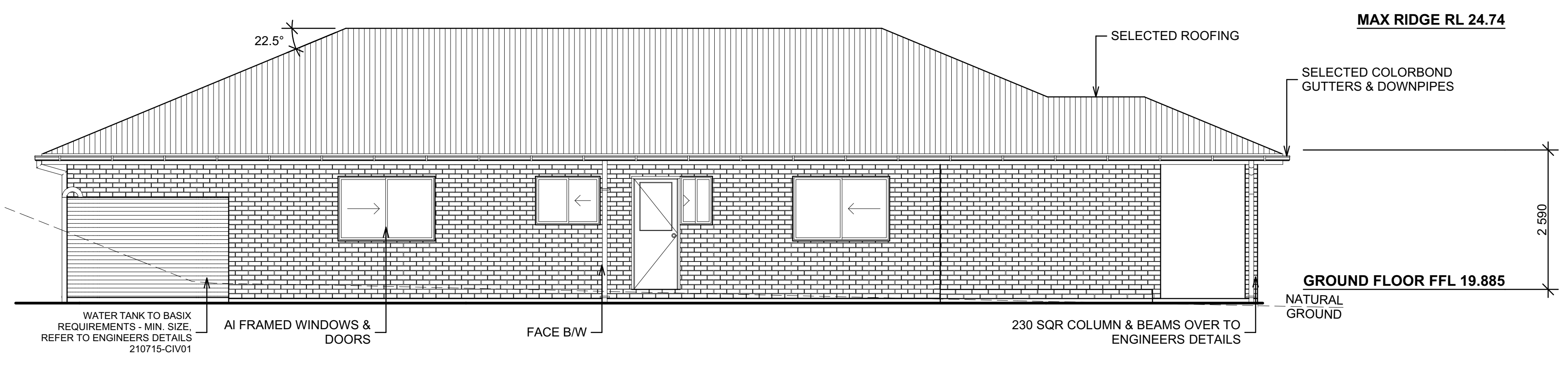
SOUTHEAST ELEVATION

1:100
DWELLING 3



NORTHEAST ELEVATION

1:100
DWELLING 4



NORTHWEST ELEVATION

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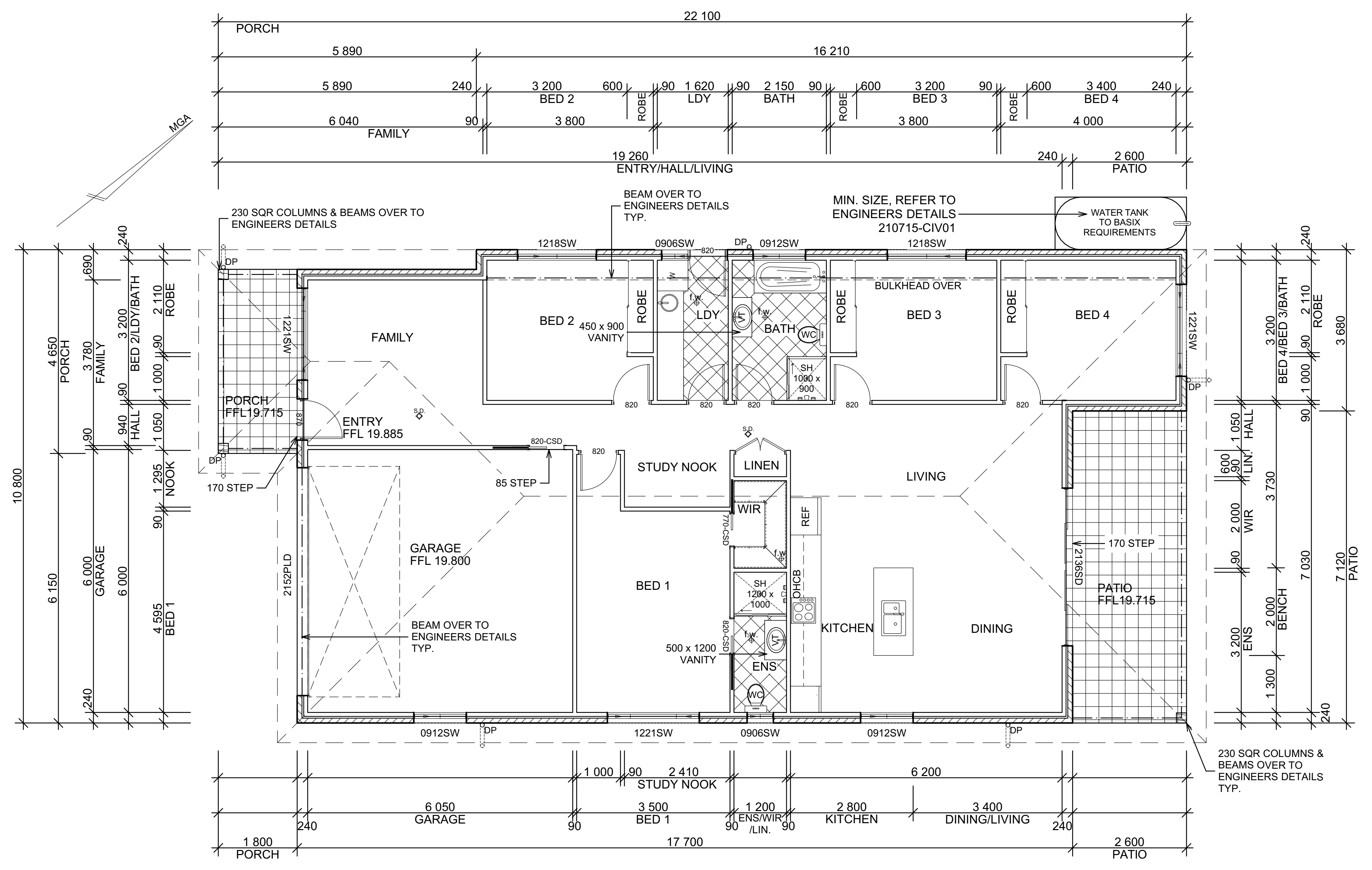
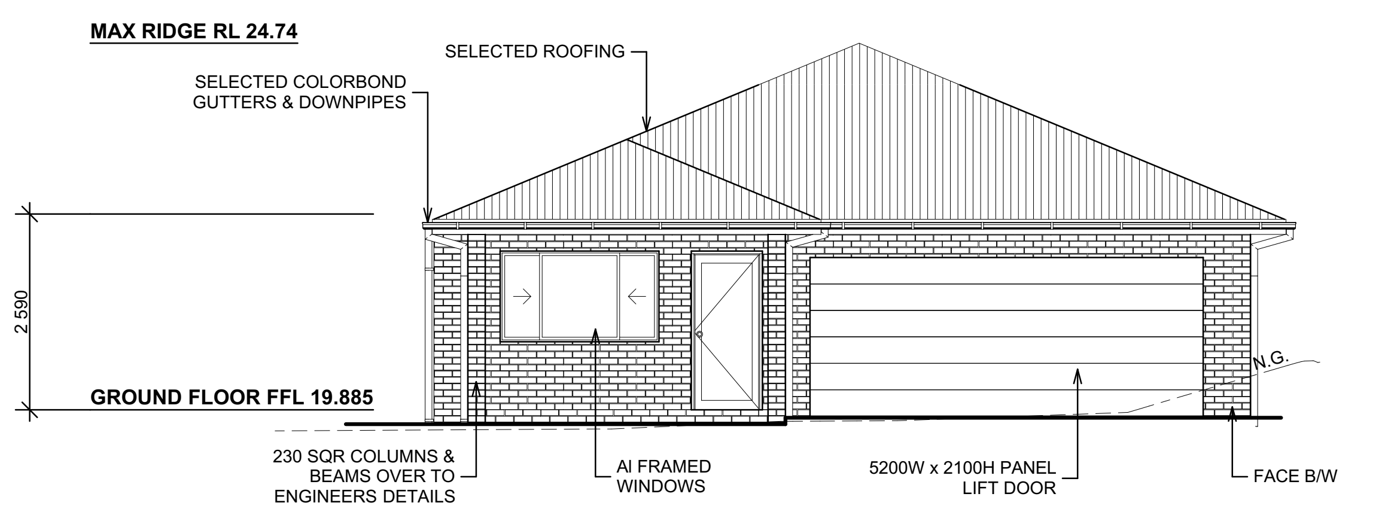
DWELLING 4



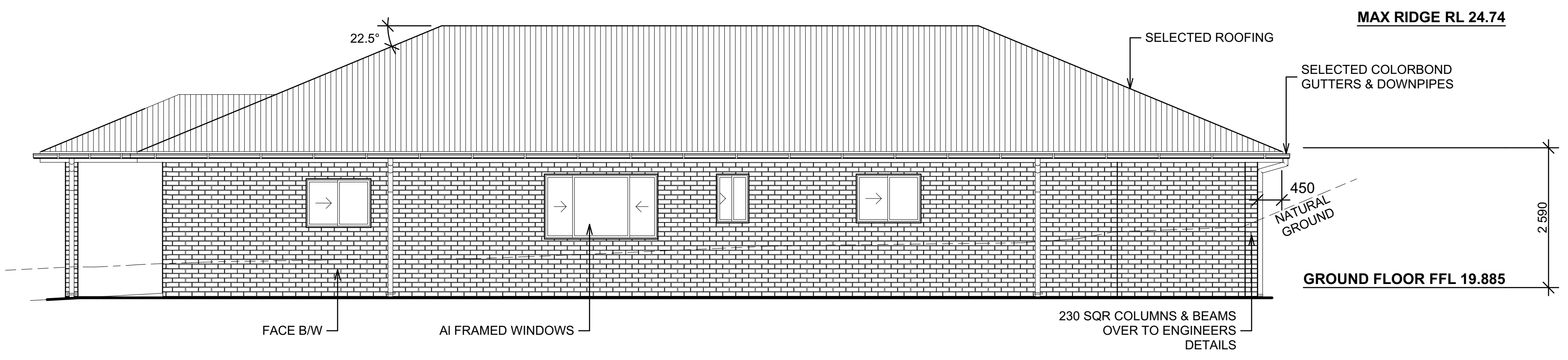
DWELLING 4 FLOOR PLAN

1:100



SOUTHWEST ELEVATION

1:100
DWELLING 4



SOUTHEAST ELEVATION

1:100
DWELLING 4

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PROJECT: **PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA**

CLIENT: **UNICOMB**

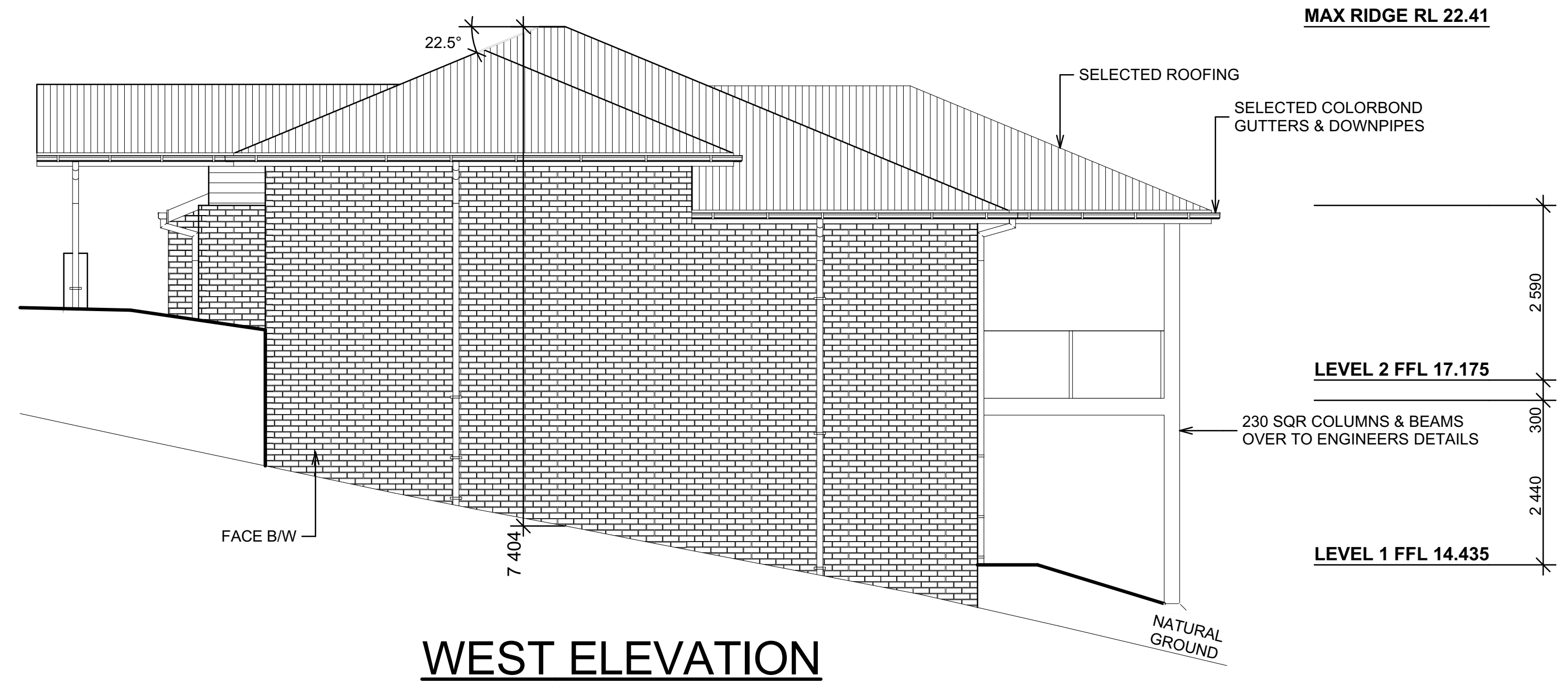
TITLE: **DWELLINGS 3 & 4 FLOOR PLANS & ELEVATIONS**

FILE: **2103113** DATE: **18/06/2021** SHEET: **5** OF **10**

A1

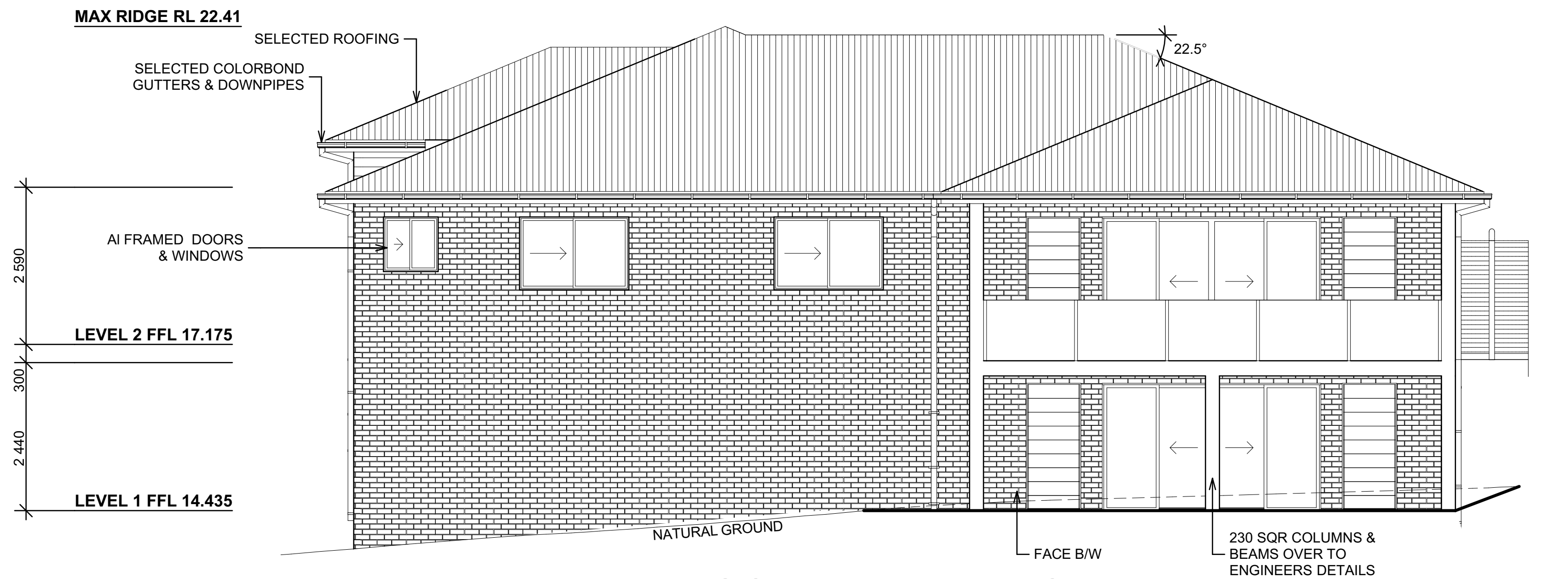
NORTH ELEVATION

1:100
DWELLING 5



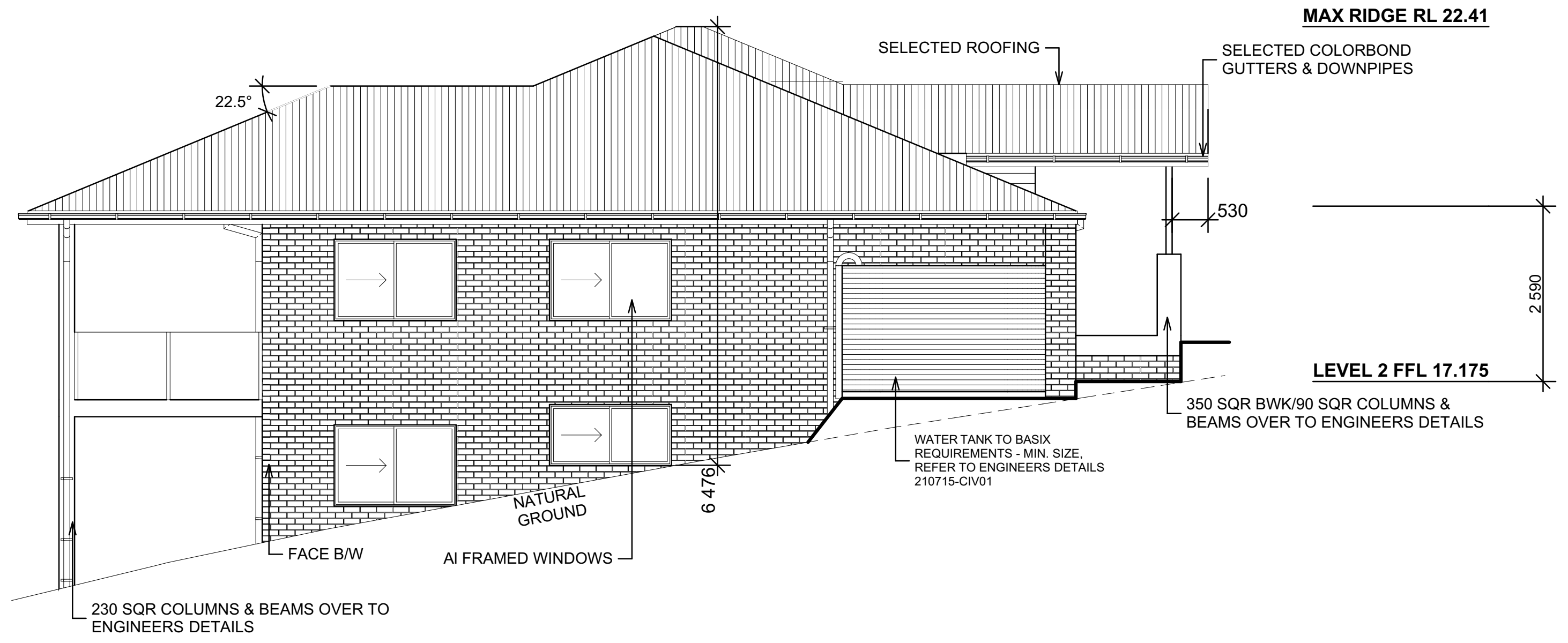
WEST ELEVATION

1:100
DWELLING 5



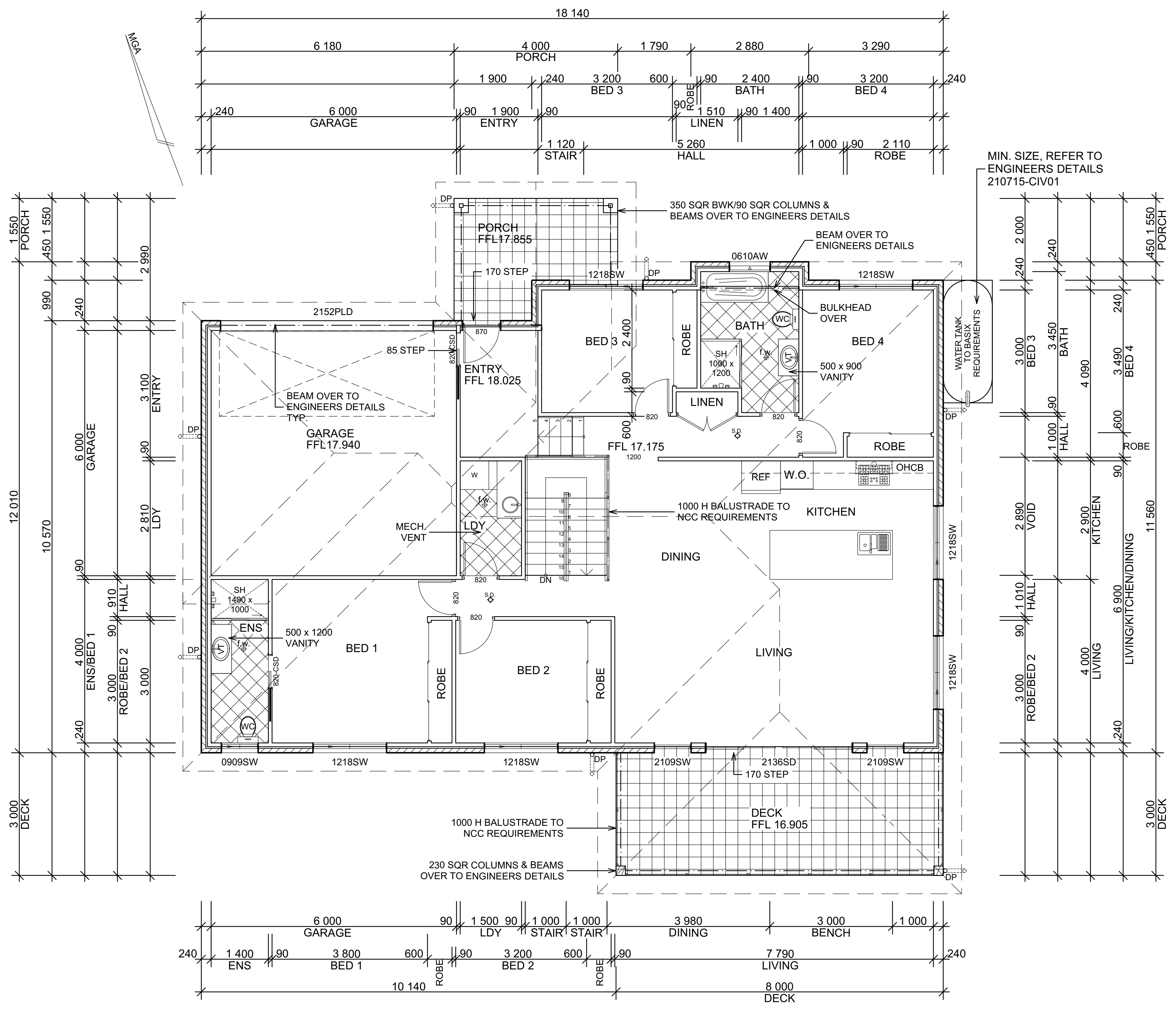
SOUTH ELEVATION

1:100
DWELLING 5



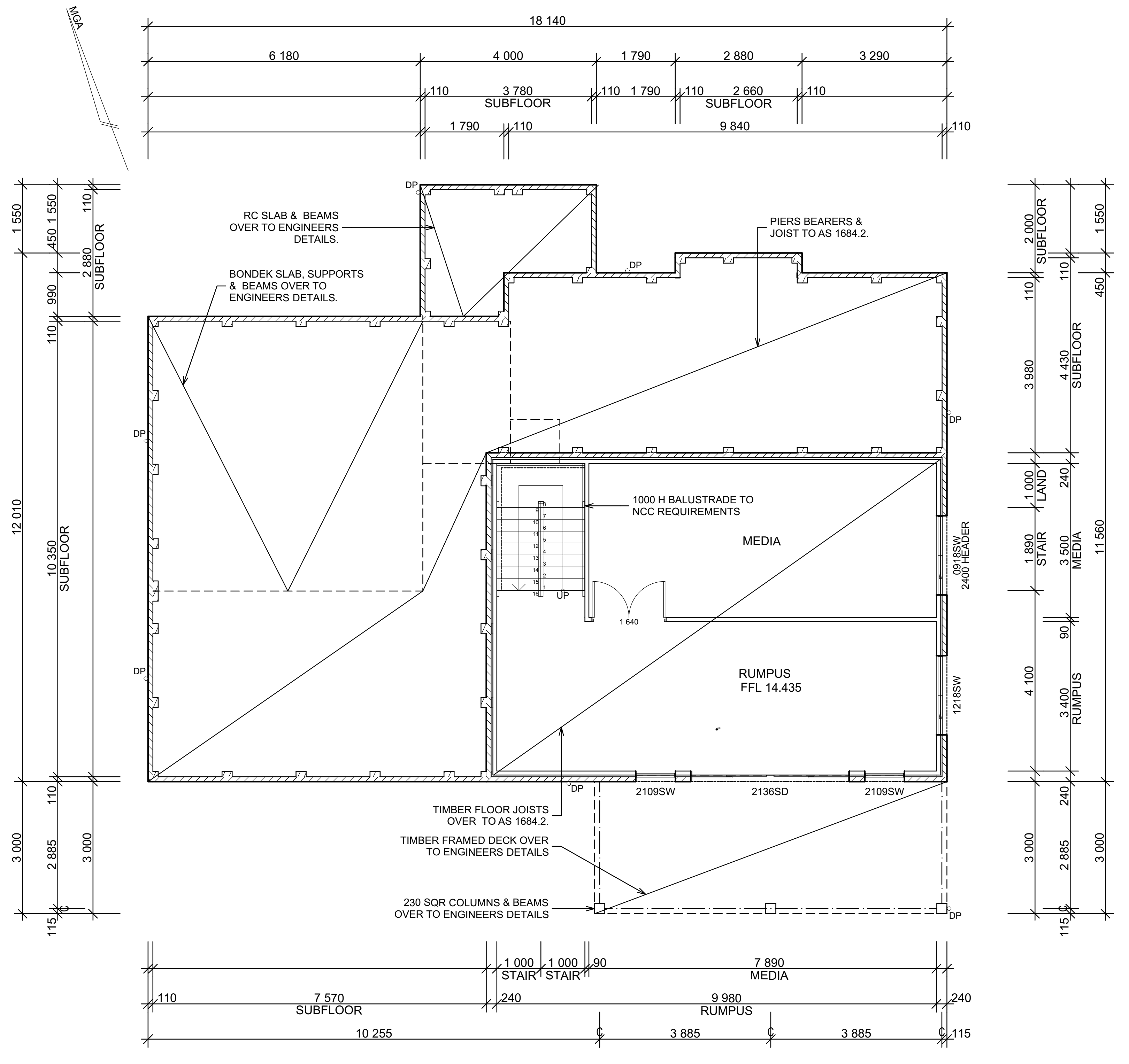
EAST ELEVATION

1:100
DWELLING 5



DWELLING 5 LEVEL 2 FLOOR PLAN

1:100



DWELLING 5 LEVEL 1 FLOOR PLAN

1:100

UNICOMB LOT 5			
7B OAKLAND CLOSE			
BASIX Certificate No.- 1206656S			
Site Area (m²)	787 m²	Roof Area (m²)	267 m²
Total Area of Garden & Lawn (m²)			450 m²
Area of Indigenous or low water use plants (m²)			10 m²

SUMMARY OF BASIX COMMITMENTS

This is a summary of the BASIX Commitments as detailed in the BASIX Certificate. Builders and Owners must refer to the CURRENT BASIX Certificate for Complete details. For definitions refer to www.basix.nsw.gov.au

WATER COMMITMENTS			
Fixtures:			
Shower Heads	4* 6<=7.5 L/m	Toilet	4*
Kitchen Taps	4*	Basin Taps	4*
Clothes Washers	~	Dishwashers	~
Hot Water Recirculation	~		
Pool/Spa			
Alternative Water:			
Rainwater Tank Size (L)	3000 L		
Collected from Roof Area (m²)	265 m²		
Tank Connected To:			
All Toilets	YES	Laundry W/M Cold Tap	YES
One Outdoor Tap	YES	All Hot Water Systems	YES
THERMAL COMFORT COMMITMENTS - Refer to TPA Specification on plans			

ENERGY COMMITMENTS				
Hot Water	4* INTANTANEOUS GAS			
Cooling System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Heating System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Ventilation	Bathroom	NATURAL	~	
	Kitchen	UNDUCTED FAN	MANUAL	
	Laundry	DUCTED FAN	TIMER OFF	
Natural Lighting	Window/Skylight in Kitchen			YES
	Window/Skylight in Bathrooms/Toilets	YES	QTY	1
Artificial Lighting	ALL Bedrooms lit by fluorescent lamps		DEDICATED	YES
	ALL Living/Dining lit by fluorescent lamps		DEDICATED	YES
	Kitchen lit by fluorescent lamps	YES	DEDICATED	YES
	Bathrms/Toilets lit by fluoro lamps	YES	DEDICATED	YES
	Laundry lit by fluorescent lamps	YES	DEDICATED	YES
	Hallways lit by fluorescent lamps	YES	DEDICATED	YES

OTHER COMMITMENTS			
Clothes line	YES	Ventilated refrigerator space	YES
Stove/Oven	ELECTRIC OVEN & GAS RANGE		
Other			

Important Note for Development Applicants:
The following specification details the requirements necessary to achieve the thermal performance values as indicated on the BASIX Certificate. Once the development is approved by Council, these specifications will become a condition of consent and must be included in the built works. If you do not want to include these requirements, or need further information, please contact Sorensen Design.

Thermal Performance Specifications - BASIX No.: 1206656S

These are the Specifications upon which the assessment is based. If they vary from drawings or other written specifications, these Specifications shall take precedence. If only one specification option is detailed for a building element, that specification must apply to all instances of that element for the whole project. If alternate specifications are detailed, the location and extent of the alternate specification must be detailed below and / or clearly indicated on referenced documentation.

External Wall Construction	*Insulation*	*Colour (Solar Absorptance)*	*Detail*
Brick Veneer	R2.86 (or R3.4 Inc. Const)	Any	
Internal Wall Construction	*Insulation*	*Detail*	
Plasterboard on studs	none		
Ceiling Construction	*Insulation*	*Detail*	
Plasterboard	R3.45(up) To Ceilings adjacent to roof space		
Roof Construction	*Insulation*	*Colour (Solar Absorptance)*	*Detail*
Framed, Metal roof	Foil +75mm blanket	Medium 0.475-0.70	
Floor Construction	*Insulation*	*Covering*	*Detail*
Concrete	none	As drawn (if not noted default values used)	
Suspended frame, above hab. room	none	As drawn (if not noted default values used)	
Suspended frame, enclosed subfloor	R1.10 (or 1.8 Inc. Const) (down)	As drawn (if not noted default values used)	

Windows *Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
Standard Single clear Aluminium	6.7	0.7	41.37 m²	
Standard Single clear Aluminium	6.7	0.57	1.97 m²	
Skylights *Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
None				

U and SHGC values are according to ANAC 2005. Alternate products may be used if the U value is lower and the SHGC is less then 10% higher or lower then the above figures.

External Window Cover	*Detail*
Fixed shading - Eaves	*Width includes guttering, offset is distance above windows*
Width: >450 Offset: 220	Nominal only, refer to plan for detail
Fixed shading - Other	*Verandahs, Pergolas (type and description)*
Shaded porch and patio areas as drawn	

Ventilation and Infiltration to Habitable Rooms			
Open fire no damper	No	*Exhaust fans no dampers*	No
Door and window seals	Yes	*Vented skylights*	No
Vented downlights	No	*Fixed wall or ceiling vents*	No

"No" means that the item was not included in the assessment and shall not be installed.
Yes to door & window seals means that seals are to be fitted to all external doors and windows.

FINAL PLANS
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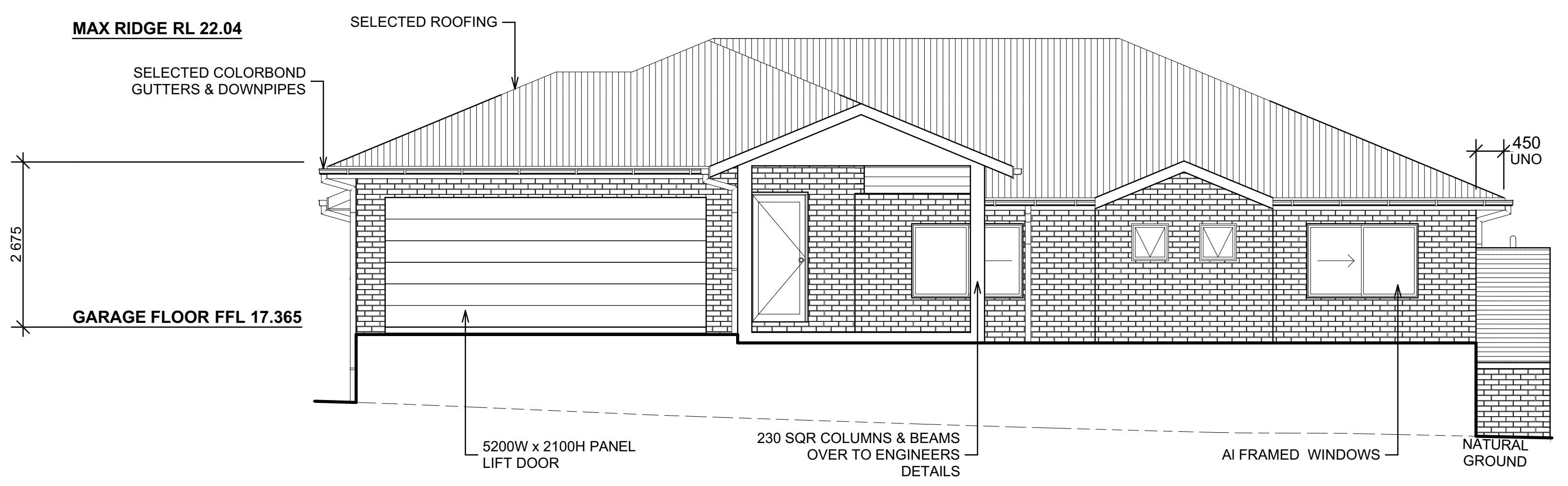
PROJECT: PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA

CLIENT: UNICOMB

TITLE: DWELLING 5 FLOOR PLANS, ELEVATIONS, BASIX SUMMARY & THERMAL PERFORMANCE ASSESSMENT

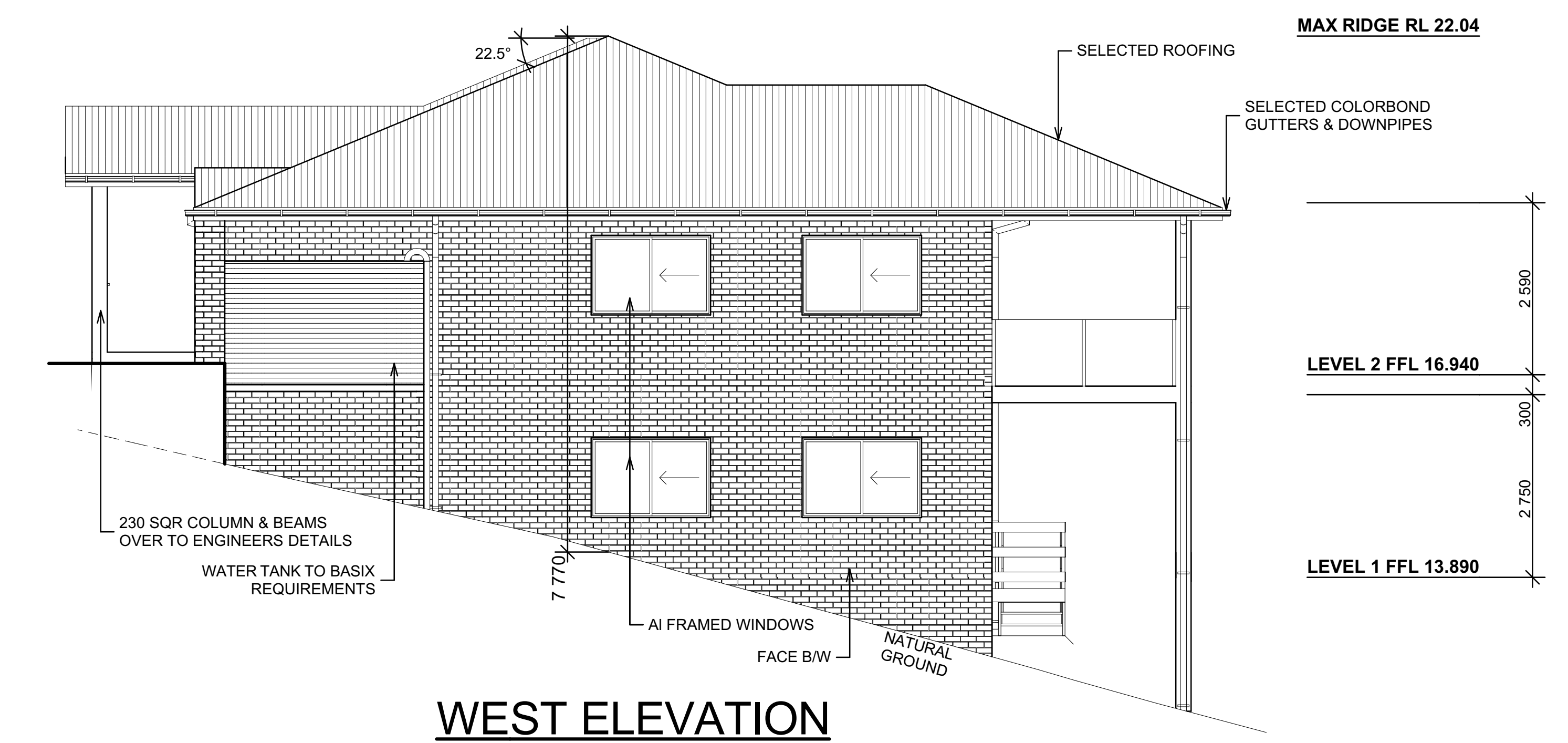
FILE: 2103113 DATE: 18/06/2021 SHEET: 6 OF 10

A1



NORTH ELEVATION

1:100
DWELLING 6

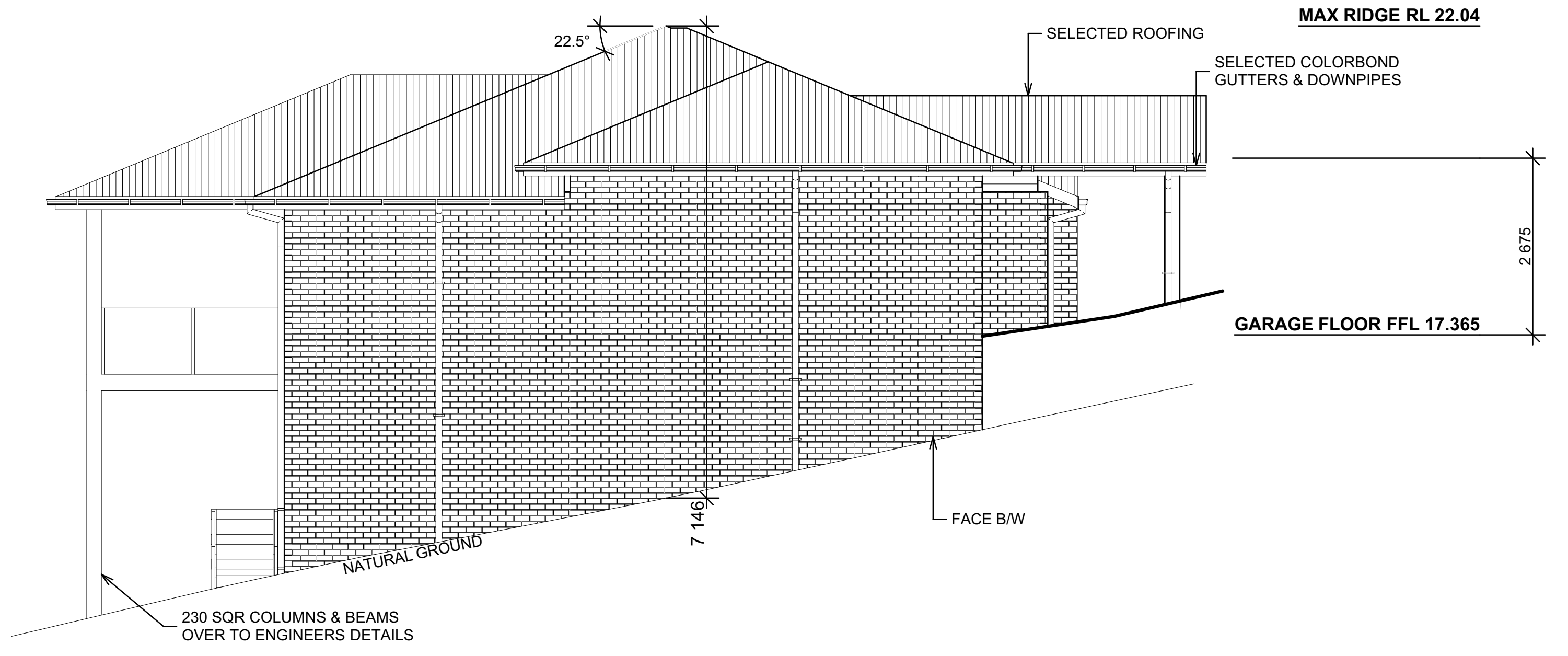


WEST ELEVATION

1:100
DWELLING 6

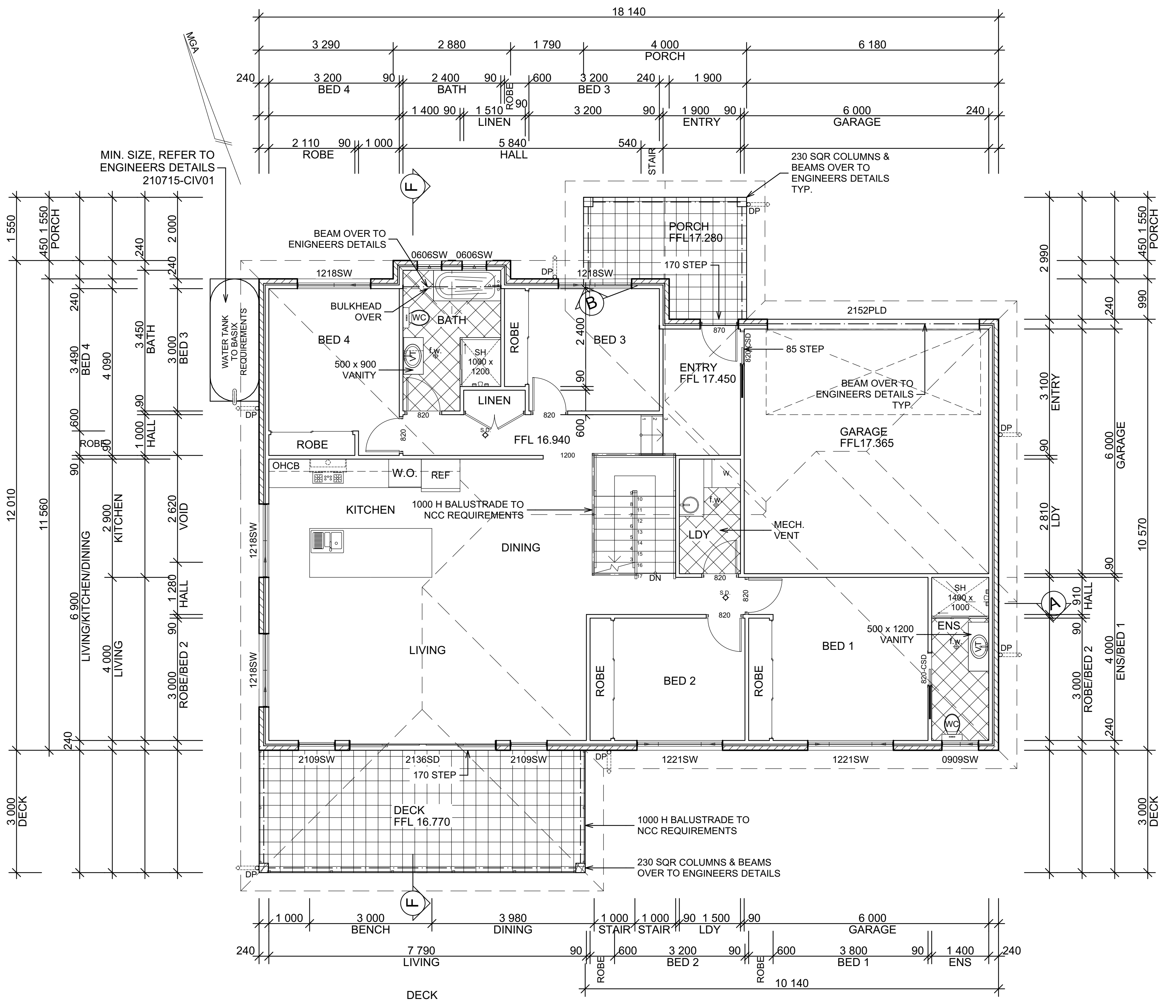
SOUTH ELEVATION

1:100
DWELLING 6



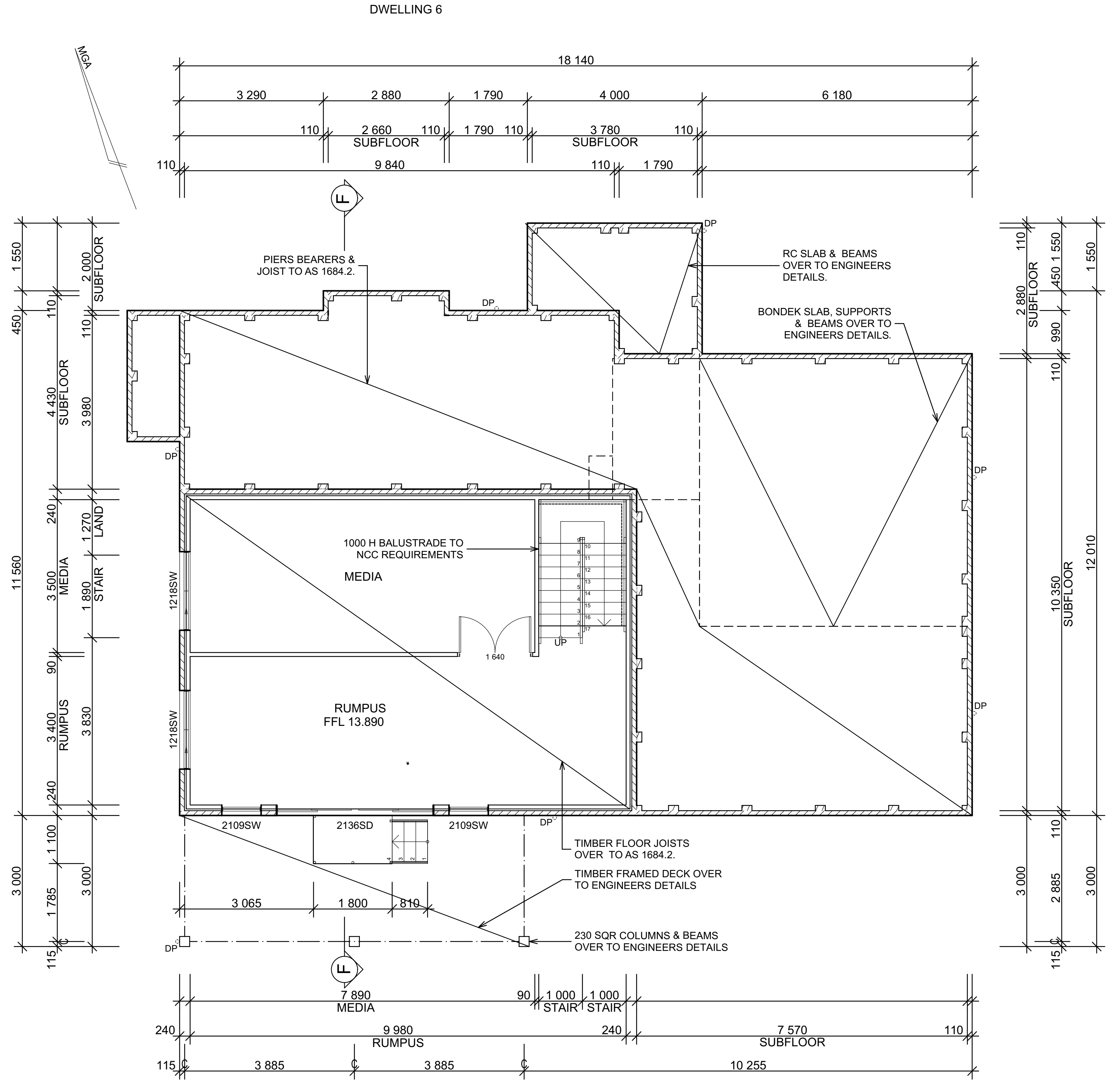
EAST ELEVATION

1:100
DWELLING 6



DWELLING 6 LEVEL 2 FLOOR PLAN

1:100



DWELLING 6 LEVEL 1 FLOOR PLAN

1:100

UNICOMB LOT 6				
7C OAKLAND CLOSE				
BASIX Certificate No.- 1206718S				
Site Area (m²)	**705 m²**	**Roof Area (m²)**	**267 m²**	
Total Area of Garden & Lawn (m²)			**442 m²**	
Area of Indigenous or low water use plants (m²)			**10 m²**	
SUMMARY OF BASIX COMMITMENTS				
This is a summary of the BASIX Commitments as detailed in the BASIX Certificate. Builders and Owners must refer to the CURRENT BASIX Certificate for Complete details. For definitions refer to www.basix.nsw.gov.au				
WATER COMMITMENTS				
Fixtures:				
Shower Heads	**4* 6<=7.5 L/m**	**Toilet**	**4***	
Kitchen Taps	**4***	**Basin Taps**	**4***	
Clothes Washers	**~**	**Dishwashers**	**~**	
Hot Water Recirculation	**~**			
Pool/Spa				
Alternative Water:				
Rainwater Tank Size (L)	**3000 L**			
Collected from Roof Area (m²)	**265 m²**			
Tank Connected To:				
All Toilets	**YES**	**Laundry W/M Cold Tap**	**YES**	
One Outdoor Tap	**YES**	**All Hot Water Systems**	**YES**	
THERMAL COMFORT COMMITMENTS - Refer to TPA Specification on plans				
ENERGY COMMITMENTS				
Hot Water	**4* INTANTANEOUS GAS**			
Cooling System	**Living**	**1-PHASE A/C D/N ZONED**	**3* (AVG. ZONE)**	
	Bedrooms	**1-PHASE A/C D/N ZONED**	**3* (AVG. ZONE)**	
Heating System	**Living**	**1-PHASE A/C D/N ZONED**	**3* (AVG. ZONE)**	
	Bedrooms	**1-PHASE A/C D/N ZONED**	**3* (AVG. ZONE)**	
Ventilation	**Bathroom**	**NATURAL**	**~**	
	Kitchen	**UNDUCTED FAN**	**MANUAL**	
	Laundry	**DUCTED FAN**	**TIMER OFF**	
Natural Lighting	**Window/Skylight in Kitchen**			**YES**
	Window/Skylight in Bathrooms/Toilets	**YES**	**QTY**	**1**
Artificial Lighting	**ALL Bedrooms lit by fluorescent lamps**		**DEDICATED**	**YES**
	ALL Living/Dining lit by fluorescent lamps		**DEDICATED**	**YES**
	Kitchen lit by fluorescent lamps	**YES**	**DEDICATED**	**YES**
	Bathrms/Toilets lit by fluoro lamps	**YES**	**DEDICATED**	**YES**
	Laundry lit by fluorescent lamps	**YES**	**DEDICATED**	**YES**
	Hallways lit by fluorescent lamps	**YES**	**DEDICATED**	**YES**
OTHER COMMITMENTS				
Clothes line	**YES**	**Ventilated refrigerator space**	**YES**	
Stove/Oven	**ELECTRIC OVEN & GAS RANGE**			
Other				

Important Note for Development Applicants:
The following specification details the requirements necessary to achieve the thermal performance values as indicated on the BASIX Certificate. Once the development is approved by Council, these specifications will become a condition of consent and must be included in the built works. If you do not want to include these requirements, or need further information, please contact Sorensen Design.

Thermal Performance Specifications - BASIX No.: 1206718S

These are the Specifications upon which the assessment is based. If they vary from drawings or other written specifications, these Specifications shall take precedence. If only one specification option is detailed for a building element, that specification must apply to all instances of that element for the whole project. If alternate specifications are detailed, the location and extent of the alternate specification must be detailed below and / or clearly indicated on referenced documentation.

External Wall Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Brick Veneer	R2.86 (or R3.4 Inc. Const)	Any			
Internal Wall Construction	*Insulation*	*Detail*			
Plasterboard on studs	none				
Ceiling Construction	*Insulation*	*Detail*			
Plasterboard	R3.45(up) To Ceilings adjacent to roof space				
Roof Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Framed, Metal roof	Foil +75mm blanket	Medium 0.475-0.70			
Floor Construction	*Insulation*	*Covering*			*Detail*
Concrete	none	As drawn (if not noted default values used)			
Suspended frame, above hab. room	none	As drawn (if not noted default values used)			
Suspended frame, enclosed subfloor	R1.10 (or 1.8 Inc. Const) (down)	As drawn (if not noted default values used)			
Windows *Glass and frame type*		*U*	*SHGC*	*Area sq m*	*Detail*
Standard	Single clear Al.	6.7	0.7	13.68 m²	
Standard	Single clear Al.	6.7	0.57	1.97 m²	
Standard	Single Hi-Tsol Low-e Al.	5.4	0.522-0.638	5.85 m²	
Improved	DG (air) Hi-Tsol Low-e/clear Al.	4.3	0.477-0.583	7.56 m²	
Thermally broken Al	DG (air), Hi-Tsol Low-e/clear	3.1	0.441-0.539	15.12 m²	
Skylights *Glass and frame type*		*U*	*SHGC*	*Area sq m*	*Detail*
None					
U and SHGC values are according to ANAC 2005. Alternate products may be used if the U value is lower and the SHGC is less then 10% higher or lower then the above figures.					
External Window Cover	*Detail*				
Fixed shading - Eaves	*Width includes guttering, offset is distance above windows*				
Width: >450 Offset: 220	Nominal only, refer to plan for detail				
Fixed shading - Other	*Verandahs, Pergolas (type and description)*				
Shaded porch and patio areas as drawn					
Ventilation and Infiltration to Habitable Rooms					
Open fire no damper	No	*Exhaust fans no dampers*	No		
Door and window seals	Yes	*Vented skylights*	No		
Vented downlights	No	*Fixed wall or ceiling vents*	No		
"No" means that the item was not included in the assessment and shall not be installed.					
Yes to door & window seals means that seals are to be fitted to all external doors and windows.					

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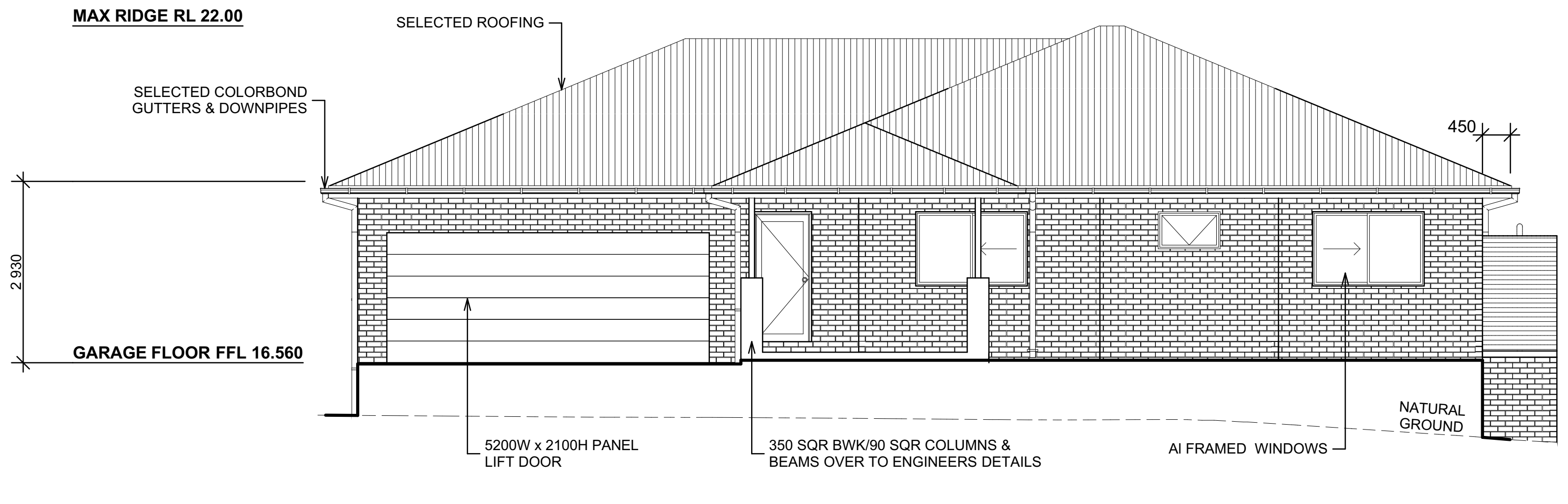
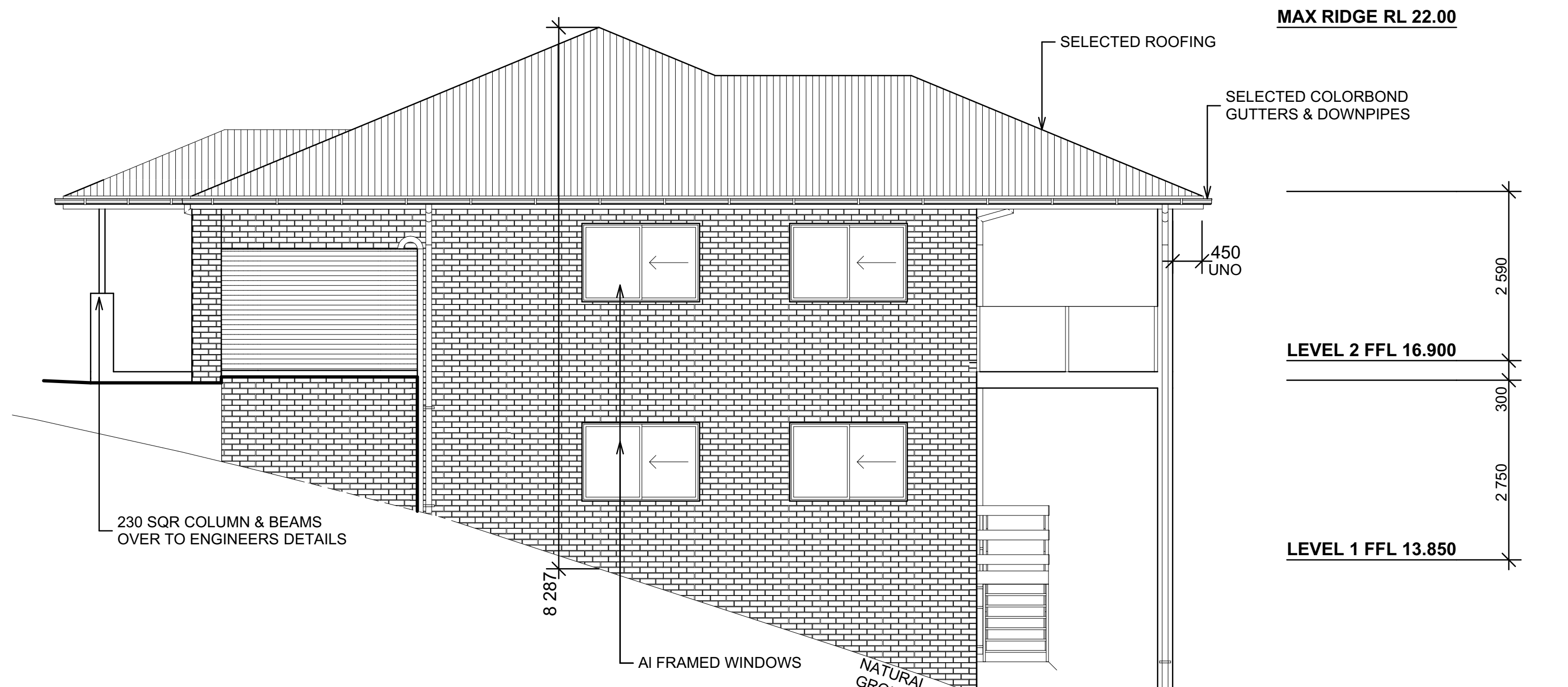
CLIENT: UNICOMB
TITLE: DWELLING 6 FLOOR PLANS, ELEVATIONS, BASIX SUMMARY & THERMAL PERFORMANCE ASSESSMENT
FILE: 2103113 DATE: 18/06/2021 SHEET: 7 OF 10

A1



NORTH ELEVATION

1:100
DWELLING 7

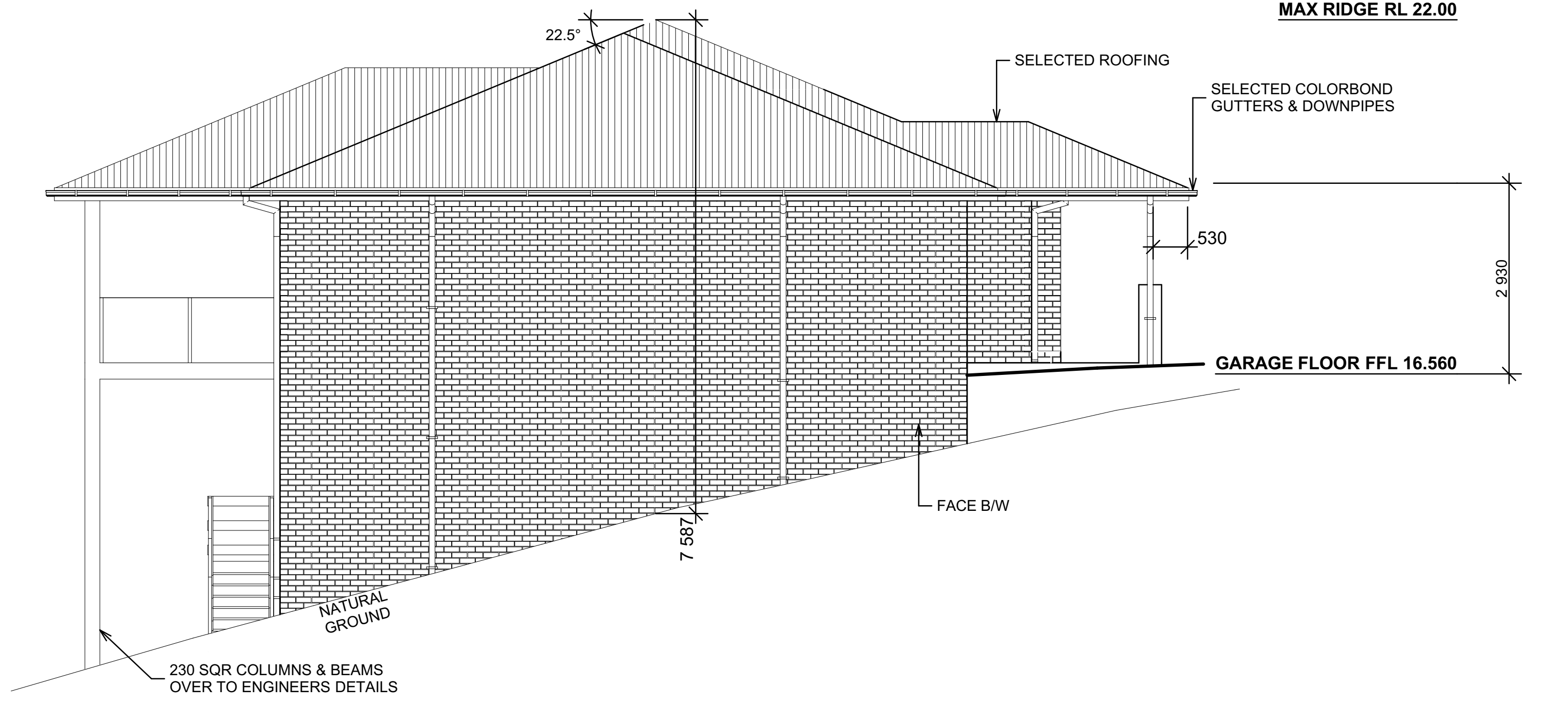


WEST ELEVATION

1:100
DWELLING 7

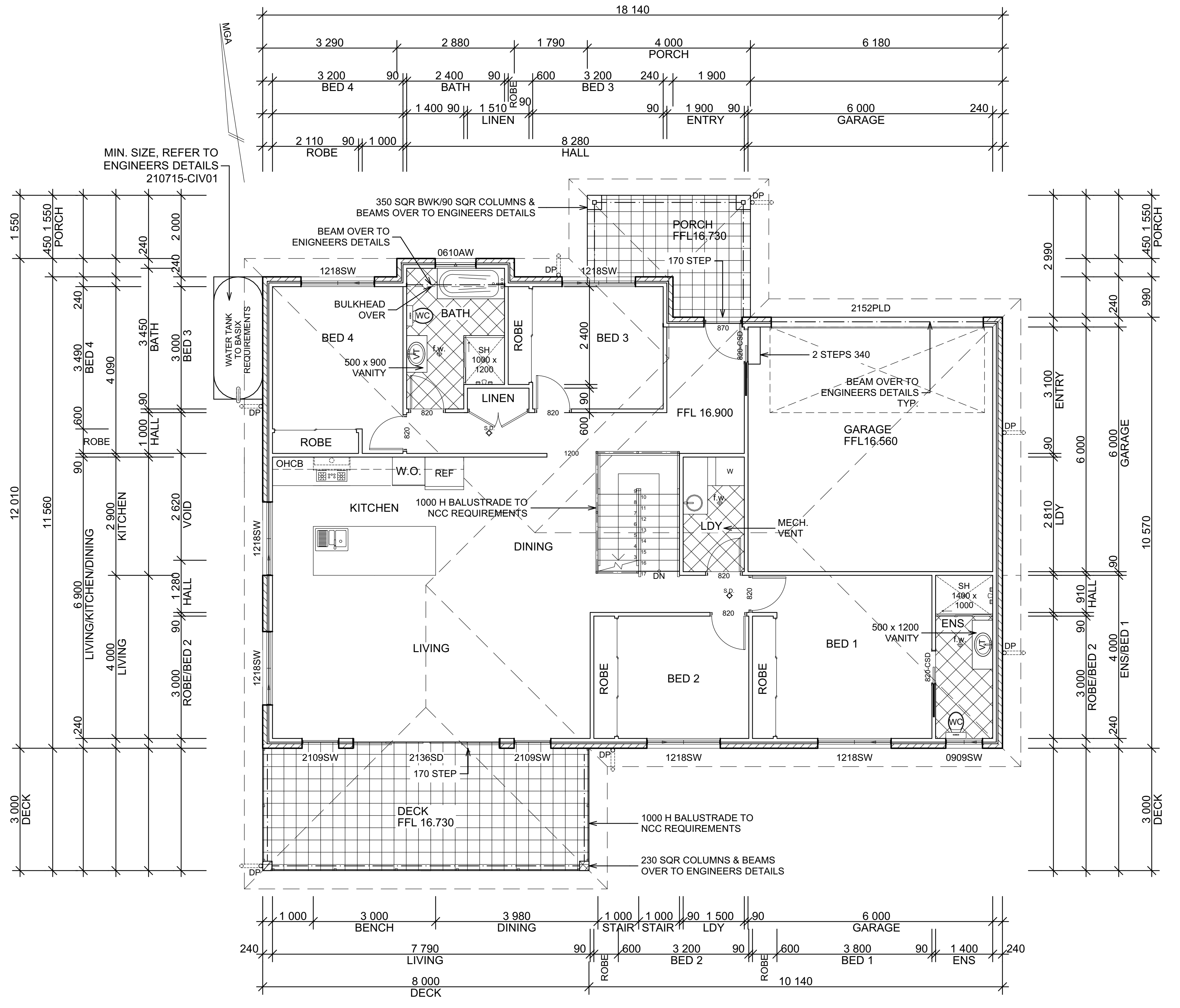
SOUTH ELEVATION

1:100
DWELLING 7



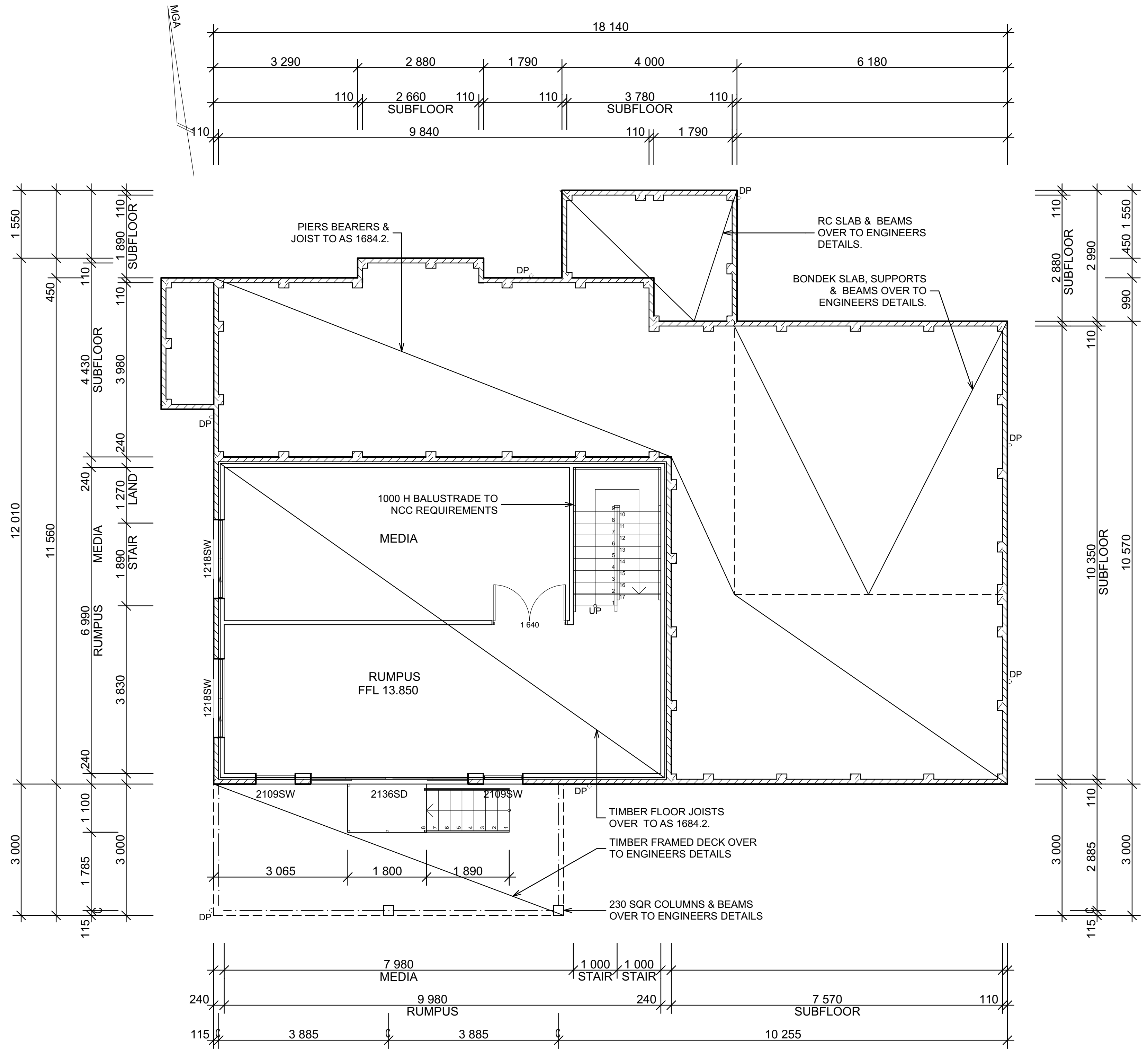
EAST ELEVATION

1:100
DWELLING 7



DWELLING 7 LEVEL 2 FLOOR PLAN

1:100



DWELLING 7 LEVEL 1 FLOOR PLAN

1:100

UNICOMB LOT 7			
7D OAKLAND CLOSE			
BASIX Certificate No.- 1206752S			
Site Area (m²)	807 m²	Roof Area (m²)	267 m²
Total Area of Garden & Lawn (m²)			450 m²
Area of Indigenous or low water use plants (m²)			10 m²

SUMMARY OF BASIX COMMITMENTS

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WATER COMMITMENTS			
Fixtures:			
Shower Heads	4* 6<=7.5 L/m	Toilet	4*
Kitchen Taps	4*	Basin Taps	4*
Clothes Washers	~	Dishwashers	~
Hot Water Recirculation	~		
Pool/Spa			
Alternative Water:			
Rainwater Tank Size (L)	3000L		
Collected from Roof Area (m²)	265 m²		
Tank Connected To:			
All Toilets	YES	Laundry W/M Cold Tap	YES
One Outdoor Tap	YES	All Hot Water Systems	YES

THERMAL COMFORT COMMITMENTS - Refer to TPA Specification on plans

ENERGY COMMITMENTS					
Hot Water	4* INTANTANEOUS GAS				
Cooling System	Living	1-PHASE A/C D/N ZONED			3* (AVG. ZONE)
	Bedrooms	1-PHASE A/C D/N ZONED			3* (AVG. ZONE)
Heating System	Living	1-PHASE A/C D/N ZONED			3* (AVG. ZONE)
	Bedrooms	1-PHASE A/C D/N ZONED			3* (AVG. ZONE)
Ventilation	Bathroom	NATURAL		~	
	Kitchen	UNDUCTED FAN		MANUAL	
	Laundry	DUCTED FAN		TIMER OFF	
Natural Lighting	Window/Skylight in Kitchen				YES
	Window/Skylight in Bathrooms/Toilets		YES	QTY	1
Artificial Lighting	ALL	Bedrooms lit by fluorescent lamps		DEDICATED	YES
	ALL	Living/Dining lit by fluorescent lamps		DEDICATED	YES
	Kitchen lit by fluorescent lamps		YES	DEDICATED	YES
	Bathrms/Toilets lit by fluoro lamps		YES	DEDICATED	YES
	Laundry lit by fluorescent lamps		YES	DEDICATED	YES
	Hallways lit by fluorescent lamps		YES	DEDICATED	YES

OTHER COMMITMENTS			
Clothes line	YES	Ventilated refrigerator space	YES
Stove/Oven	ELECTRIC OVEN & GAS RANGE		
Other			

Important Note for Development Applicants:

The following specification details the requirements necessary to achieve the thermal performance values as indicated on the BASIX Certificate. Once the development is approved by Council, these specifications will become a condition of consent and must be included in the built works. If you do not want to include these requirements, or need further information, please contact Sorensen Design.

Thermal Performance Specifications - BASIX No.: 1206752S

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External Wall Construction	*Insulation*	*Colour (Solar Absorptance)*	*Detail*
Brick Veneer	R2.86 (or R3.4 Inc. Const)	Any	
Internal Wall Construction	*Insulation*	*Detail*	
Plasterboard on studs	none		
Ceiling Construction	*Insulation*	*Detail*	
Plasterboard	R3.45(up) To Ceilings adjacent to roof space		
Roof Construction	*Insulation*	*Colour (Solar Absorptance)*	*Detail*
Framed, Metal roof	Foil +75mm blanket	Medium 0.475-0.70	
Floor Construction	*Insulation*	*Covering*	*Detail*
Concrete	none	As drawn (if not noted default values used)	
Suspended frame, above hab. room	none	As drawn (if not noted default values used)	
Suspended frame, enclosed subfloor	R1.10 (or 1.8 Inc. Const) (down)	As drawn (if not noted default values used)	

Windows	*Glass and frame type*		*U*	*SHGC*	*Area sq m*	*Detail*
Standard	Single clear	Al.	6.7	0.7	13.56 m²	
Standard	Single clear	Al.	6.7	0.57	1.97 m²	
Standard	Single Hi-Tsol Low-e	Al.	5.4	0.522-0.638	5.13 m²	
Thermally broken	DG (air), Hi-Tsol Low-e/clear	Al	3.1	0.441-0.539	22.68 m²	
Skylights	*Glass and frame type*		*U*	*SHGC*	*Area sq m*	*Detail*
None						

U and SHGC values are according to ANAC 2005. Alternate products may be used if the U value is lower and the SHGC is less then 10% higher or lower then the above figures.

External Window Cover	*Detail*

Fixed shading - Eaves		*Width includes guttering, offset is distance above windows*
Width: >450	Offset: 220	Nominal only, refer to plan for detail
Fixed shading - Other		*Verandahs, Pergolas (type and description)*
Shaded porch and patio areas as drawn		

Ventilation and Infiltration to Habitable Rooms			
Open fire no damper	No	*Exhaust fans no dampers*	No
Door and window seals	Yes	*Vented skylights*	No
Vented downlights	No	*Fixed wall or ceiling vents*	No

"No" means that the item was not included in the assessment and shall not be installed.

Yes to door & window seals means that seals are to be fitted to all external doors and windows.

FINAL PLANS
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CLIENT: **UNICOMB**

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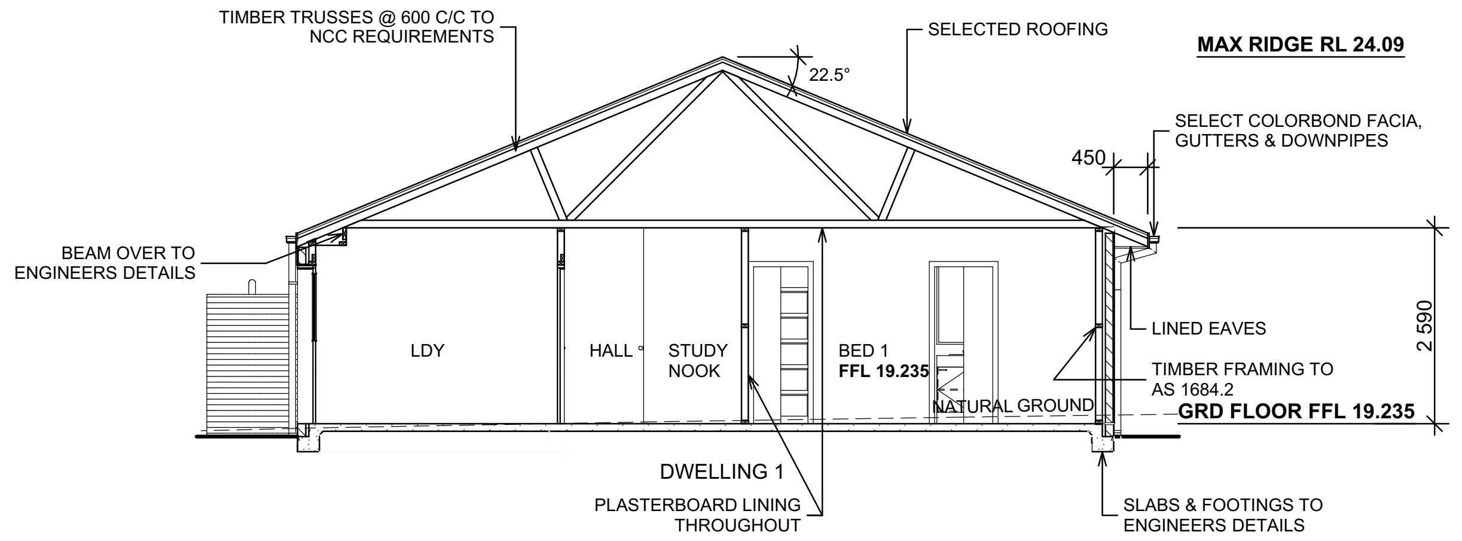
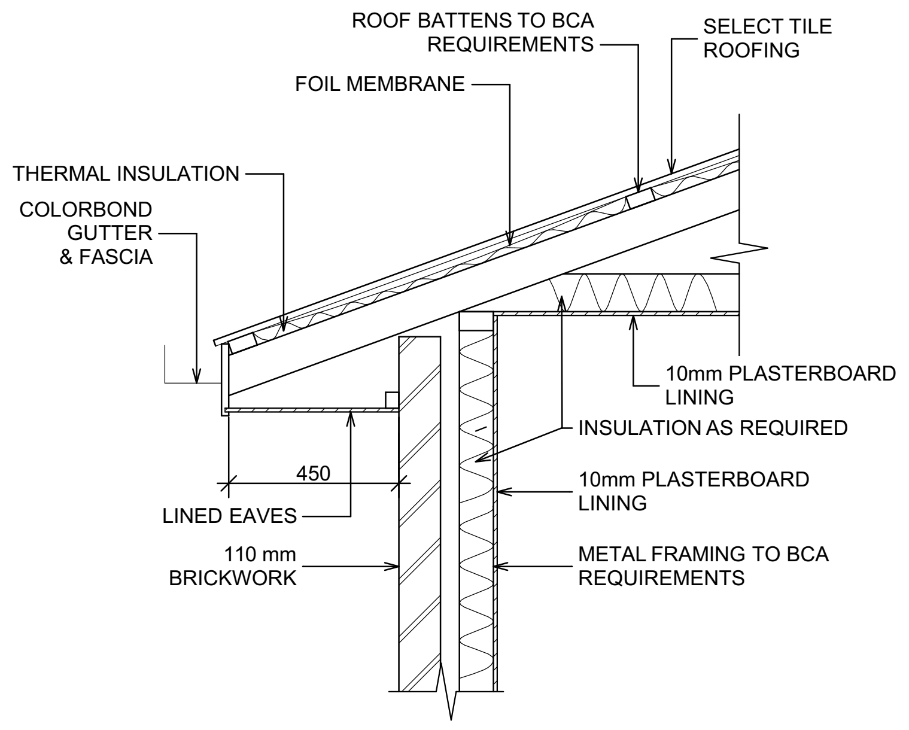
FILE: **2103113** DATE: **18/06/2021** SHEET: **8** OF **10**

A1



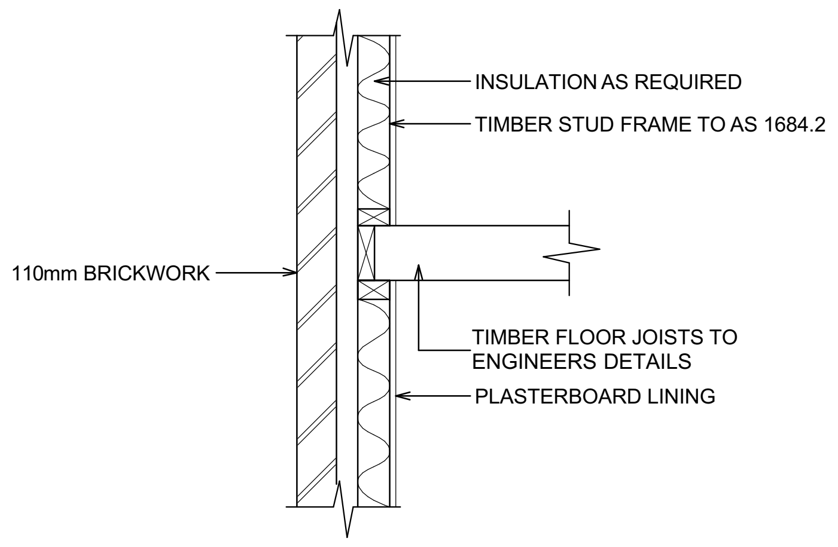
SECTION A-A

1:100
DWELLINGS 2-4 SIMILAR



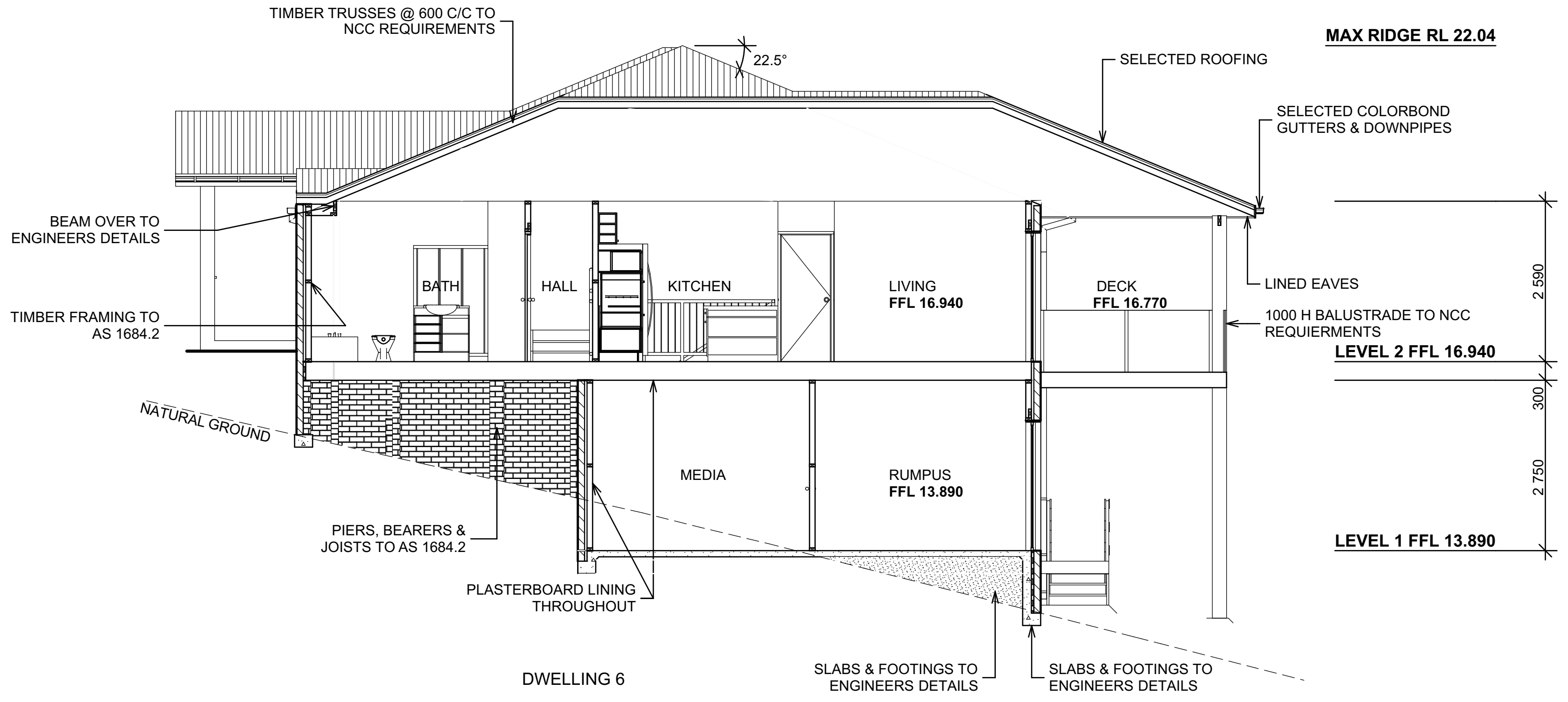
TYPICAL EAVE DETAIL

1:20



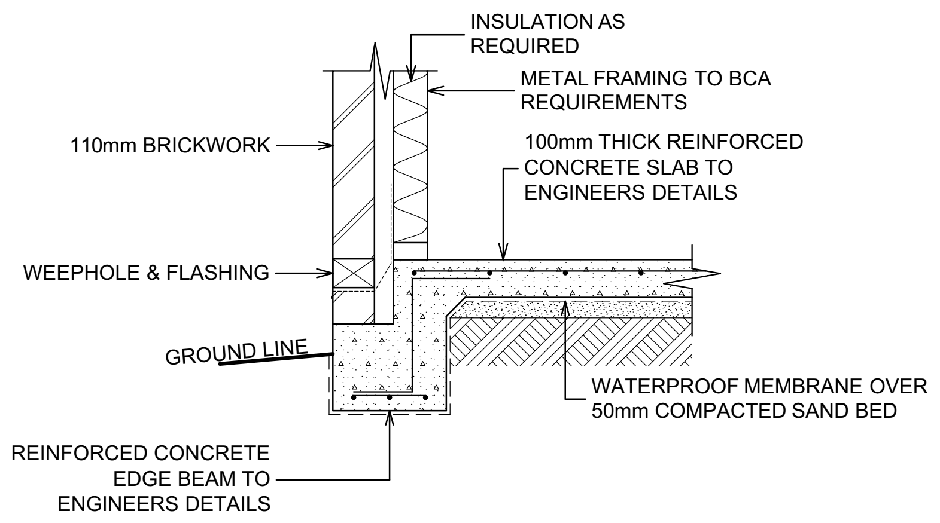
TYPICAL FLOOR TO WALL JUNCTION

1:20



SECTION F-F

1:100
DWELLINGS 5 & 7 SIMILAR



TYPICAL SLAB EDGE REBATE DETAIL

1:20

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ISSUE	DETAILS
A	18/6/21 - INITIAL ISSUE

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PROJECT: **PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA**

CLIENT: **UNICOMB**

TITLE: **DETAILS, SECTIONS A-A & F-F**

FILE: **2103113** DATE: **18/06/2021** SHEET: **9** OF **10**

A1

UNICOMB LOT 8				
5 OAKLAND CLOSE				
BASIX Certificate No.- 1204035S				
Site Area (m²)	456 m²	Roof Area (m²)	248 m²	
Total Area of Garden & Lawn (m²)			205 m²	
Area of Indigenous or low water use plants (m²)			~	
SUMMARY OF BASIX COMMITMENTS				
This is a summary of the BASIX Commitments as detailed in the BASIX Certificate. Builders and Owners must refer to the CURRENT BASIX Certificate for Complete details. For definitions refer to www.basix.nsw.gov.au				
WATER COMMITMENTS				
Fixtures:				
Shower Heads	4* 6<=7.5 L/m	Toilet	4*	
Kitchen Taps	4*	Basin Taps	4*	
Clothes Washers	~	Dishwashers	~	
Hot Water Recirculation	~			
Pool/Spa				
Alternative Water:				
Rainwater Tank Size (L)	2000 L			
Collected from Roof Area (m²)	246 m²			
Tank Connected To:				
All Toilets	YES	Laundry W/M Cold Tap	YES	
One Outdoor Tap	YES	All Hot Water Systems	YES	
THERMAL COMFORT COMMITMENTS - Refer to TPA Specification on plans				
ENERGY COMMITMENTS				
Hot Water	4* INTANTANEOUS GAS			
Cooling System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Heating System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Ventilation	Bathroom	NATURAL	~	
	Kitchen	UNDUCTED FAN	MANUAL	
	Laundry	NATURAL	~	
Natural Lighting	Window/Skylight in Kitchen			YES
	Window/Skylight in Bathrooms/Toilets	YES	QTY	1
Artificial Lighting	ALL Bedrooms lit by fluorescent lamps		DEDICATED	YES
	ALL Living/Dining lit by fluorescent lamps		DEDICATED	YES
	Kitchen lit by fluorescent lamps	YES	DEDICATED	YES
	Bathrms/Toilets lit by fluoro lamps	YES	DEDICATED	YES
	Laundry lit by fluorescent lamps	YES	DEDICATED	YES
	Hallways lit by fluorescent lamps	YES	DEDICATED	YES
OTHER COMMITMENTS				
Clothes line	YES	Ventilated refrigerator space	YES	
Stove/Oven	ELECTRIC OVEN & GAS RANGE			
Other				

Important Note for Development Applicants:

The following specification details the requirements necessary to achieve the thermal performance values as indicated on the BASIX Certificate. Once the development is approved by Council, these specifications will become a condition of consent and must be included in the built works. If you do not want to include these requirements, or need further information, please contact Sorensen Design.

Thermal Performance Specifications - BASIX No.: 1204035S

These are the Specifications upon which the assessment is based. If they vary from drawings or other written specifications, these Specifications shall take precedence. If only one specification option is detailed for a building element, that specification must apply to all instances of that element for the whole project. If alternate specifications are detailed, the location and extent of the alternate specification must be detailed below and / or clearly indicated on referenced documentation.

External Wall Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Brick Veneer	R2.86 (or R3.4 Inc. Const)	Any			
Internal Wall Construction	*Insulation*	*Detail*			
Plasterboard on studs	none				
Ceiling Construction	*Insulation*	*Detail*			
Plasterboard	R2.95(up) To Ceilings adjacent to roof space				
Roof Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Framed, Metal roof	Foil +75mm blanket	Medium 0.475-0.70			
Floor Construction	*Insulation*	*Covering*			*Detail*
Concrete	none	As drawn (if not noted default values used)			
Windows	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
Standard	Single clear Aluminium	6.7	0.7	24.48 m²	
Standard	Single clear Aluminium	6.7	0.57	2.514 m²	
Skylights	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
None					
U and SHGC values are according to ANAC 2005. Alternate products may be used if the U value is lower and the SHGC is less then 10% higher or lower then the above figures.					
External Window Cover	*Detail*				
Fixed shading - Eaves	*Width includes guttering, offset is distance above windows*				
Width: >450 Offset: 220	Nominal only, refer to plan for detail				
Fixed shading - Other	*Verandahs, Pergolas (type and description)*				
Shaded porch and patio areas as drawn					
Ventilation and Infiltration to Habitable Rooms					
Open fire no damper	No	*Exhaust fans no dampers*	No		
Door and window seals	Yes	*Vented skylights*	No		
Vented downlights	No	*Fixed wall or ceiling vents*	No		
"No" means that the item was not included in the assessment and shall not be installed.					
Yes to door & window seals means that seals are to be fitted to all external doors and windows.					

UNICOMB LOT 2				
5A OAKLAND CLOSE				
BASIX Certificate No.- 1204099S				
Site Area (m²)	495 m²	Roof Area (m²)	248 m²	
Total Area of Garden & Lawn (m²)			241 m²	
Area of Indigenous or low water use plants (m²)			~	
SUMMARY OF BASIX COMMITMENTS				
This is a summary of the BASIX Commitments as detailed in the BASIX Certificate. Builders and Owners must refer to the CURRENT BASIX Certificate for Complete details. For definitions refer to www.basix.nsw.gov.au				
WATER COMMITMENTS				
Fixtures:				
Shower Heads	4* 6<=7.5 L/m	Toilet	4*	
Kitchen Taps	4*	Basin Taps	4*	
Clothes Washers	~	Dishwashers	~	
Hot Water Recirculation	~			
Pool/Spa				
Alternative Water:				
Rainwater Tank Size (L)	2000 L			
Collected from Roof Area (m²)	246 m²			
Tank Connected To:				
All Toilets	YES	Laundry W/M Cold Tap	YES	
One Outdoor Tap	YES	All Hot Water Systems	YES	
THERMAL COMFORT COMMITMENTS - Refer to TPA Specification on plans				
ENERGY COMMITMENTS				
Hot Water	4* INTANTANEOUS GAS			
Cooling System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Heating System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Ventilation	Bathroom	NATURAL	~	
	Kitchen	UNDUCTED FAN	MANUAL	
	Laundry	NATURAL	~	
Natural Lighting	Window/Skylight in Kitchen			YES
	Window/Skylight in Bathrooms/Toilets	YES	QTY	1
Artificial Lighting	ALL Bedrooms lit by fluorescent lamps		DEDICATED	YES
	ALL Living/Dining lit by fluorescent lamps		DEDICATED	YES
	Kitchen lit by fluorescent lamps	YES	DEDICATED	YES
	Bathrms/Toilets lit by fluoro lamps	YES	DEDICATED	YES
	Laundry lit by fluorescent lamps	YES	DEDICATED	YES
	Hallways lit by fluorescent lamps	YES	DEDICATED	YES
OTHER COMMITMENTS				
Clothes line	YES	Ventilated refrigerator space	YES	
Stove/Oven	ELECTRIC OVEN & GAS RANGE			
Other				

Important Note for Development Applicants:

The following specification details the requirements necessary to achieve the thermal performance values as indicated on the BASIX Certificate. Once the development is approved by Council, these specifications will become a condition of consent and must be included in the built works. If you do not want to include these requirements, or need further information, please contact Sorensen Design.

Thermal Performance Specifications - BASIX No.: 1204099S

These are the Specifications upon which the assessment is based. If they vary from drawings or other written specifications, these Specifications shall take precedence. If only one specification option is detailed for a building element, that specification must apply to all instances of that element for the whole project. If alternate specifications are detailed, the location and extent of the alternate specification must be detailed below and / or clearly indicated on referenced documentation.

External Wall Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Brick Veneer	R2.86 (or R3.4 Inc. Const)	Any			
Internal Wall Construction	*Insulation*	*Detail*			
Plasterboard on studs	none				
Ceiling Construction	*Insulation*	*Detail*			
Plasterboard	R2.95(up) To Ceilings adjacent to roof space				
Roof Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Framed, Metal roof	Foil +75mm blanket	Medium 0.475-0.70			
Floor Construction	*Insulation*	*Covering*			*Detail*
Concrete	none	As drawn (if not noted default values used)			
Windows	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
Standard	Single clear Aluminium	6.7	0.7	23.76 m²	
Standard	Single clear Aluminium	6.7	0.57	2.514 m²	
Skylights	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
None					
U and SHGC values are according to ANAC 2005. Alternate products may be used if the U value is lower and the SHGC is less then 10% higher or lower then the above figures.					
External Window Cover	*Detail*				
Fixed shading - Eaves	*Width includes guttering, offset is distance above windows*				
Width: >450 Offset: 220	Nominal only, refer to plan for detail				
Fixed shading - Other	*Verandahs, Pergolas (type and description)*				
Shaded porch and patio areas as drawn					
Ventilation and Infiltration to Habitable Rooms					
Open fire no damper	No	*Exhaust fans no dampers*	No		
Door and window seals	Yes	*Vented skylights*	No		
Vented downlights	No	*Fixed wall or ceiling vents*	No		
"No" means that the item was not included in the assessment and shall not be installed.					
Yes to door & window seals means that seals are to be fitted to all external doors and windows.					

UNICOMB LOT 3				
7 OAKLAND CLOSE				
BASIX Certificate No.- 1204101S				
Site Area (m²)	496 m²	Roof Area (m²)	248 m²	
Total Area of Garden & Lawn (m²)			242 m²	
Area of Indigenous or low water use plants (m²)			~	
SUMMARY OF BASIX COMMITMENTS				
This is a summary of the BASIX Commitments as detailed in the BASIX Certificate. Builders and Owners must refer to the CURRENT BASIX Certificate for Complete details. For definitions refer to www.basix.nsw.gov.au				
WATER COMMITMENTS				
Fixtures:				
Shower Heads	4* 6<=7.5 L/m	Toilet	4*	
Kitchen Taps	4*	Basin Taps	4*	
Clothes Washers	~	Dishwashers	~	
Hot Water Recirculation	~			
Pool/Spa				
Alternative Water:				
Rainwater Tank Size (L)	2000 L			
Collected from Roof Area (m²)	246 m²			
Tank Connected To:				
All Toilets	YES	Laundry W/M Cold Tap	YES	
One Outdoor Tap	YES	All Hot Water Systems	YES	
THERMAL COMFORT COMMITMENTS - Refer to TPA Specification on plans				
ENERGY COMMITMENTS				
Hot Water	4* INTANTANEOUS GAS			
Cooling System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Heating System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Ventilation	Bathroom	NATURAL	~	
	Kitchen	UNDUCTED FAN	MANUAL	
	Laundry	NATURAL	~	
Natural Lighting	Window/Skylight in Kitchen			YES
	Window/Skylight in Bathrooms/Toilets	YES	QTY	1
Artificial Lighting	ALL Bedrooms lit by fluorescent lamps		DEDICATED	YES
	ALL Living/Dining lit by fluorescent lamps		DEDICATED	YES
	Kitchen lit by fluorescent lamps	YES	DEDICATED	YES
	Bathrms/Toilets lit by fluoro lamps	YES	DEDICATED	YES
	Laundry lit by fluorescent lamps	YES	DEDICATED	YES
	Hallways lit by fluorescent lamps	YES	DEDICATED	YES
OTHER COMMITMENTS				
Clothes line	YES	Ventilated refrigerator space	YES	
Stove/Oven	ELECTRIC OVEN & GAS RANGE			
Other				

Important Note for Development Applicants:

The following specification details the requirements necessary to achieve the thermal performance values as indicated on the BASIX Certificate. Once the development is approved by Council, these specifications will become a condition of consent and must be included in the built works. If you do not want to include these requirements, or need further information, please contact Sorensen Design.

Thermal Performance Specifications - BASIX No.: 1204101S

These are the Specifications upon which the assessment is based. If they vary from drawings or other written specifications, these Specifications shall take precedence. If only one specification option is detailed for a building element, that specification must apply to all instances of that element for the whole project. If alternate specifications are detailed, the location and extent of the alternate specification must be detailed below and / or clearly indicated on referenced documentation.

External Wall Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Brick Veneer	R2.86 (or R3.4 Inc. Const)	Any			
Internal Wall Construction	*Insulation*	*Detail*			
Plasterboard on studs	none				
Ceiling Construction	*Insulation*	*Detail*			
Plasterboard	R2.95(up) To Ceilings adjacent to roof space				
Roof Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Framed, Metal roof	Foil +75mm blanket	Medium 0.475-0.70			
Floor Construction	*Insulation*	*Covering*			*Detail*
Concrete	none	As drawn (if not noted default values used)			
Windows	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
Standard	Single clear Aluminium	6.7	0.7	25.83 m²	
Standard	Single clear Aluminium	6.7	0.57	2.514 m²	
Skylights	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
None					
U and SHGC values are according to ANAC 2005. Alternate products may be used if the U value is lower and the SHGC is less then 10% higher or lower then the above figures.					
External Window Cover	*Detail*				
Fixed shading - Eaves	*Width includes guttering, offset is distance above windows*				
Width: >450 Offset: 220	Nominal only, refer to plan for detail				
Fixed shading - Other	*Verandahs, Pergolas (type and description)*				
Shaded porch and patio areas as drawn					
Ventilation and Infiltration to Habitable Rooms					
Open fire no damper	No	*Exhaust fans no dampers*	No		
Door and window seals	Yes	*Vented skylights*	No		
Vented downlights	No	*Fixed wall or ceiling vents*	No		
"No" means that the item was not included in the assessment and shall not be installed.					
Yes to door & window seals means that seals are to be fitted to all external doors and windows.					

UNICOMB LOT 4				
7A OAKLAND CLOSE				
BASIX Certificate No.- 1204103S				
Site Area (m²)	408 m²	Roof Area (m²)	248 m²	
Total Area of Garden & Lawn (m²)			168 m²	
Area of Indigenous or low water use plants (m²)			~	
SUMMARY OF BASIX COMMITMENTS				
This is a summary of the BASIX Commitments as detailed in the BASIX Certificate. Builders and Owners must refer to the CURRENT BASIX Certificate for Complete details. For definitions refer to www.basix.nsw.gov.au				
WATER COMMITMENTS				
Fixtures:				
Shower Heads	4* 6<=7.5 L/m	Toilet	4*	
Kitchen Taps	4*	Basin Taps	4*	
Clothes Washers	~	Dishwashers	~	
Hot Water Recirculation	~			
Pool/Spa				
Alternative Water:				
Rainwater Tank Size (L)	2000 L			
Collected from Roof Area (m²)	246 m²			
Tank Connected To:				
All Toilets	YES	Laundry W/M Cold Tap	YES	
One Outdoor Tap	YES	All Hot Water Systems	YES	
THERMAL COMFORT COMMITMENTS - Refer to TPA Specification on plans				
ENERGY COMMITMENTS				
Hot Water	4* INTANTANEOUS GAS			
Cooling System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Heating System	Living	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
	Bedrooms	1-PHASE A/C D/N ZONED	3* (AVG. ZONE)	
Ventilation	Bathroom	NATURAL	~	
	Kitchen	UNDUCTED FAN	MANUAL	
	Laundry	NATURAL	~	
Natural Lighting	Window/Skylight in Kitchen			YES
	Window/Skylight in Bathrooms/Toilets	YES	QTY	1
Artificial Lighting	ALL Bedrooms lit by fluorescent lamps		DEDICATED	YES
	ALL Living/Dining lit by fluorescent lamps		DEDICATED	YES
	Kitchen lit by fluorescent lamps	YES	DEDICATED	YES
	Bathrms/Toilets lit by fluoro lamps	YES	DEDICATED	YES
	Laundry lit by fluorescent lamps	YES	DEDICATED	YES
	Hallways lit by fluorescent lamps	YES	DEDICATED	YES
OTHER COMMITMENTS				
Clothes line	YES	Ventilated refrigerator space	YES	
Stove/Oven	ELECTRIC OVEN & GAS RANGE			
Other				

Important Note for Development Applicants:

The following specification details the requirements necessary to achieve the thermal performance values as indicated on the BASIX Certificate. Once the development is approved by Council, these specifications will become a condition of consent and must be included in the built works. If you do not want to include these requirements, or need further information, please contact Sorensen Design.

Thermal Performance Specifications - BASIX No.: 1204103S

These are the Specifications upon which the assessment is based. If they vary from drawings or other written specifications, these Specifications shall take precedence. If only one specification option is detailed for a building element, that specification must apply to all instances of that element for the whole project. If alternate specifications are detailed, the location and extent of the alternate specification must be detailed below and / or clearly indicated on referenced documentation.

External Wall Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Brick Veneer	R2.86 (or R3.4 Inc. Const)	Any			
Internal Wall Construction	*Insulation*	*Detail*			
Plasterboard on studs	none				
Ceiling Construction	*Insulation*	*Detail*			
Plasterboard	R2.95(up) To Ceilings adjacent to roof space				
Roof Construction	*Insulation*	*Colour (Solar Absorptance)*			*Detail*
Framed, Metal roof	Foil +75mm blanket	Medium 0.475-0.70			
Floor Construction	*Insulation*	*Covering*			*Detail*
Concrete	none	As drawn (if not noted default values used)			
Windows	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
Standard	Single clear Aluminium	6.7	0.7	25.11 m²	
Standard	Single clear Aluminium	6.7	0.57	2.514 m²	
Skylights	*Glass and frame type*	*U*	*SHGC*	*Area sq m*	*Detail*
None					
U and SHGC values are according to ANAC 2005. Alternate products may be used if the U value is lower and the SHGC is less then 10% higher or lower then the above figures.					
External Window Cover	*Detail*				
Fixed shading - Eaves	*Width includes guttering, offset is distance above windows*				
Width: >450 Offset: 220	Nominal only, refer to plan for detail				
Fixed shading - Other	*Verandahs, Pergolas (type and description)*				
Shaded porch and patio areas as drawn					
Ventilation and Infiltration to Habitable Rooms					
Open fire no damper	No	*Exhaust fans no dampers*	No		
Door and window seals	Yes	*Vented skylights*	No		
Vented downlights	No	*Fixed wall or ceiling vents*	No		
"No" means that the item was not included in the assessment and shall not be installed.					
Yes to door & window seals means that seals are to be fitted to all external doors and windows.					

NORTH DWY ELEVATION

SOUTH DWY ELEVATION

FINAL PLANS
NOT FOR CONSTRUCTION

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ISSUE	DETAILS
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PROJECT: **PROPOSED MULTI DWELLINGS DEVELOPMENT AT LOTS 304 & 306, DP1241334, 5 & 7 OAKLAND CLOSE BOLWARRA**

CLIENT: **UNICOMB**

TITLE: **LOTS 2, 3, 4 & 8 BASIX SUMMARIES & THERMAL PERFORMANCE ASSESSMENTS DWY VIEWS**

FILE: **2103113** DATE: **18/06/2021** SHEET: **10** OF **10**

A1

STORMWATER PHILOSOPHY

- ALL ROOFWATER IS DIRECTED TO 2 x 4000L ABOVE GROUND TANKS MADE UP OF 2500L OSD & 1500L RAINWATER. THE STORED RAINWATER WILL BE REUSED INTERNALLY.
- OVERFLOW FROM THE RAINWATER TANKS WILL BE DIRECTED TO STORMWATER PITS WITHIN THE DRIVEWAY. A LOW FLOW PIPE WILL RESTRICT DISCHARGE FROM THE TANK TO 0.9 L/s. THE SIZE OF THE TANK AND ALLOWABLE DISCHARGE HAS BEEN PROPORTIONED TO THE IMPERVIOUS PERCENTAGE OF THE ROOF AREA FOR EACH LOT.
- REMAINING IMPERVIOUS AREAS ON THE HIGH SIDE OF THE DRIVEWAY WILL SHEET FLOW TO THE ROAD TO BE CAPTURED IN KERB INLET PITS. REMAINING IMPERVIOUS AREAS ON THE LOW SIDE OF THE DRIVEWAY WILL CAPTURED BY A GRATED DRAIN AND DIRECTED TO A LEVEL SPREADER AT THE REAR OF THE BLOCK.
- SUFFICIENT VOLUME HAS BEEN PROVIDED TO LIMIT THE POST-DEVELOPMENT DISCHARGE FROM ALL STORM EVENTS UP TO AND INCLUDING THE 1 IN 100 YEAR EVENT.
- DISCHARGE TO THE SURFACE INLET PIT IN ALL STORM EVENTS WILL BE LIMITED TO THE 1 IN 10 YEAR PRE-DEVELOPED FLOWS. STORM EVENTS GREATER THAN 1 IN 10 YEAR WILL BE SAFELY CONVEYED VIA SHEET FLOW DOWN THE PROPOSED DRIVEWAY.

STORMWATER CALCULATIONS

SITE AREA = 4789.00 m²

ROOF AREA = 1610.10 m²

BYPASS AREA 1 = 1593.50 m²
DRIVEWAY AREA = 432.76 m²
PERVIOUS AREA = 1160.74 m²
IMPERVIOUS % = 27%

BYPASS AREA 2 = 1587.66 m²
DRIVEWAY AREA = 546.00 m²
PERVIOUS AREA = 1041.66 m²
IMPERVIOUS % = 34%

Onsite Detention Calculations (OSD)

$Q_{PRE(10 Yr)}$ = C I A (t_C = 5min)
= 0.4 x 162 x 4789
= 86.22 L/s

$Q_{PRE(100Yr)}$ = C I A (t_C = 5min)
= 0.48 x 266 x 4789
= 169.88 L/s

ROOF WATER IS THE ONLY STORM WATER THAT WILL BE CAPTURED & STORED WITHIN THIS SITE. ALL OTHER FLOW WILL BE BYPASS FLOW. THE BYPASS FLOW WILL BE CONVEYED TO THE DRIVEWAY & DISCHARGED TO THE STREET OR THE FLOW WILL MAINTAIN PREDEVELOPMENT FLOW CONDITIONS.

$Q_{BYPASS AREA 1 (10 Yr)}$ = C I A (t_C = 5min)
= 0.54 x 162 x 1593.5
= 38.42 L/s

$Q_{BYPASS AREA 2 (10 Yr)}$ = C I A (t_C = 5min)
= 0.57 x 162 x 1587.66
= 40.87 L/s

$Q_{BYPASS TOTAL (10Yr)}$ = 38.42 + 40.87
= 79.29 L/s

THEREFORE THE ALLOWABLE DISCHARGE FROM THE SITE IN THE 10 YEAR STORM EVENT IS = $Q_{PRE(10 Yr)}$ - $Q_{BYPASS TOTAL (10Yr)}$
= 86.22 - 79.29
= 6.93 L/s

EACH LOT WILL BE ABLE TO DISCHARGE AN EQUAL PORTION OF THIS (7 LOTS)
Q ALLOWABLE PER LOT (10Yr) = 0.99 L/s

$Q_{BYPASS AREA 1 (100 Yr)}$ = C I A (t_C = 5min)
= 0.64 x 266 x 1593.5
= 75.71 L/s

$Q_{BYPASS AREA 2 (100 Yr)}$ = C I A (t_C = 5min)
= 0.69 x 266 x 1587.66
= 80.52 L/s

$Q_{BYPASS TOTAL (100Yr)}$ = 75.71 + 80.52
= 156.23 L/s

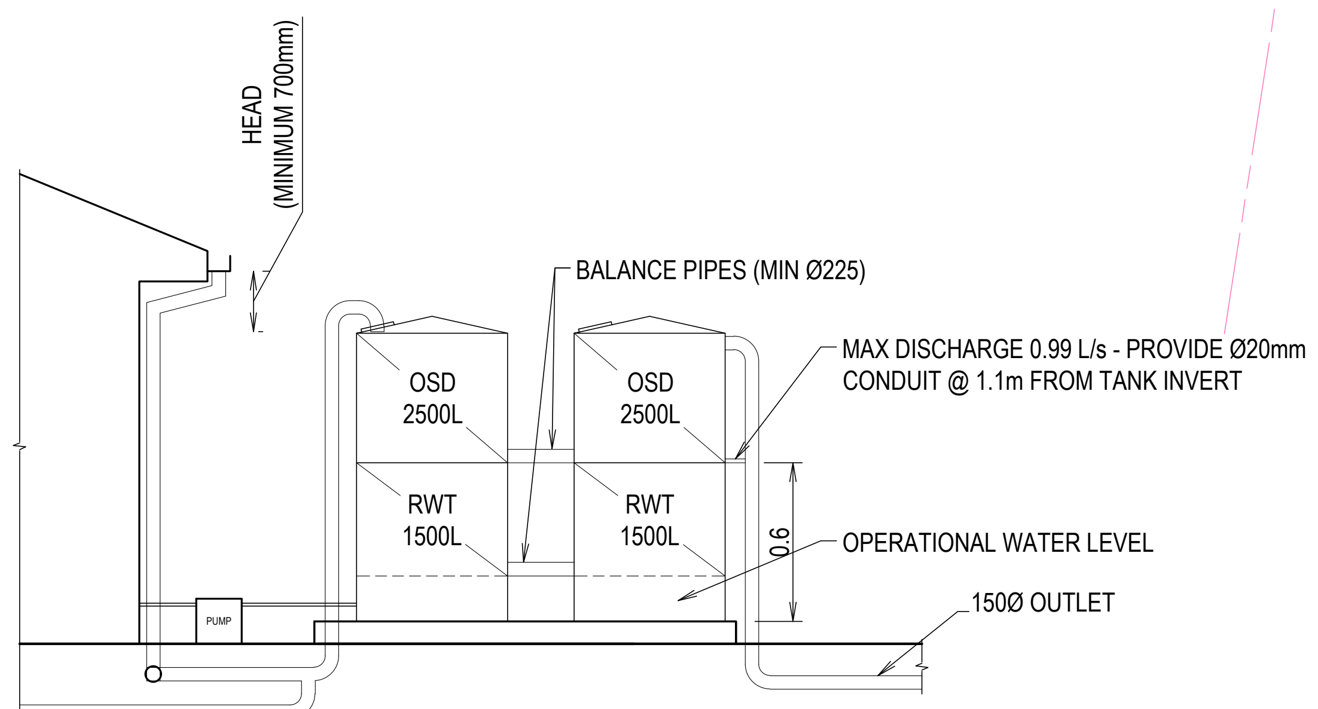
ALLOWABLE $DISCHARGE_{(100Yr)}$ = 169.88 - 6.93
= 13.65 L/s

THE OSD STORAGE FOR EACH LOT IS DETERMINED BY THE 100 Yr STORM EVENT.

$Q_{ROOF AREA (100Yr)}$ = C I A (t_C = 5min)
= 1 x 266 x 1610.10
= 118.97 L/s

VOLUME FOR OSD = 118.97 - 6.93 (t_C = 5min)
= 112.04 L/s
= 33.61 m^3

VOLUME FOR OSD PER $LOT_{(7 LOTS)}$ = 4.8 m^3



Ø100mm CLEANOUT PIPE CONNECTED FROM LOW POINT OF DOWNPIPE TO NEAREST PIT. PROVIDE SCREW CAP TO END WITH Ø6mm DIAMETER HOLE IN CAP.

RWT SCHEMATIC SECTION

NTS

REFER TO HYDRAULIC ENGINEERS DRAWING FOR TANK DETAILS

DIAL 1100 BEFORE YOU DIG
IT IS THE BUILDERS RESPONSIBILITY TO CONFIRM DEPTH & LOCATION OF ALL SERVICES PRIOR TO CONSTRUCTION AS THIS MAY AFFECT THE DESIGN.

REVISIONS					
REV	DATE	DRN	CHK	APP	DRAWING STATUS
C	07.06.21	J.T.	M.M.	M.M.	REVISED ISSUE FOR DA
B	10.05.21	J.T.	M.M.	M.M.	REVISED ISSUE FOR DA
A	29.04.21	J.T.	M.M.	M.M.	ISSUED FOR DA

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North

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0402 915 549
ABN 64 625 755 482
DRB CONSULTING ENGINEERS

OVERALL PLAN & CIVIL DETAILS
80 (LOTS 304 & 306) OAKLANDS CLOSE,
BOLWARRA
PERCEPTION PLANNING

DRAWING STATUS
NOT FOR CONSTRUCTION

SHEET SIZE
A1

SCALE
1:300

PROJECT REF No.
210695

DRAWING No.
CIV01

REVISION
B

LEGEND

▥	SURFACE INLET PIT DETAILS PROVIDED AT CC STAGE
▬ ▬ ▬	uPVC STORMWATER PIPE
───	PROPOSED DESIGN CONTOUR LEVEL
16.69	EXISTING SURFACE LEVEL
←	INDICATES DIRECTION OF SURFACE FLOW
←	INDICATED DIRECTION OF OVERLAND FLOW
▥	GRATED DRAIN DETAILS PROVIDED AT CC STAGE
800H	APPROXIMATE HEIGHT OF WALL
16.85	DESIGN FINISHED SURFACE LEVEL

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SHEET CIV02

SHEET CIV04

REVISIONS

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C	07.06.21	J.T.	M.M.	M.M.	REVISED ISSUE FOR DA
B	10.05.21	J.T.	M.M.	M.M.	REVISED ISSUE FOR DA
A	28.04.21	J.T.	M.M.	M.M.	ISSUED FOR DA

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DRB CONSULTING ENGINEERS

STORMWATER MANAGEMENT PLAN - SHEET 1
80 (LOTS 304 & 306) OAKLANDS CLOSE,
BOLWARRA
PERCEPTION PLANNING

DRAWING STATUS
NOT FOR CONSTRUCTION

SHEET SIZE
A1

SCALE
1:100

PROJECT REF No.
210695

DRAWING No.
CIV02

REVISION
B

LEGEND

▥	SURFACE INLET PIT DETAILS PROVIDED AT CC STAGE
▬ ▬ ▬	uPVC STORMWATER PIPE
───	PROPOSED DESIGN CONTOUR LEVEL
16.69	EXISTING SURFACE LEVEL
←	INDICATES DIRECTION OF SURFACE FLOW
←	INDICATED DIRECTION OF OVERLAND FLOW
▥	GRATED DRAIN DETAILS PROVIDED AT CC STAGE
800H	APPROXIMATE HEIGHT OF WALL
16.85	DESIGN FINISHED SURFACE LEVEL

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SHEET CIV03

SHEET CIV05

REVISIONS

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C	07.06.21	J.T.	M.M.	M.M.	REVISED ISSUE FOR DA
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STORMWATER MANAGEMENT PLAN - SHEET 2
80 (LOTS 304 & 306) OAKLANDS CLOSE,
BOLWARRA
PERCEPTION PLANNING

DRAWING STATUS	SHEET SIZE
NOT FOR CONSTRUCTION	A1
	SCALE 1:100

PROJECT REF No.	DRAWING No.	REVISION
210695	CIV03	B

LEGEND

▦	SURFACE INLET PIT DETAILS PROVIDED AT CC STAGE
▬ ▬	uPVC STORMWATER PIPE
―	PROPOSED DESIGN CONTOUR LEVEL
16.69	EXISTING SURFACE LEVEL
←	INDICATES DIRECTION OF SURFACE FLOW
←	INDICATED DIRECTION OF OVERLAND FLOW
▥	GRATED DRAIN DETAILS PROVIDED AT CC STAGE
800H	APPROXIMATE HEIGHT OF WALL
16.85	DESIGN FINISHED SURFACE LEVEL

DIAL 1100 BEFORE YOU DIG

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CONSTRUCTION AS THIS
MAY AFFECT THE DESIGN.

REVISIONS

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B	10.05.21	J.T.	M.M.	M.M.	REVISED ISSUE FOR DA
A	28.04.21	J.T.	M.M.	M.M.	ISSUED FOR DA

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STORMWATER MANAGEMENT PLAN - SHEET 3
80 (LOTS 304 & 306) OAKLANDS CLOSE,
BOLWARRA
PERCEPTION PLANNING

DRAWING STATUS
NOT FOR CONSTRUCTION

SHEET SIZE
A1

SCALE
1:100

PROJECT REF No.
210695

DRAWING No.
CIV04

REVISION
B

LEGEND

▥	SURFACE INLET PIT DETAILS PROVIDED AT CC STAGE
▬ ▬ ▬	uPVC STORMWATER PIPE
──	PROPOSED DESIGN CONTOUR LEVEL
16.69	EXISTING SURFACE LEVEL
←	INDICATES DIRECTION OF SURFACE FLOW
←	INDICATED DIRECTION OF OVERLAND FLOW
▥	GRATED DRAIN DETAILS PROVIDED AT CC STAGE
800H	APPROXIMATE HEIGHT OF WALL
16.85	DESIGN FINISHED SURFACE LEVEL

DIAL 1100 BEFORE YOU DIG

IT IS THE BUILDERS RESPONSIBILITY TO CONFIRM DEPTH & LOCATION OF ALL SERVICES PRIOR TO CONSTRUCTION AS THIS MAY AFFECT THE DESIGN.

REVISIONS

REV	DATE	DRN	CHK	APP	DRAWING STATUS
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A	28.04.21	J.T.	M.M.	M.M.	ISSUED FOR DA

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STORMWATER MANAGEMENT PLAN - SHEET 4
80 (LOTS 304 & 306) OAKLANDS CLOSE,
BOLWARRA
PERCEPTION PLANNING

DRAWING STATUS: NOT FOR CONSTRUCTION
SHEET SIZE: A1
SCALE: 1:100
PROJECT REF No.: 210695
DRAWING No.: CIV05
REVISION: B

Geotechnical General Notes

Introduction

These notes have been provided in order to explain your geotechnical report. Not all elements are necessarily relevant to all reports.

Geotechnical Report

This geotechnical report is based on information gained from personal local experience, understanding of local geology, limited site investigation, subsurface sampling and/or laboratory testing. This report is tailored to provide information relevant to the scope of the project. Agility have performed the geotechnical investigation in general accordance with current professional and industry standards.

The extent of testing was limited to discrete test locations and variations that cannot be inferred or predicted may occur in ground conditions between test locations. To the best of our knowledge, information presented in this report represents a reasonable interpretation of the general condition of the site. Under no circumstances, however, do these findings represent the actual state of the site at all points. For this reason, this report must be regarded as interpretive rather than as a factual document as the report is limited by the scope of information on which interpretations are based upon. Site access constraints such as existing dwellings, steep sloping sites, dense vegetation and underground services may limit the understanding of the sub-surface profile across the site.

This geotechnical engineering report is based on conditions which existed at the time of subsurface exploration. Without approval from Agility Engineering, this report should not be used if there are any changes to the scope of the project or changes to the site conditions. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and thus, the reliability of this geotechnical report. Without consultation, Agility Engineering will not accept responsibility for problems that occur due to project modifications and/or site modifications. The programme of field sampling, laboratory testing and interpretations presented within this report are limited in nature and Agility Engineering does not assume liability for site conditions not accessible during the time of the investigation.

Agility Engineering should be contacted immediately should subsurface conditions be found to differ from those described in this report.

Engineering Logs

The engineering logs (borehole, test pit logs presented in this report are a geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils, groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an inaccurate indication of the true water table;
- Water table levels will vary from time to time with seasons, weather and/or tidal events. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable groundwater observations may be made by installing piezometer standpipes which may be monitored over variable extended timeframes.

Tree Effects

Due to complex tree root geometry, variable moisture extraction by trees and the difficulty in predicting future tree growth, a precise design for the effects of trees is outside current knowledge. The owner must be aware that although precautions have been taken for the effects of trees in our design, some distortion must be accepted. Engineers are not experts in tree growth and cannot be expected to know the anticipated growth and mature height of trees.

Site Inspection

Agility Engineering will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Soil & Rock Classification

Description and Classification Methods

The description and classification of soils and rocks used within this report are based on descriptions and classifications detailed in Australian Standard AS 1726:2017.

Soil Types

AS 1726:2017 defines soil as particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking. The dominant soil component is given capital letters and secondary and minor soil components are given lower case letters. FILL and TOPSOIL are also given block letters and are indicated at the beginning of the soil description.

Particle Size of Soil Components

Type		Particle size (mm)
	BOULDERS	>200
	COBBLES	63 - 200
Coarse grained soil	GRAVEL Course	19 - 63
	GRAVEL Medium	6.7 - 19
	GRAVEL Fine	2.36 – 6.7
	SAND Course	0.6 – 2.36
	SAND Medium	0.21 – 0.6
	SAND Fine	0.075 – 0.21
Fine grained soil*	SILT	0.002 - 0.075
	CLAY	<0.002

* Fine grained soils to be described from engineering behaviour by visual tactile techniques

Fine Grained Soil Plasticity

Soil plasticity is characterised from the liquid limit of silts and clays. When laboratory tests are not available, plasticity is estimated using field visual and tactile methods.

Plasticity	Liquid limit for silt	Liquid limit for clay
Non-plastic	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35, ≤50
High plasticity	>50	>50

Course Grained Soil Particle Characteristics

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - one or more intermediate sizes poorly represented
- Gap graded – one or more intermediate sizes absent
- Uniform - an excess of a particular particle size

Where significant, particle shape can be defined as being rounded, sub-rounded, sub-angular, angular, flaky, platy or elongated.

Moisture Condition

Soil Type	Moisture Condition	Description
Course grained soil	Dry (D)	Non-cohesive and free running
	Moist (M)	Soil cool, darkened and sticks together
	Wet (W)	Soil cool dark, free water forms when handling
Fine grained soil	*w*<PL	Soil dryer than plastic limit, hard and friable or powdery
	w ~PL	Soil near plastic limit, can be moulded
	w >PL	Soil wetter than plastic limit, soil usually weakened, free water forms when handling

Cohesive Soil Consistency

Cohesive soils include fine grained soils and coarse grained soils with sufficient fine grained components to induce cohesive behaviour. Consistency describes the ease with which a soil can be remoulded measured by the indicative undrained shear strength of the soil or assessed by field tests.

Consistency	Abbreviation	Undrained shear strength (kPa)
Very Soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very Stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Relative Density of Non-Cohesive, Coarse Grained Soils

Non-cohesive soils are classified on the basis of relative density, generally assessed from penetration test procedures and well-established correlations.

Relative Density	Abbreviation	Density Index %
Very loose	VL	<15
Loose	L	15 - 35
Medium Dense	MD	35 - 65
Dense	D	65 - 85
Very Dense	VD	>85

Rock Classification

The rock type is given in capital letters followed by the grain size, colour, fabric and texture of the rock. The degree of weathering and the rock material strength classification are provided. Where no point load strength index or laboratory testing was undertaken, rock strength will be estimated using field assessment techniques in accordance with AS 1726:2017 or estimated from drilling resistance.

APPENDIX B - LANDSLIDE TERMINOLOGY

The following provides a summary of landslide terminology which should (for uniformity of practice) be adopted when classifying and describing a landslide. It has been based on Cruden & Varnes (1996) and the reader is recommended to refer to the original documents for a more detailed discussion, other terminology and further examples of landslide types and processes.

Landslide

The term ***landslide*** denotes “the movement of a mass of rock, debris or earth down a slope”. The phenomena described as landslides are not limited to either the “land” or to “sliding”, and usage of the word has implied a much more extensive meaning than its component parts suggest. Ground subsidence and collapse are excluded.

Classification of Landslides

Landslide classification is based on Varnes (1978) system which has two terms: the first term describes the material type and the second term describes the type of movement.

The material types are ***Rock***, ***Earth*** and ***Debris***, being classified as follows:-

The material is either rock or soil.

Rock:	is “a hard or firm mass that was intact and in its natural place before the initiation of movement.”
Soil:	is “an aggregate of solid particles, generally of minerals and rocks, that either was transported or was formed by the weathering of rock in place. Gases or liquids filling the pores of the soil form part of the soil.”
Earth:	“describes material in which 80% or more of the particles are smaller than 2 mm, the upper limit of sand sized particles.”
Debris:	“contains a significant proportion of coarse material; 20% to 80% of the particles are larger than 2 mm and the remainder are less than 2 mm.”

The terms used should describe the displaced material in the landslide before it was displaced.

The types of movement describe how the landslide movement is distributed through the displaced mass. The five kinematically distinct types of movement are described in the sequence ***fall***, ***topple***, ***slide***, ***spread*** and ***flow***.

The following table shows how the two terms are combined to give the landslide type:

Table B1: Major types of landslides. Abbreviated version of Varnes’ classification of slope movements (Varnes, 1978).

TYPE OF MOVEMENT		**TYPE OF MATERIAL**		
		BEDROCK	**ENGINEERING SOILS**	
			Predominantly Coarse	**Predominantly Fine**
FALLS		Rock fall	Debris fall	Earth fall
TOPPLES		Rock topple	Debris topple	Earth topple
SLIDES	ROTATIONAL	Rock slide	Debris slide	Earth slide
	TRANSLATIONAL			
LATERAL SPREADS		Rock spread	Debris spread	Earth spread
FLOWS		Rock flow (Deep creep)	Debris flow (Soil creep)	Earth flow
COMPLEX	Combination of two or more principle types of movement			

Figure B1 gives schematics to illustrate the major types of landslide movement. Further information and photographs of landslides are available on the USGS website at http://landslides.usgs.gov.

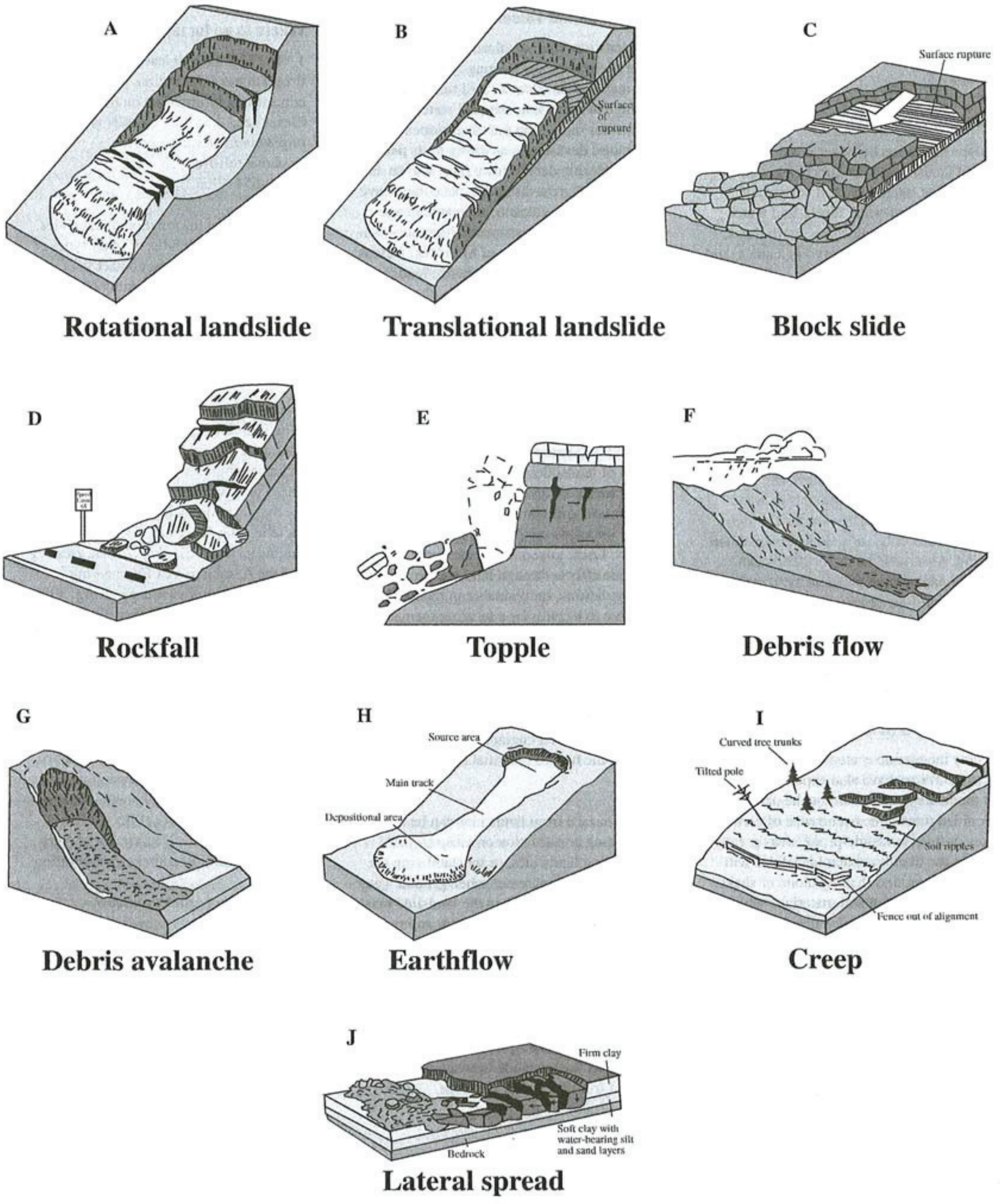


Figure B1: These schematics illustrate the major types of landslide movement.
(From US Geological Survey Fact Sheet 2004-3072, July 2004, with kind permission for reproduction.)

The nomenclature of a landslide can become more elaborate as more information about the movement becomes available. To build up the complete identification of the movement, descriptors are added in front of the two-term classification using a preferred sequence of terms. The suggested sequence provides a progressive narrowing of the focus of the descriptors, first by time and then by spatial location, beginning with a view of the whole landslide, continuing with parts of the movement and finally defining the materials involved. The recommended sequence, as shown in Table B2, describes activity (including state, distribution and style) followed by descriptions of all movements (including rate, water content, material and type). Definitions of the terms in Table B2 are given in Cruden & Varnes (1996).

Second or subsequent movements in complex or composite landslides can be described by repeating, as many times as necessary, the descriptors used in Table B2. Descriptors that are the same as those for the first movement may then be dropped from the name.

For example, the very large and rapid slope movement that occurred near the town of Frank, Alberta, Canada, in 1903 was a *complex, extremely rapid, dry rock fall – debris flow*. From the full name of this landslide at Frank, one would know that both the debris flow and the rock fall were extremely rapid and dry because no other descriptors are used for the debris flow.

The full name of the landslide need only be given once; subsequent references should then be to the initial material and type of movement; for the above example, "the rock fall" or "the Frank rock fall" for the landslide at Frank, Alberta.

Table B2: Glossary for forming names of landslides.

Activity

State	**Distribution**	**Style**
Active	Advancing	Complex
Reactivated	Retrogressive	Composite
Suspended	Widening	Multiple
Inactive	Enlarging	Successive
Dormant	Confined	Single
Abandoned	Diminishing	
Stabilised	Moving	
Relict		

Description of First Movement

Rate	**Water Content**	**Material**	**Type**
Extremely rapid	Dry	Rock	Fall
Very rapid	Moist	Earth	Topple
Rapid	Wet	Debris	Slide
Moderate	Very Wet		Spread
Slow			Flow
Very slow			
Extremely slow			

Note: Subsequent movements may be described by repeating the above descriptors as many times as necessary. These terms are described in more detail in Cruden & Varnes (1996) and examples are given.

Landslide Features

Varnes (1978, Figure 2.1t) provided an idealised diagram showing the features for a *complex earth slide – earth flow*, which has been reproduced here as Figure B2. Definitions of landslide dimensions are given in Cruden & Varnes (1996).

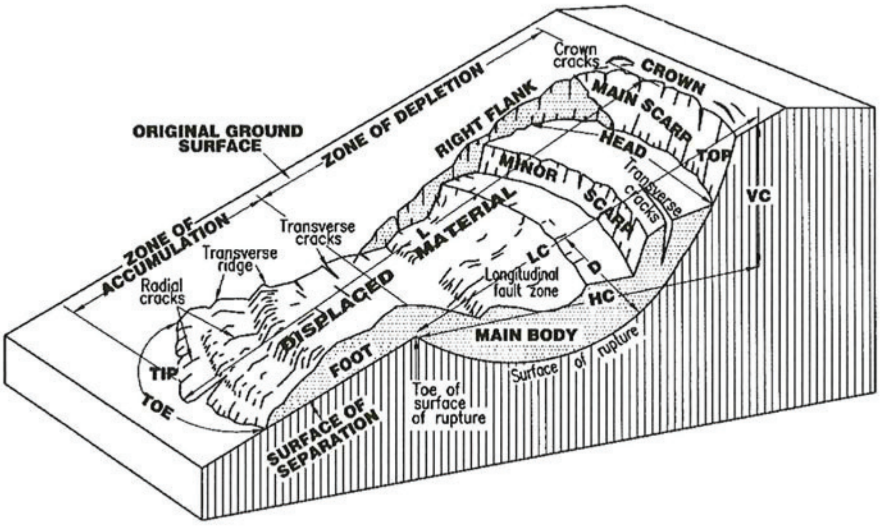


Figure B2: Block of Idealised Complex Earth Slide – Earth Flow

(*Varnes, D J (1978,)Slope Movement Types and Processes. In Special Report 176: Landslides: Analysis and Control(R L Schuster & R J Krizek, eds.), TRB, National Research Council, Washington, DC, pp.11-33).*

Rate of Movement

Figure B3 shows the velocity scale proposed by Cruden & Varnes (1996) which rationalises previous scales. The term "creep" has been omitted due to the many definitions and interpretations in the literature.

Velocity Class	Description	Velocity (mm/sec)	Typical Velocity	Probable Destructive Significance
7	Extremely Rapid			Catastrophe of major violence; buildings destroyed by impact of displaced material; many deaths; escape unlikely
		5 x 10^{3}	5 m/sec	
6	Very Rapid			Some lives lost; velocity too great to permit all persons to escape
		5 x 10^{1}	3 m/min	
5	Rapid			Escape evaluation possible; structures; possessions, and equipment destroyed
		5 x 10^{-1}	1.8 m/hr	
4	Moderate			Some temporary and insensitive structures can be temporarily maintained
		5 x 10^{-3}	13 m/month	
3	Slow			Remedial construction can be undertaken during movement; insensitive structures can be maintained with frequent maintenance work if total movement is not large during a particular acceleration phase
		5 x 10^{-5}	1.6 m/year	
2	Very Slow			Some permanent structures undamaged by movement
		5 x 10^{-7}	15 mm/year	
	Extremely **SLOW**			Imperceptible without instruments; construction **POSSIBLE WITH PRECAUTIONS**

Figure B3: Proposed Landslide Velocity Scale and Probable Destructive Significance.

REFERENCES AND ACKNOWLEDGEMENT

Cruden, D.M., & Varnes, D.J. (1996), "Landslide Types and Processes", Ch.3 in "Landslides. Investigation and Mitigation", Eds Turner, A.K. and Schuster, R.L. Special Report 247, Transport Research Board, National Research Council, Washington D.C. Extracts reprinted above by kind permission of the authors and publishers. Copies of the publication can be obtained from "Transport Research Board, National Research Council, 2101 Constitution Avenue, N.W., Washington D.C. 20418, USA.

IAEG (International Association of Engineering Geology) Commission on Landslides, (1990). Suggested nomenclature for landslides, Bulletin IAEG, No. 41, pp.13-16.

Varnes, D.J. (1978). Slope Movement Types and Processes. In *Special Report 176: Landslides: Analysis and Control* (R.L. Schuster and R.J. Krizek, eds.), TRB, National Research Council, Washington, D.C., pp.11-33.

WP/WLI (International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory) (1990). A suggested method for reporting a landslide. Bulletin IAEG, 41, pp.5-12

WP/WLI (International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory) (1993). A suggested method for describing the activity of a landslide. Bulletin International Association of Engineering Geology, 47: 53-57.

WP/WLI (International Geotechnical Societies' UENSCO Working Party on World Landslide Inventory) (1994). Multilingual Glossary for Landslides, Bitech Press, Vancouver, in press.

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

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

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

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

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

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

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

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

APPENDIX 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 F- EXAMPLE OF VULNERABILITY VALUES

SUMMARY OF HONG KONG VULNERABILITY RANGES FOR PERSONS, AND RECOMMENDED VALUES FOR LOSS OF LIFE FOR LANDSLIDING IN SIMILAR SITUATIONS

The following table is adapted from P J Finlay, G R Mostyn & R Fell (1999). *Landslides: Prediction of Travel Distance and Guidelines for Vulnerability of Persons*. Proc 8th. Australia New Zealand Conference on Geomechanics, Hobart. Australian Geomechanics Society, ISBN 1 86445 0029, Vol 1, pp.105-113.

Case	Range in Data	Recommended Value	Comments
Person in Open Space			
If struck by a rockfall	0.1 – 0.7	0.5	May be injured but unlikely to cause death
If buried by debris	0.8 – 1.0	1.0	Death by asphyxia almost certain
If not buried	0.1 – 0.5	0.1	High chance of survival
Persons in a Vehicle			
If the vehicle is buried/crushed	0.9 – 1.0	1.0	Death is almost certain
If the vehicle is damaged only	0 – 0.3	0.3	High chance of survival
Person in a Building			
If the building collapses	0.9 – 1.0	1.0	Death is almost certain
If the building is inundated with debris and the person buried	0.8 – 1.0	1.0	Death is highly likely
If the debris strikes the building only	0 – 0.1	0.05	Very high chance of survival

EXAMPLE OF VULNERABILITY VALUES FOR DESTRUCTION OF PEOPLE, BUILDINGS AND ROADS

The following table is adapted from Marion Michael-Leiba, Fred Baynes, Greg Scott & Ken Granger (2002). *Quantitative Landslide Risk Assessment of Cairns*. Australian Geomechanics, June 2002.

Geomorphic Unit	Vulnerability Values		
	People	Buildings	Roads
Hill slopes	0.05	0.25	0.3
Proximal debris fan	0.5	1.0	1.0
Distal debris fan	0.05	0.1	0.3

EXAMPLE OF VULNERABILITY VALUES FOR LIFE FOR ROCKFALLS AND DEBRIS FLOWS FOR LAWRENCE HARGRAVE DRIVE PROJECT, COALCLIFF TO CLIFTON AREA, AUSTRALIA

The following table is adapted from R A Wilson, A T Moon, M Hendricks & I E Stewart (2005). *Application of quantitative risk assessment to the Lawrence Hargrave Drive Project, New South Wales,Australia*. Landslide Risk Management - Hungr, Fell, Couture & Eberhardt (eds) 2005. Taylor & Francis Group, London, ISBN 04 1538 043X.

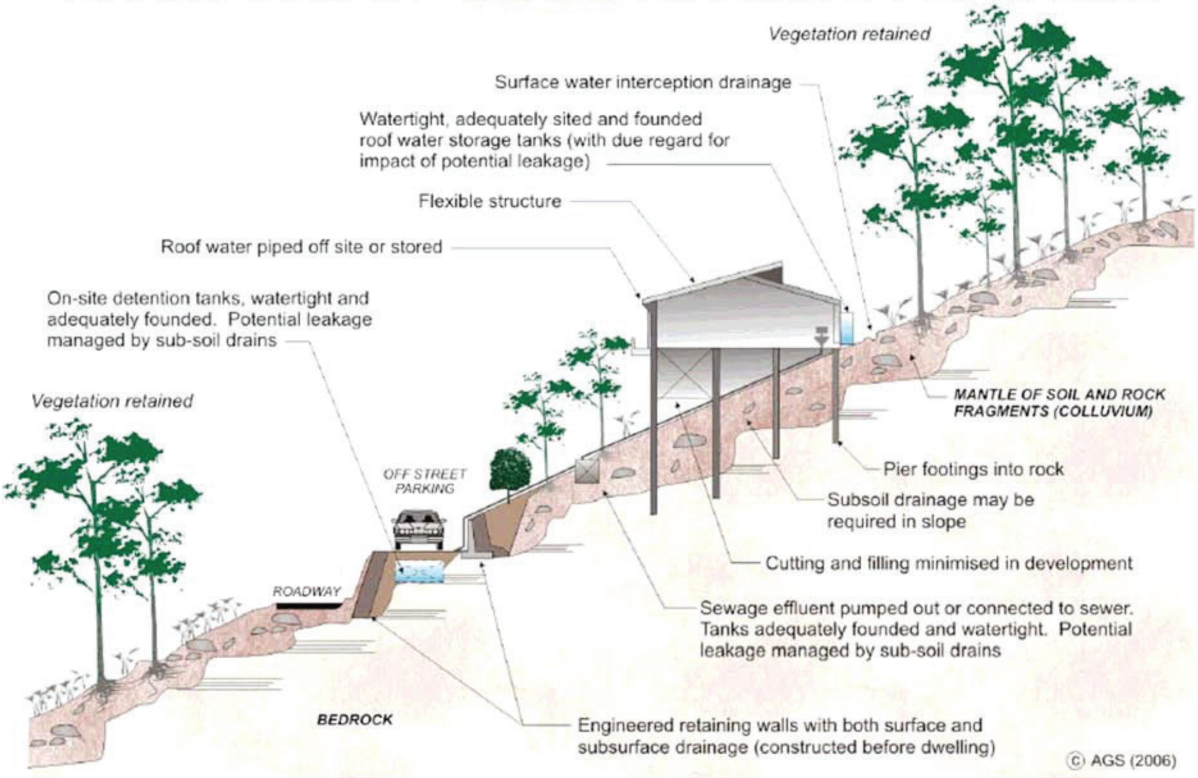
Order of magnitude of landslide crossing road (m^3)	**Rockfalls from Scarborough Cliff**		**Debris flow from Northern Amphitheatre**	
	Landslide hits car	**Car hits landslide**	**Landslide hits car**	**Car hits landslide**
0.03	0.05	0.006	–	–
0.3	0.1	0.002	–	–
3	0.3	0.03	0.001	–
30	0.7	0.03	0.01	0.001
300	1	0.03	0.1	0.003
3,000	1	0.03	1	0.003

NOTE: The above data should be applied with common sense, taking into account the circumstances of the landslide being studied. Judgment may indicate values other than the recommended value are appropriate for a particular case.

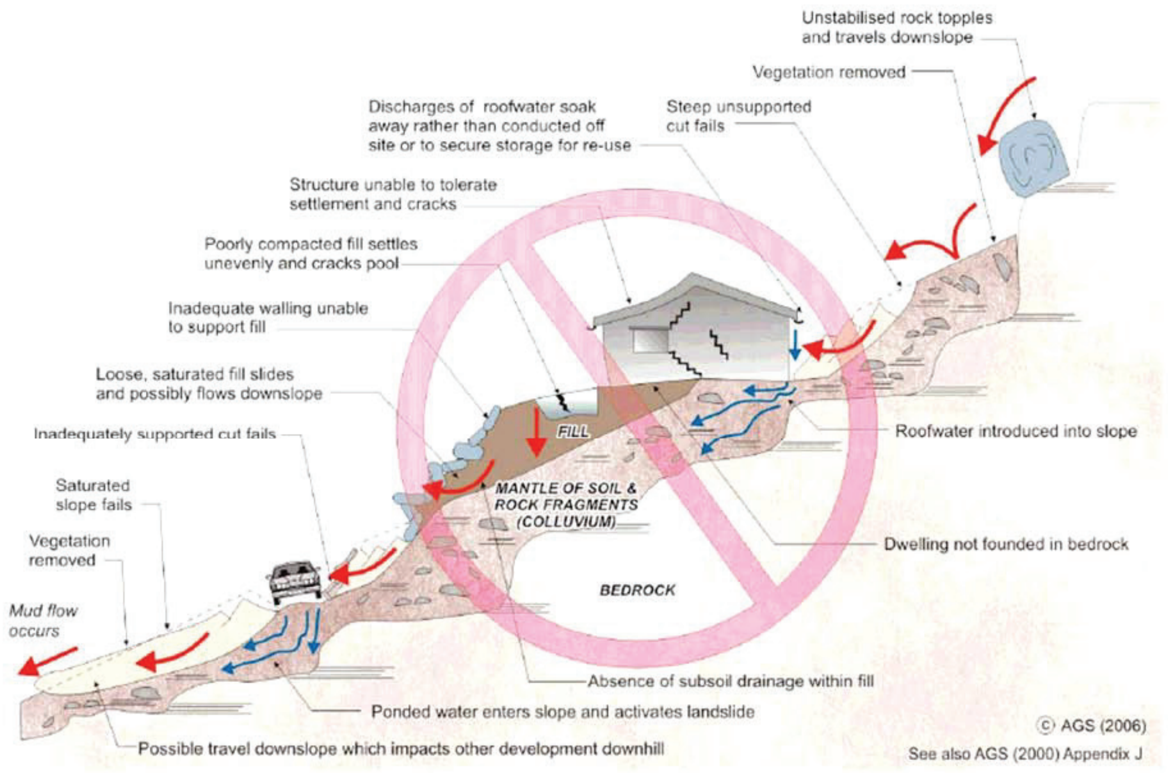
APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

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

EXAMPLES OF GOOD HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE



Foundation Maintenance and Footing Performance:

A Homeowner's Guide

CSIRO

BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth

Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation

Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay

Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots

In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself

Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures

Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

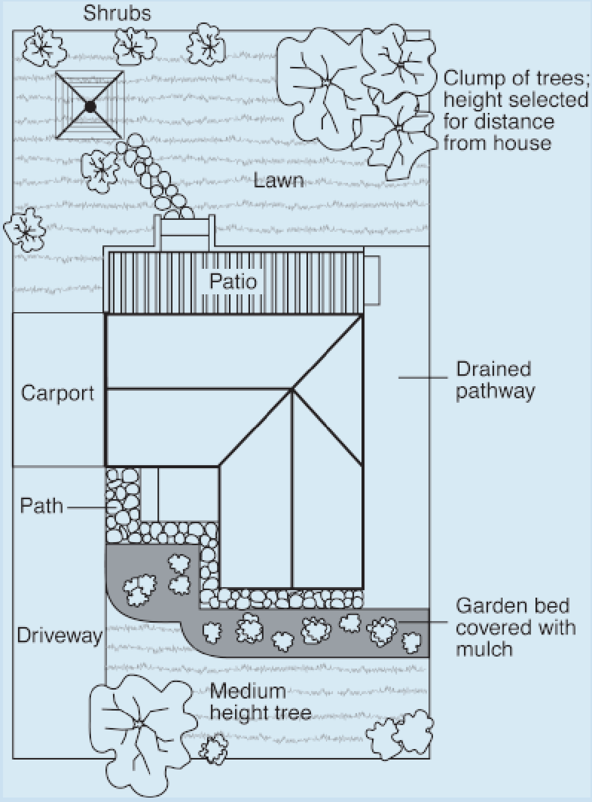
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

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Distributed by

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