

# APPENDIX E

Stormwater Management Plan prepared by LCJ Engineers

brazier motti





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HURA018/AC/DN

14 October 2025

Hurst Constructions Qld  
446 Ingham Road  
GARbutt Qld 4814

ATTENTION: Mr Jarrod Hurst

Dear Jarrod

**AFFORDABLE HOUSING**  
**344-350 ROSS RIVER ROAD, CRANBROOK**  
**STORMWATER MANAGEMENT PLAN**

LCJ Engineers (LCJ) has been commissioned to provide a Stormwater Management Plan in support of the abovementioned development. The proposed development involves a Development Permit for a Material Change of Use (multiple dwelling) and the site is located at the listed properties below:

- 344-346 Ross River Road (lot 3/SP146326); and
- 350 Ross River Road (lots 1/RP721729 and 2/RP721729).

The proposed development consists of buildings, carpark and landscaping areas. A concept architectural layout plan is attached to this report. The proposed development will also include external roadworks for rear access and carparking, as per Council agreement during the pre-lodgement meeting.

The site is currently composed of two (2) residential properties, is generally on flat ground, and is located within the Medium Density Residential zone in Cranbrook. The site is adjacent to the Aitkenvale Major Centre Precinct.

This report is aimed at addressing the site stormwater management, including the pre and post-development flows, and the stormwater quality. A separate report will address the site flooding issue (by others).

**Stormwater Management Plan**

**Lawful point of discharge**

The site is bordered by Ross River Road to the northwest, existing properties to the east and west, and Council road reserve to the south. The site is currently falling towards the south and discharging towards an existing lot (office carpark of a special precinct centre). In general, the lawful point of discharge is towards the Council road reserve.

It is to be noted that generally, DTMR preference is to have minimal discharge onto their State-Controlled road. Therefore, the proposed development is to have the majority of the site runoff to discharge onto the Council road reserve and along the laneway towards Albert Street.

**Development stormwater flows**

The pre-existing site condition has been adopted as the base for determining pre-development stormwater flows (i.e. residential lands with houses built). The pre-development site condition breakdown is shown in Table 1 and Figure 1.

It is to be noted that the minimum fraction of non-zero fraction of impervious from QUDM Table 4.53 is 0.2. Therefore, the adopted fraction of impervious for the predevelopment is 0.2.

**Table 1 – Post-development Site characteristics**

Area type	Area (m <sup>2</sup> )
Roof	549
Total lot area	5254.4
Fraction Impervious ( <i>f<sub>i</sub></i> )	0.10 (adopted 0.2)

The pre-development flows are summarised in Table 2.



**Figure 1 – Pre-development site characteristics. Source: TownsvilleMAPS**

The stormwater drainage flows were calculated using the rational method for the purposes of determining onsite detention. The time of concentration was determined to be 50 minutes based on Friend's equation for 65m long flow path along short grass paddock.

Where:	$Q_y$	=	$C_y \cdot I_y \cdot A / 360$	(QUDM - Equation 4.2)
	$Q_y$	=	Peak flow rate (m <sup>3</sup> /s) for annual exceedance probability (AEP) of 1 in 'y' years	
	y	=	Average recurrence Interval (ARI) in years	
	$C_y$	=	Coefficient of discharge (dimensionless) for AEP of 1 in 'y' years	
	$F_y$	=	Frequency Factor – As per QUDM Table 4.5.2	
	$C_{10}$	=	10-year discharge coefficient – As per QUDM Table 4.5.3	
	$I_{10}$	=	1-hour rainfall intensity for the 10-year ARI (10% AEP)	
		=	74.9 mm/hr for Aitkenvale	
	A	=	Area of catchment (ha)	
		=	0.525	
	$I_y$	=	Average rainfall intensity (mm/hr) for a design duration of 't' hours/minutes and an AEP of 1 in 'y' years	
	t	=	The nominal design storm defined by the time of concentration	
		=	50 minutes	
	$f_i$	=	Fraction impervious (adopted)	
		=	0.20	

**Table 2 – Pre-developed flows**

Hydrology event	Pre-developed case <i>i.e. <math>f_i = 0.20</math>, <math>t_c = 50</math> mins, <math>C_{10} = 0.74</math></i>		
	$C_y$	$I_y$ (mm/hr)	Q (L/s)
63% AEP (1-year ARI)	0.59	44	38.4
39% AEP (2-year ARI)	0.63	51	46.6
18% AEP (5-year ARI)	0.70	70	71.6
10% AEP (10-year ARI)	0.74	82	88.9
5% AEP (20-year ARI)	0.78	94	106.9
2% AEP (50-year ARI)	0.85	110	136.1
1% AEP (100-year ARI)	0.89	121	156.7

The breakdown of the developed site area adopted in our stormwater calculations is shown in Table 3. The post-development flows are summarised in Table 4.

**Table 3 – Post-development site characteristics**

Area type	Area (m <sup>2</sup> )
Building footprint / roof	2698.4
Driveway and footpath (beyond roof)	882.2
Total impervious	3580.6
Total lot area	5254.4
Fraction Impervious ( $f_i$ )	0.68

**Table 4 – Post-developed flows**

Hydrology event	Post-developed case $f_i = 0.68, t_c = 5 \text{ mins}, C_{10} = 0.84$		
	$C_y$	$'I_y$ (mm/hr)	Q (L/s)
63% AEP (1-year ARI)	0.67	111	108.3
39% AEP (2-year ARI)	0.71	127	131.3
18% AEP (5-year ARI)	0.79	174	201.8
10% AEP (10-year ARI)	0.84	205	250.1
5% AEP (20-year ARI)	0.88	234	300.1
2% AEP (50-year ARI)	0.96	271	380.9
1% AEP (100-year ARI)	1.00	299	436.34

'Simplistic' guidance on initial sizing of detention basins is not provided in QUDM 2016 but is provided in Section 5.05.1 of QUDM 2007. The formulae to determine the initial basin sizing are as follows:

$$\begin{array}{llll} V_s / V_i = & r(1+2r)/3 & \text{Culp – 1948} & \text{Equation 5.01} \\ V_s / V_i = & r & \text{Boyd – 1989} & \text{Equation 5.02} \\ V_s / V_i = & r(3+5r)/8 & \text{Carroll – 1990} & \text{Equation 5.03} \\ V_s / V_i = & r(2+r)/3 & \text{Basha – 1994} & \text{Equation 5.04} \end{array}$$

Where:

$$\begin{array}{ll} V_s & = \text{Initial Basin Sizing} \\ r & = \text{Reduction Ratio} \\ & = (Q_i - Q_o) / Q_i \\ Q_i & = \text{Post development flow} \\ Q_o & = \text{Predevelopment flow} \\ V_i & = \text{Initial estimate of the inflow volume} \\ & = 4t_c Q_i / 3 \text{ – if rational method used to determine } Q_i \end{array}$$

For a reduction ratio of greater than 0.6, the recommended formula for initial basin sizing is the Culp Equation.

**Table 5 –Pre versus post-development stormwater flows**

Hydrology event	Pre-development Flow, $Q_o$ (L/sec)	Post-development Flow, $Q_i$ (L/sec)	Reduction Ratio (r)	$V_i$ (m <sup>3</sup> )	$V_s$ (m <sup>3</sup> )
63% AEP (1-year ARI)	38.4	108.3	0.65	43.3	21.3
39% AEP (2-year ARI)	46.6	131.3	0.65	52.5	25.9
18% AEP (5-year ARI)	71.6	201.8	0.65	80.7	39.8
10% AEP (10-year ARI)	88.9	250.1	0.64	100.1	49.2
5% AEP (20-year ARI)	106.9	300.1	0.64	120.0	58.9
2% AEP (50-year ARI)	136.1	380.9	0.64	152.4	74.6
1% AEP (100-year ARI)	156.7	436.34	0.64	174.54	85.1

The proposed development therefore will increase the post-development storm flows. Using initial sizing methods (Culp Equation) the required additional flood storage for the increase in impervious area is 85.1kL for a 1% AEP event.

The required flood storage can be achieved by installing four (4) above ground rainwater tanks (23.65kL each), with a total storage of 94.6kL. The rainwater tanks will be used to detain the excess discharge from the proposed development. To be effective as stormwater detention, the storage tank must fully discharge over a period of around 12 to 24 hours. To achieve the necessary decant rate for the detention tank, the tank is required to be fitted with a 15mm diameter outlet orifice.

### **Stormwater Quality Management Plan**

Water quality modelling has been undertaken of the post-development (mitigated) scenario using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software (Version 6.3.0) to calculate the target reduction criteria as specified in the TCC City Plan, Section SC6.4.10 - *Stormwater Quality*. A stormwater treatment train has been developed and modelled for the site to determine the effectiveness of the proposed system in achieving the relevant water quality objectives.

The Environmental Values (EVs) of the receiving environment and the Water Quality Objective (WQOs) for stormwater discharges from the site have been identified for the development using the TCC City Plan as listed on Table 6.

The Stormwater Quality Management Plan uses split catchment land use pollutant export parameters based on the “MUSIC Modelling Guidelines, Version 3.0 - 2018” for the current proposed development.

**Table 6 – Environmental values and water quality objective**

<b>Environmental Value (EV)</b>	<b>Water Quality Objective (WQO) TCC City Plan - Minimum load reduction</b>
Total Suspended Solids (TSS)	80%
Total Phosphorus (TP)	65%
Total Nitrogen (TN)	40%
Gross Pollutants (GP)	90%

**Reference TCC City Plan Clause SC6.4.10.2 (3)**

The rainfall parameters used in the design of the SQMP have been sourced from the Bureau of Meteorology (BOM) and are summarised in Table 7.

The MUSIC guidelines are included with the MUSIC modelling software and were prepared by Water by Design MUSIC Modelling. Where these guidelines have recommended using locally derived catchment parameters, the following guides listed in order of precedence, have been used:

- Townsville City Council document, Townsville City Plan February 2022 (TCC City Plan);
- Water by Design, “MUSIC Modelling Guidelines November 2018”.
- Mackay Regional Council publication, “Mackay Regional Council Music Guidelines – Version 1.1 (September 2008)”; and
- Brisbane City Council publication, “Guidelines for Pollutant Export Modelling in Brisbane Version 7”.

**Table 7 – Runoff parameters**

Input parameter	Data used in modelling
Rainfall station	032040 TOWNSVILLE AERO
Time step	6 minutes
Modelling period	1970-1983
Mean annual rainfall (mm)	1031mm
Evapotranspiration	1143mm
Rainfall runoff parameters	Commercial and industrial
Pollutant export parameters	Commercial

The Mackay Regional Council MUSIC Guidelines Version 1.1 (September 2008) defines the soil categories set out in Table 8.

**Table 8 – Soil categories**

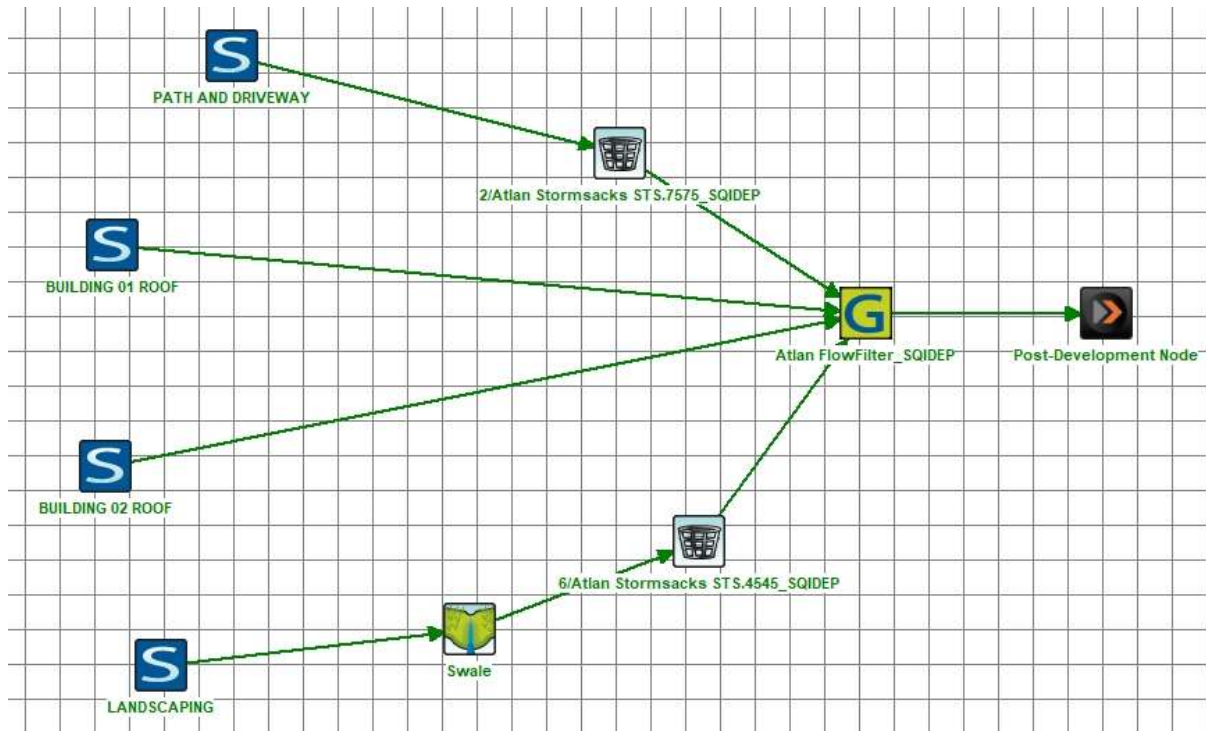
Soil category to be adopted for selecting MUSIC rainfall runoff parameters	Description
Upland	Soils of uplands derived from acid crystalline tuffs on 1-4% slope. Soils of uplands derived from acid to intermediate intrusive and dykes. Soils of uplands derived from basic to intermediate volcanoes on 2-8% slopes. Soils of uplands derived from sedimentary rocks on 2-8% slopes.
Lowland	Soils types not covered by other two (2) soil categories.
Sandy	Soils of the beach ridges and coastal dunes.

The site is not in an 'upland' and is not a beach ridge or coastal dune. This site has been assumed to have a 'Lowland' soil category.

### Developed site with stormwater treatment measures

A schematic of the post-developed site with treatment measures is shown in Figure 2. The schematic details the concept configuration of the proposed treatment train of water quality improvement measures that will be implemented. Generally, the proposed development will utilise stormwater quality measures including eight (8) x Atlan StormSacks and Atlan FlowFilter (or approved equivalent). Refer also attached sketch **SK03** for the concept stormwater layout.

Details of stormwater treatment devices and underground stormwater network will be provided in the detailed design phase of the development.



**Figure 2 - MUSIC treatment train model of post-developed site with treatment measures installed**

The results of the MUSIC modelling for the proposed development with our proposed treatment train at “Outlet” node are shown in Figure 3.

	Sources	Residual Load	% Reduction
<b>Flow (ML/yr)</b>	4.05	4.01	1
<b>Total Suspended Solids (kg/yr)</b>	394	62.4	84.2
<b>Total Phosphorus (kg/yr)</b>	1.05	0.231	78.1
<b>Total Nitrogen (kg/yr)</b>	8.45	5.04	40.4
<b>Gross Pollutants (kg/yr)</b>	66	6.46	90.2

**Figure 3 - MUSIC modelling results of post-developed site with treatment measures installed – using treatment devices as outlined in Table 4**

As shown in Figure 3, the proposed stormwater treatment measures generally comply with TCC City Plan, Section SC6.4.10.2 (3). Therefore, the proposed development is not expected to have an adverse impact on the existing stormwater runoff quality.

Table 9 summarises our recommendation for stormwater treatment train solutions:

**Table 9 – Proposed treatment train solutions**

Catchment	Device 1	Device 2	Device 3	Outlet
Driveway and footpath	2 x Atlan StormSacks	-	Atlan FlowFilter FLF.1200 (3 cartridges)	Outlet node
Building 01	-	-		
Building 02				
Landscaped area	Grassed swales	6 x Atlan StormSacks		

In summary, if the proposed measures are implemented, the development site is not expected to have an adverse impact on the stormwater quality.

If we can be of further assistance, please advise Arry Charrismanagara of this office at your earliest convenience.

Yours faithfully



**DE JOHNSTONE**  
MANAGER  
BE (Hons), MIE Aust., CP Eng





COUNTERPOINT

ROSS RIVER ROAD RESIDENTIAL  
344/346 & 350 ROSS RIVER RD  
CRANBROOK, QLD, 4814

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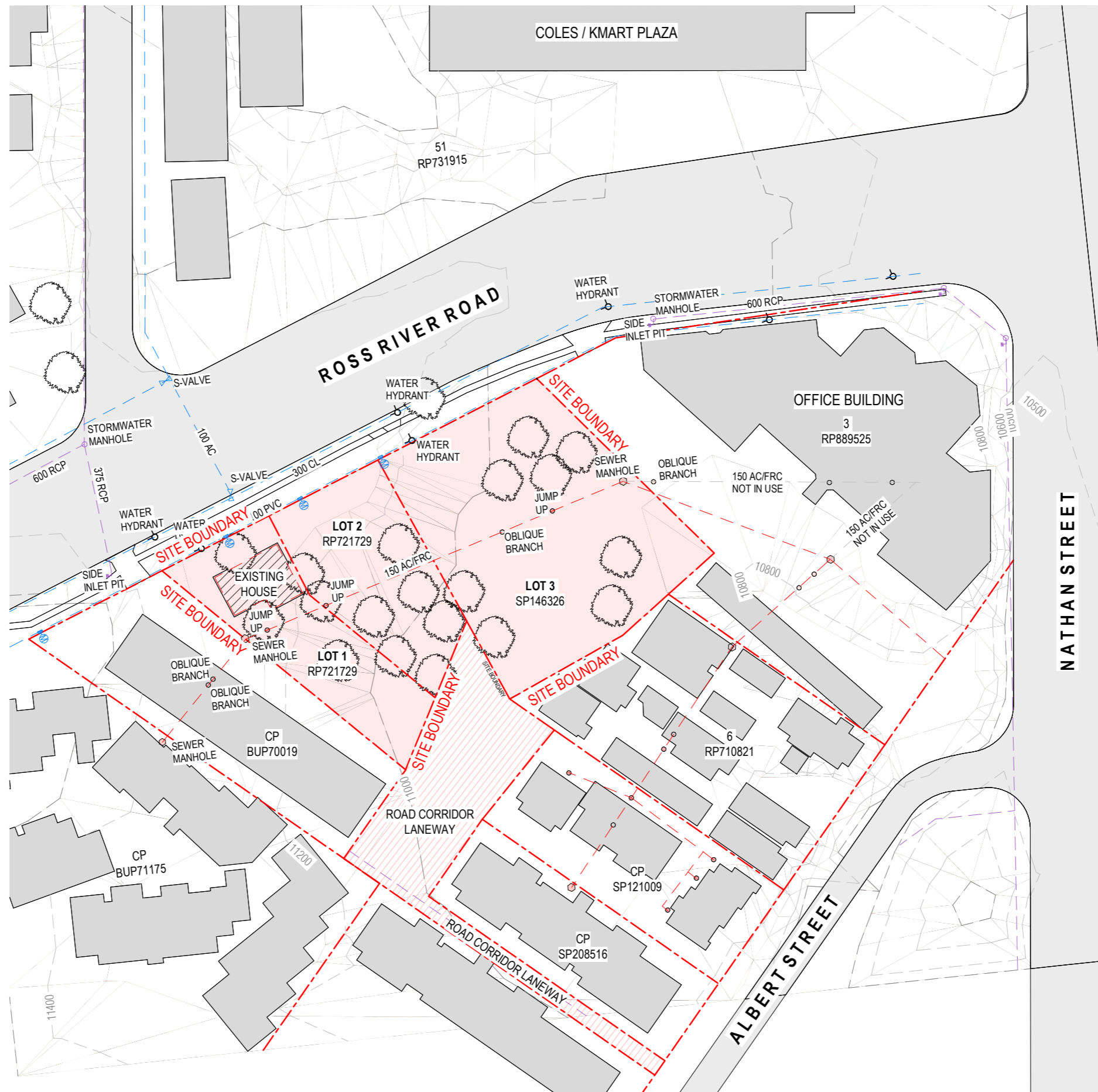


VIEW FROM ROSS RIVER ROAD

DRAWING LIST		
SHEET NUMBER	SHEET NAME	REVISION
DA-00	COVER SHEET	P5
DA-10	EXISTING SITE PLAN	P2
DA-11	DEMOLITION SITE PLAN	
DA-15	PROPOSED SITE PLAN	P5
DA-20	PROPOSED FLOOR PLAN - GROUND	P5
DA-21	PROPOSED FLOOR PLAN - LEVEL 1	P5
DA-22	PROPOSED FLOOR PLAN - LEVEL 2	P5
DA-23	PROPOSED FLOOR PLAN - LEVEL 3	P5
DA-24	PROPOSED FLOOR PLAN - LEVEL 4	P5
DA-25	PROPOSED ROOF PLAN	P5
DA-30	EXTERNAL WORKS - PART A	P5

DRAWING LIST		
SHEET NUMBER	SHEET NAME	REVISION
DA-31	EXTERNAL WORKS - PART B	P5
DA-32	EXTERNAL WORKS - PART C	P5
DA-40	SITE ELEVATIONS - SHEET 01	P5
DA-41	SITE ELEVATIONS - SHEET 02	P5
DA-45	BUILDING ELEVATIONS - SHEET 01	P5
DA-46	BUILDING ELEVATIONS - SHEET 02	P5
DA-47	BUILDING ELEVATIONS - SHEET 03	P5
DA-50	SECTION - SHEET 01	
DA-51	SECTION - SHEET 02	
DA-60	PERSPECTIVE - SHEET 01	
DA-61	PERSPECTIVE - SHEET 02	

DRAWING LIST		
SHEET NUMBER	SHEET NAME	REVISION
DA-62	PERSPECTIVE - SHEET 03	
DA-63	PERSPECTIVE - SHEET 04	
DA-70	DETAIL UNIT TYPE - SHEET 01	
DA-71	DETAIL UNIT TYPE - SHEET 02	
DA-72	DETAIL UNIT TYPE - SHEET 03	
DA-73	DETAIL UNIT TYPE - SHEET 04	



**1 EXISTING SITE PLAN**  
DA-40 SCALE 1:1000

NOTE:  
LOCATION OF LEVELS, BOUNDARIES,  
SERVICES TO BE CONFIRMED BY  
SURVEYOR

PROJECT  
**ROSS RIVER ROAD RESIDENTIAL**  
344/346 & 350 ROSS RIVER RD  
CRANBROOK, QLD, 4814

CLIENT DETAILS

TITLE  
**EXISTING SITE PLAN**

PROJECT NO.  
**25869**

DATE  
**19.06.25**

DRAWING No.  
**DA-10**

ISSUE  
**P2**



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 TO BE DEMOLISHED



**1 EXISTING/DEMO SITE PLAN**  
DA-40 SCALE 1:1000

NOTE:  
LOCATION OF LEVELS, BOUNDARIES, SERVICES,  
AND EXISTING BUILDING TO BE CONFIRMED BY  
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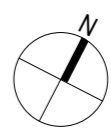
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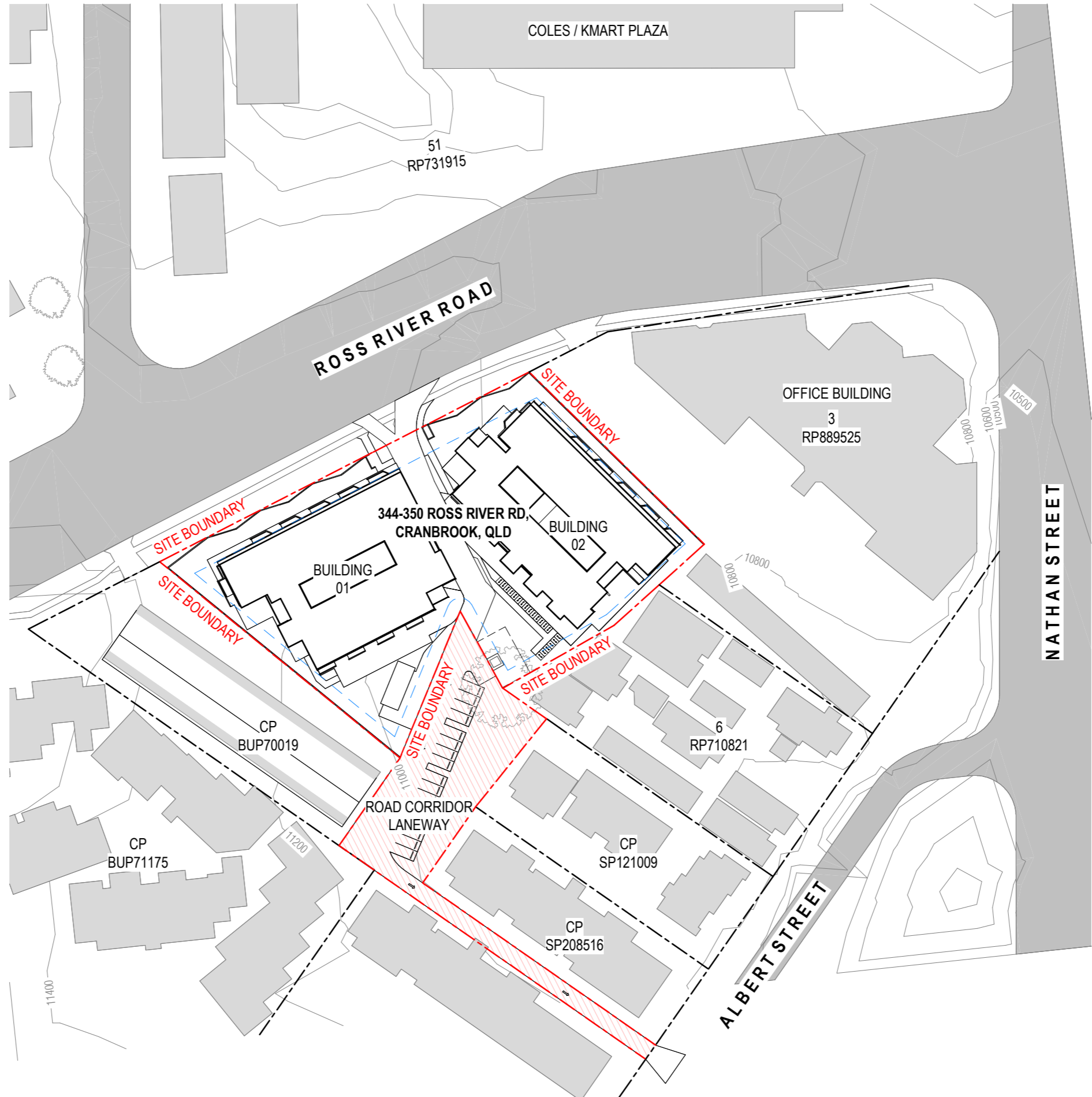
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BUILDING CLASS 2  
TYPE A CONSTRUCTION

**1 PROPOSED SITE PLAN**  
DA-40 SCALE 1:1000

NOTE:  
LOCATION OF LEVELS, BOUNDARIES,  
SERVICES TO BE CONFIRMED BY  
SURVEYOR

PROJECT  
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CRANBROOK, QLD, 4814

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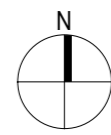
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DATE  
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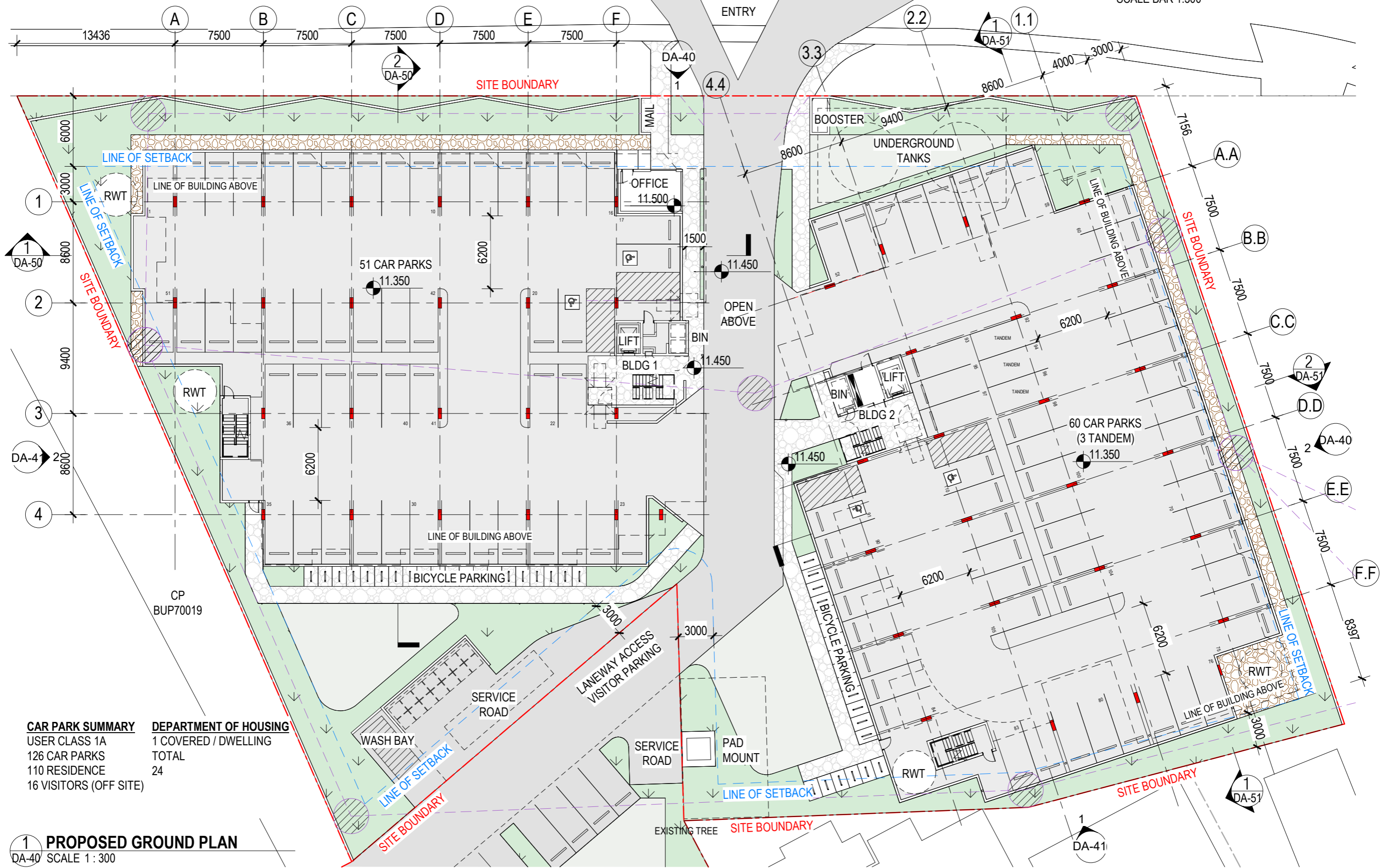
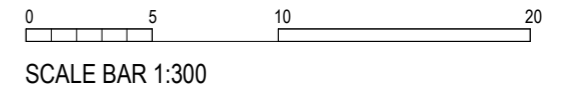
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ROSS RIVER ROAD



**CAR PARK SUMMARY**  
 USER CLASS 1A  
 126 CAR PARKS  
 110 RESIDENCE  
 16 VISITORS (OFF SITE)

**DEPARTMENT OF HOUSING**  
 1 COVERED / DWELLING  
 TOTAL  
 24

**1 PROPOSED GROUND PLAN**  
 DA-40 SCALE 1 : 300

PROJECT  
**ROSS RIVER ROAD RESIDENTIAL**  
 344/346 & 350 ROSS RIVER RD  
 CRANBROOK, QLD, 4814

CLIENT DETAILS

TITLE  
**PROPOSED FLOOR PLAN - GROUND**

PROJECT NO.  
**25869**

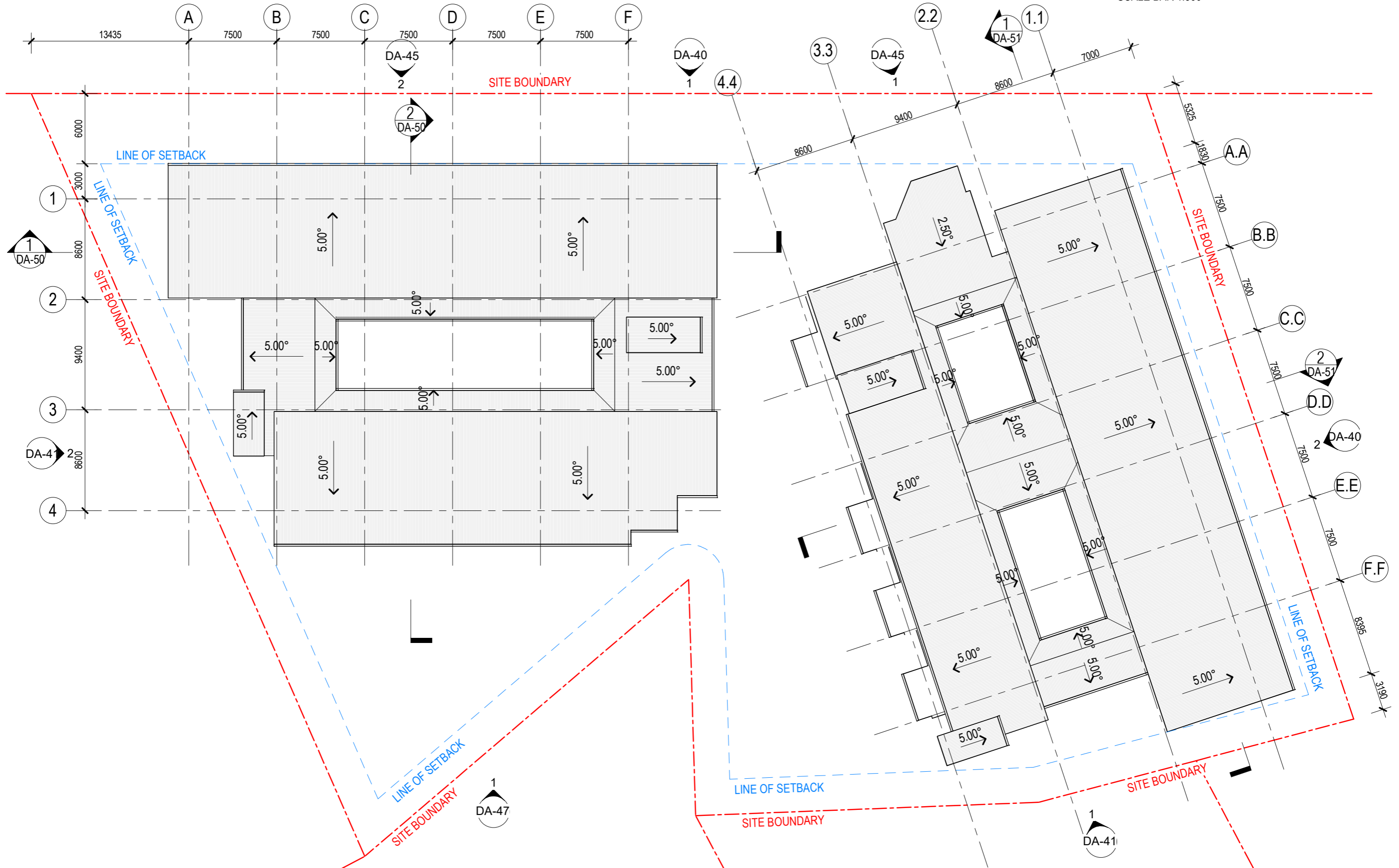
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CLIENT DETAILS

TITLE  
PROPOSED ROOF PLAN

PROJECT NO.  
25869

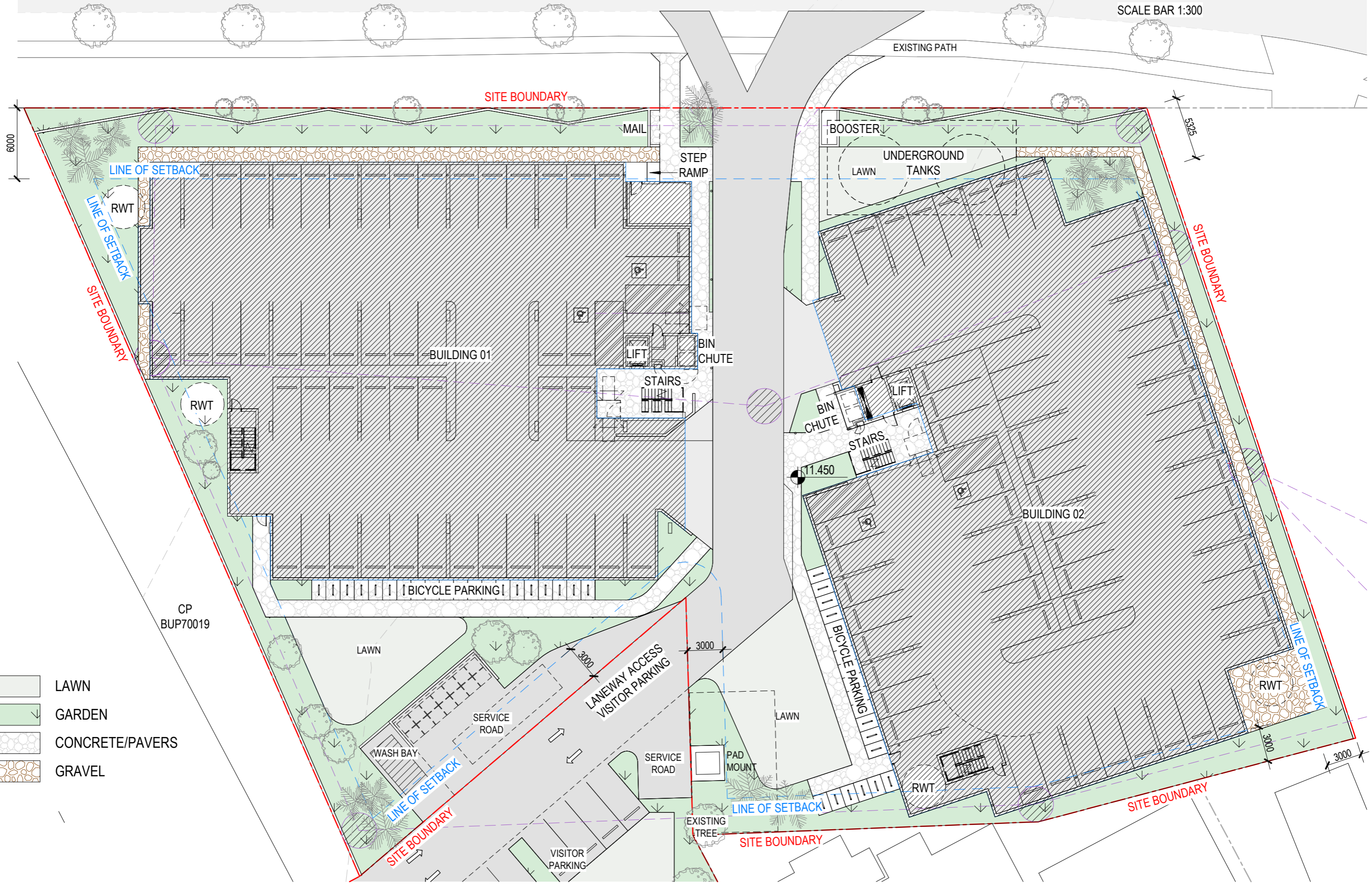
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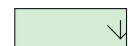


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-  LAWN
-  GARDEN
-  CONCRETE/PAVERS
-  GRAVEL

PROJECT  
**ROSS RIVER ROAD RESIDENTIAL**  
 344/346 & 350 ROSS RIVER RD  
 CRANBROOK, QLD, 4814

CLIENT DETAILS

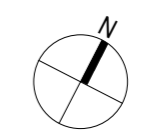
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PROJECT NO.  
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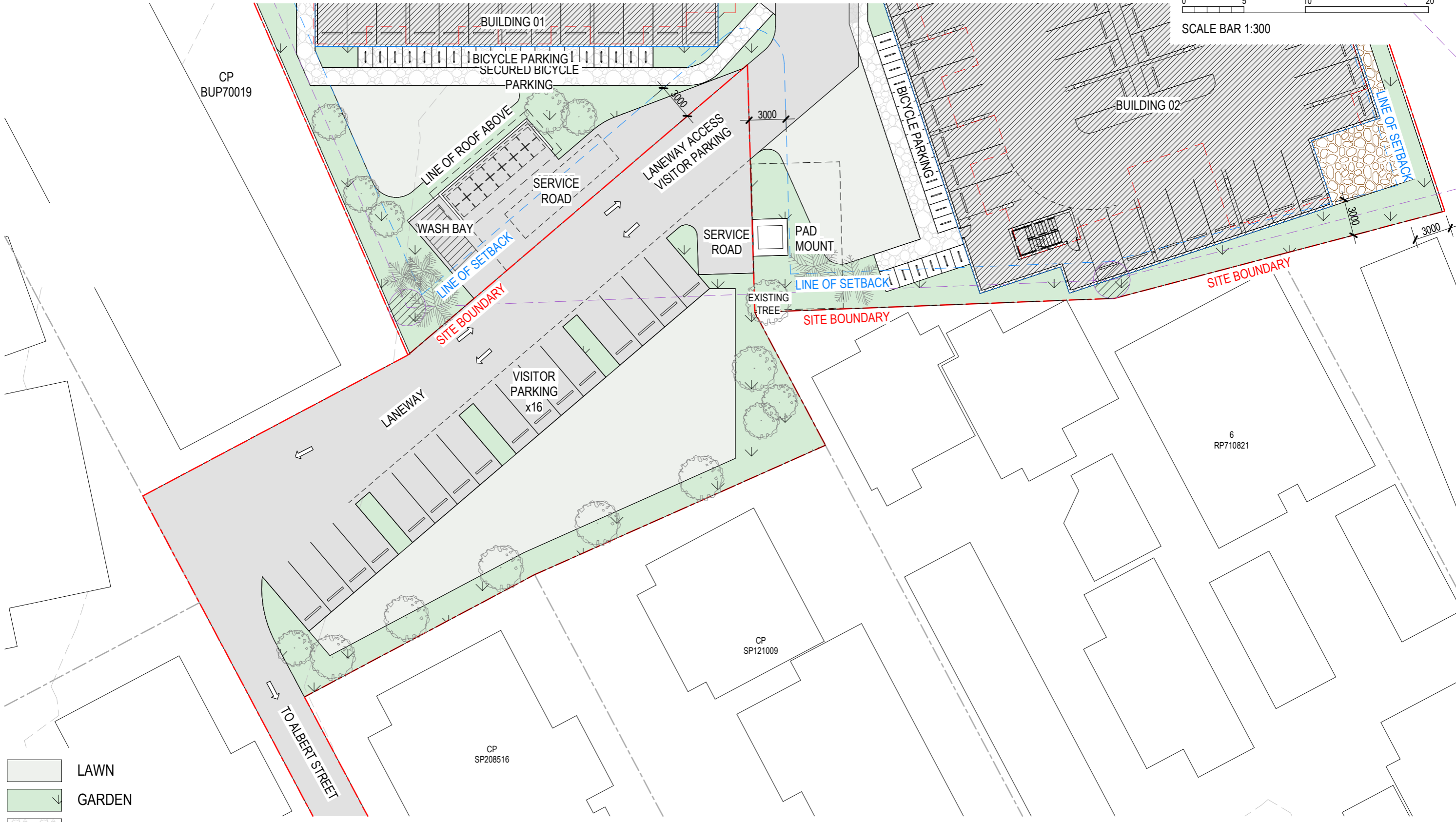
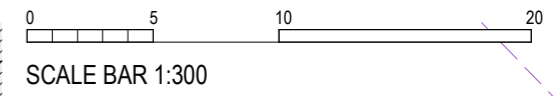
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-  GRAVEL

**1 EXTERNAL WORKS - PART B**  
DA-40 SCALE 1:300

PROJECT  
**ROSS RIVER ROAD RESIDENTIAL**  
 344/346 & 350 ROSS RIVER RD  
 CRANBROOK, QLD, 4814

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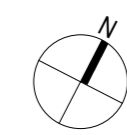
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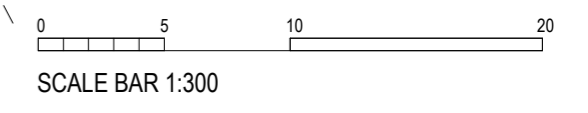
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-  LAWN
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-  CONCRETE/PAVERS
-  GRAVEL

**1 EXTERNAL WORKS - PART C**  
DA-40 SCALE 1 : 300

PROJECT  
**ROSS RIVER ROAD RESIDENTIAL**  
 344/346 & 350 ROSS RIVER RD  
 CRANBROOK, QLD, 4814

CLIENT DETAILS

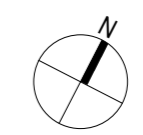
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