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**Carbean Road, Karara
Conceptual Stormwater Management Plan**

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Executive Summary

Acciona Energia has engaged Burchills Engineering Solutions to prepare a Conceptual Stormwater Management Plan (CSMP) for the proposed development located at Lot 15 on SP332758.

This CSMP has been prepared in accordance with the Goondiwindi Regional Council Planning Scheme Version 2 and is to accompany the Development Application for a Battery Energy Storage System (BESS), an Operations and Maintenance Facility Compound, Substation, Temporary Laydown, access tracks, fencing and 33kV underground MV cables. The CSMP has referenced relevant guidelines relating to stormwater management to form the conceptual basis of the stormwater plan. The following conclusions have been made as a result of this study.

Stormwater Quantity

- As a result of the proposed development, the magnitude of peak stormwater discharge exiting the site has increased by 54% in the 1% AEP event;
- However, within the regional catchment there is an increase in flow of 0.2% in the 1% AEP event due to the proposed development;
- The change in flows is considered negligible in comparison to the total flows conveyed through the regional catchment and no mitigation measures are required;
- Scour protection has been designed for the two proposed cross road culverts.

Stormwater Quality

- As the town of Karara has a population of less than 25,000 people and is situated within the Western Queensland climatic region, the development does not trigger the State Planning Policy criterion for stormwater quality management.

Erosion and Sediment Control

- An Erosion Hazard Assessment has identified that the site is high-risk with regard to erosion potential. It has also been identified that the construction site will require Type 3 sediment control techniques.





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1. Introduction

Acciona Energia has engaged Burchills Engineering Solutions to prepare a Conceptual Stormwater Management Plan (CSMP) to be considered as part of a Development Application to Goondiwindi Regional Council (GRC) for a development along Carbean Road, Karara QLD 4352, legally described as Lot 15 on SP332758.

The subject site is situated within the Goondiwindi Regional Council (GRC) Local Government Area (LGA) and is zoned by the Goondiwindi Regional Council Planning Scheme Version 2 (GRPS v2) as being located within the 'Rural Zone – Traprock Precinct.'

1.1 Background

1.1.1 Regulatory Requirements and Technical Guidelines

The strategies proposed in this CSMP have been developed to address the requirements of the GRC Planning Scheme Version 2 (GRC, 2018), and have also been prepared in accordance with the following guidelines:

- State Planning Policy (SPP) July 2017 (DSPIP, 2017);
- GRPS Schedule 6 Planning Scheme Policies – SC6.2.4 Standards for Stormwater Drainage – GRPS v2 (GRC, 2018);
- Queensland Urban Drainage Manual (QUDM) Fourth Edition (IPWEAQ, 2017);
- Australian Rainfall & Runoff (AR&R): A Guide to Flood Estimation (Ball J, 2019); and,
- Australian Government – Bureau of Meteorology (Bureau of Meteorology, n.d.).

1.2 Purpose

The main objectives of this CSMP have been established from the criteria set out in the GRPS Development Codes (GRC, 2018) and are summarised as follows:

- Stormwater drainage is designed and managed during the construction and operation of development to avoid adverse impacts on surrounding development or compromise the natural health and functioning of adjoining waterway systems.

1.3 Assessment Criteria

The aim of this Conceptual Stormwater Management Plan is to review the existing flows on the site, and to compare with the post-development flows to ensure that the development has a non-worsening effect and does not negatively impact any nearby properties.





2. Site Detail

2.1 Location

The subject site is located on a block of land off Carbean Road, legally described as Lot 15 on SP332758. The site occupies an area of approximately 11.1ha of the 2054ha lot. The site is situated to the east of the Cunningham Highway.

The site is identified by the GRPS v2 (GRC, 2018) as being located within the *Rural Zone – Traprock Precinct*. Figure 2.1 below illustrates the location of the subject site.

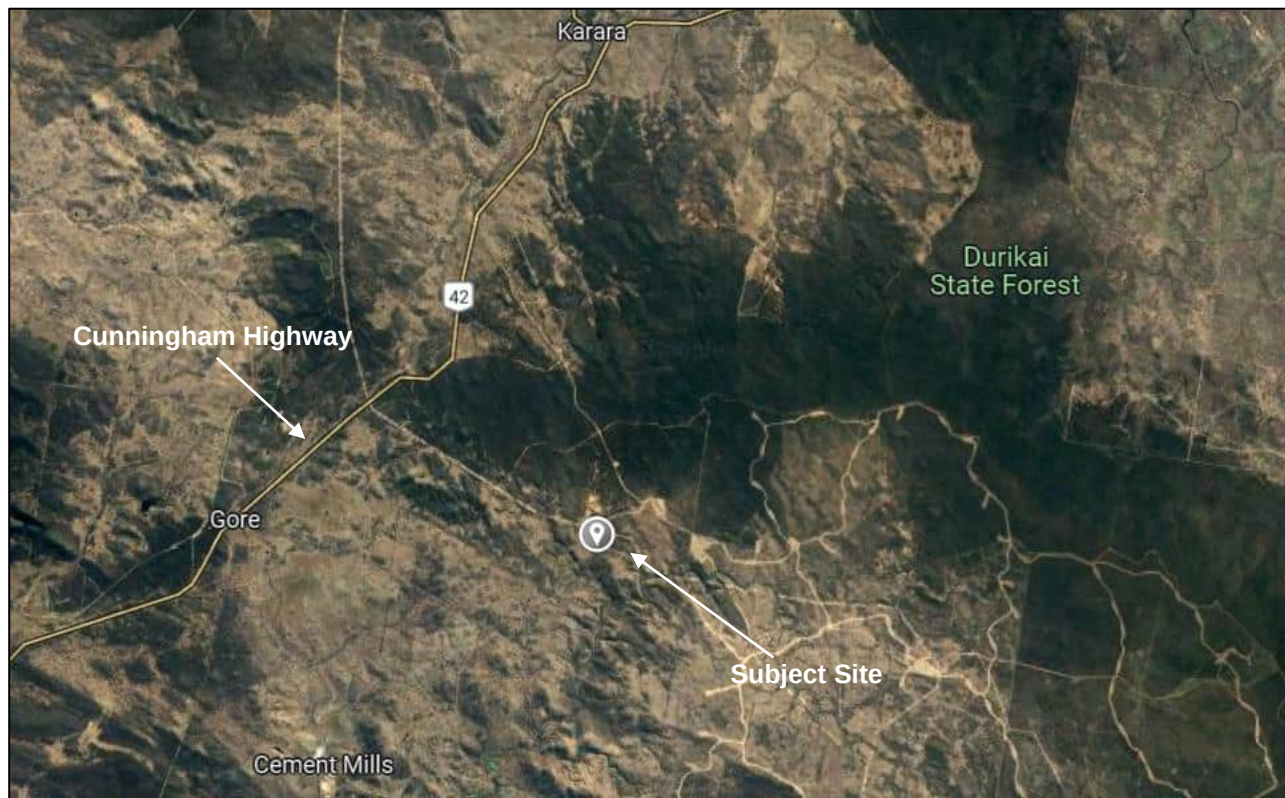


Figure 2.1 Site Locality Map

2.2 Existing Land Uses and Topography

Currently the site contains the MacIntyre Intermediate Switching Station (MISS), operated and maintained by Powerlink, but otherwise comprises of a combination of bushland vegetation and grasslands on gently sloping plains to steep hills which are used for grazing livestock. Cunningham Highway is located to the west of the site and is otherwise surrounded by rural, predominately undeveloped land.

The subject site generally grades towards the unnamed creek outlet near the southern border. Refer to Figure 2.2 below.



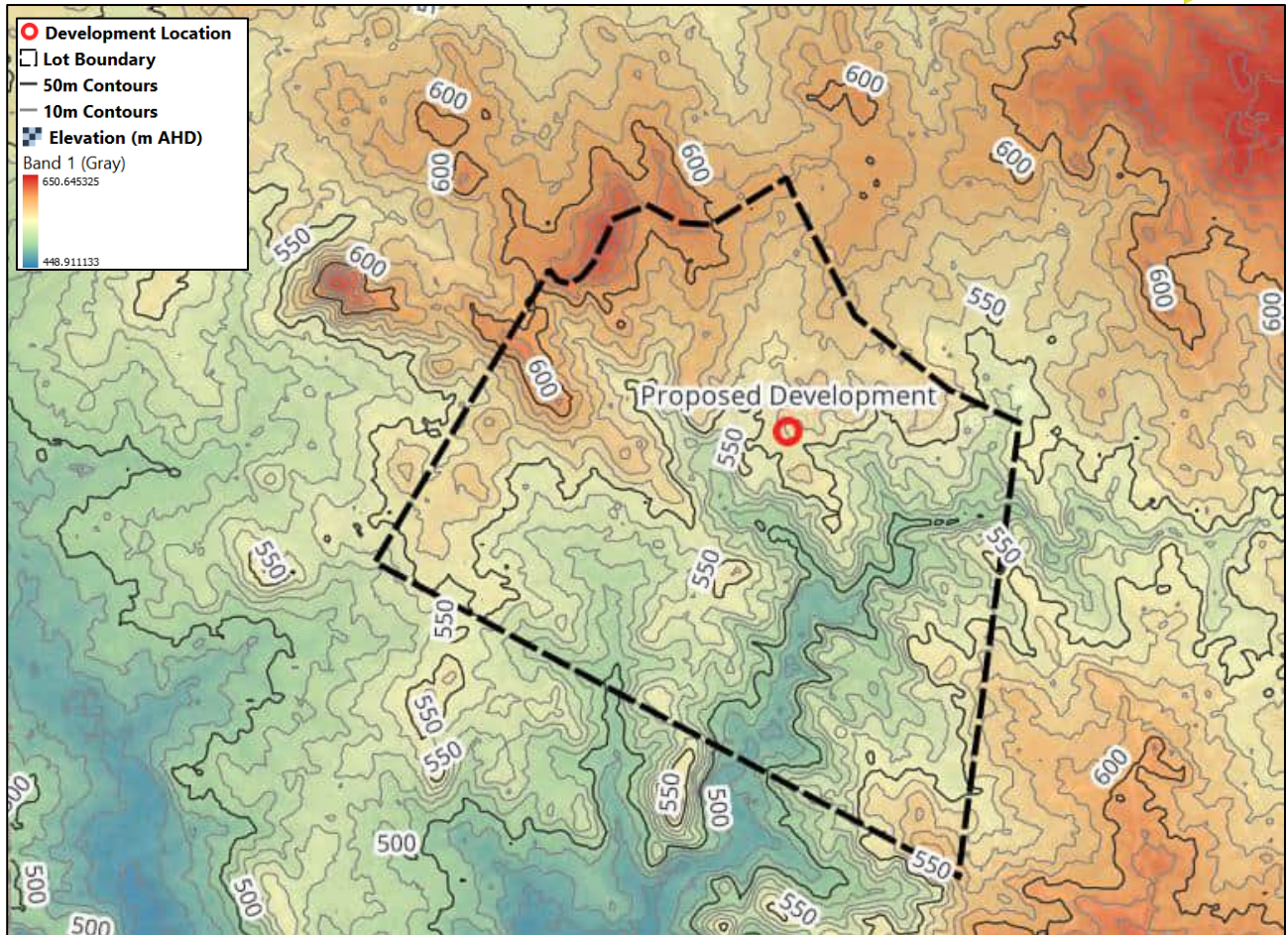


Figure 2.2 Site Topography

2.3 Downstream Environment

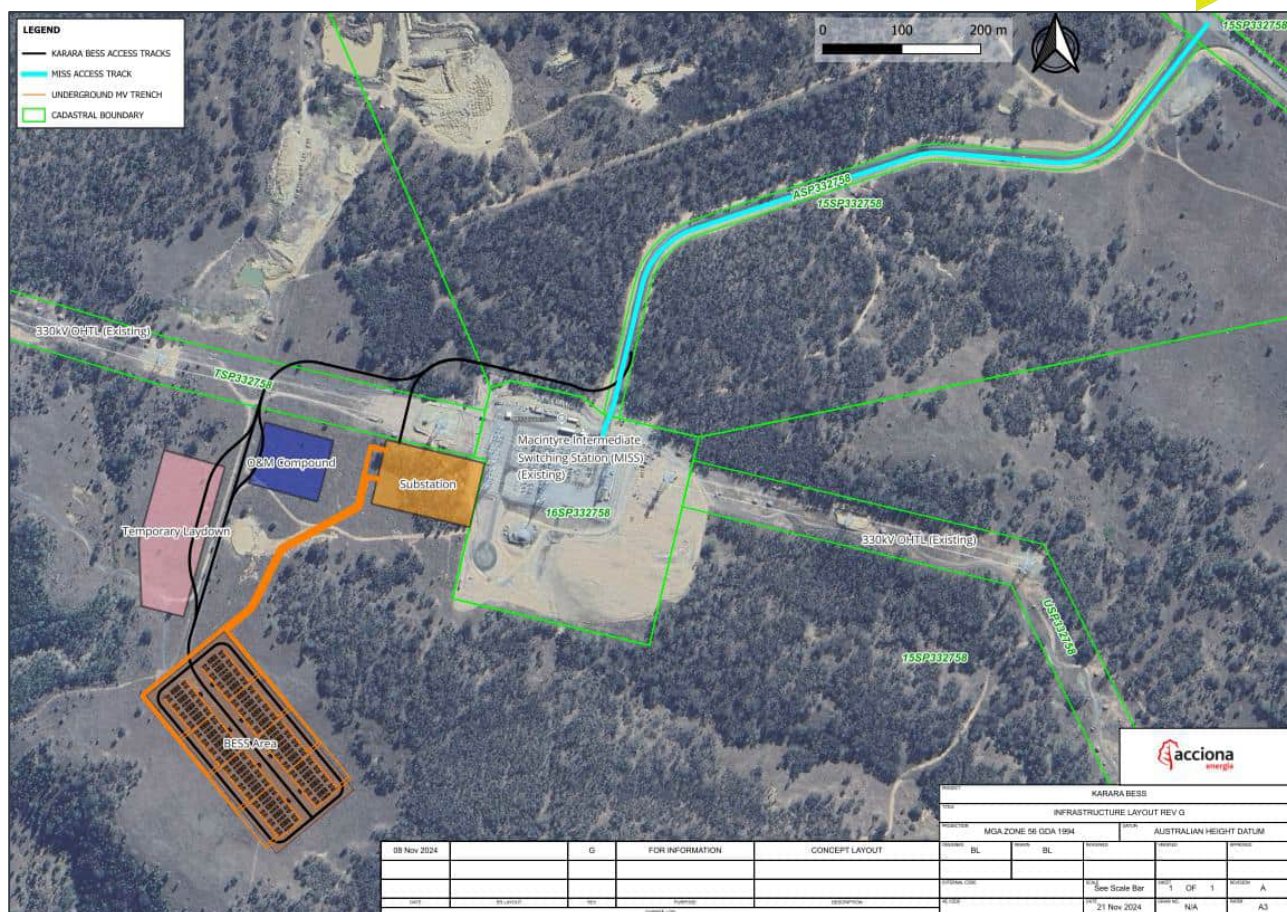
Runoff from the site is conveyed via overland flow, eventually discharging to the unnamed creek to the south.

2.4 Rainfall

According to the data obtained from the nearest active Bureau of Meteorology (BOM) station, 041377 at Tummurrami, the mean annual rainfall for the site has been estimated to be 647.7 mm.

2.5 Proposed Development

The proposed development will involve the construction of a Battery Energy Storage System (BESS), an Operations and Maintenance Facility Compound, Substation, Temporary Laydown, access tracks, fencing and 33kV underground MV cables. Refer to Figure 2.3 for more information.





3. Stormwater Quantity Assessment

3.1 Overview

The following section outlines the catchment details including Points of Discharge (PD), the flow on the local and regional site, catchment parameters and peak runoff estimation.

3.2 Subject Site

3.2.1 Local Catchment PD's

Three (3) PD's have been identified at the subject site as outline below:

- PD A is located along the southern boundary of Catchment A.
- PD B is located along the southern portion of the western boundary of Catchment B
- PD C is located along the south-western boundary of Catchment C

The pre and post developed PD locations are the same. Refer to Figure 3.1 and Figure 3.2 for more detail on PD locations.

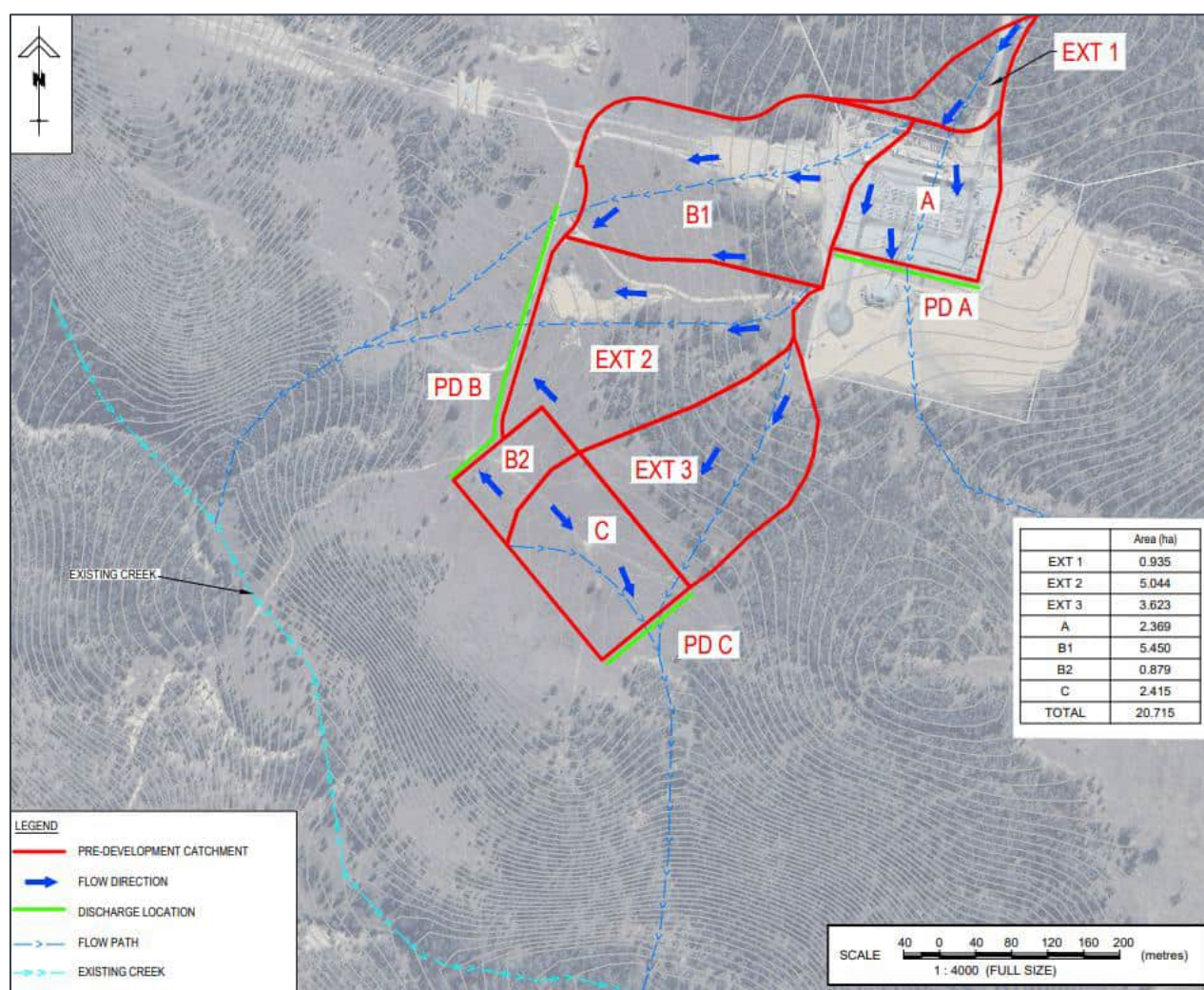


Figure 3.1 Pre-Development Catchment Map



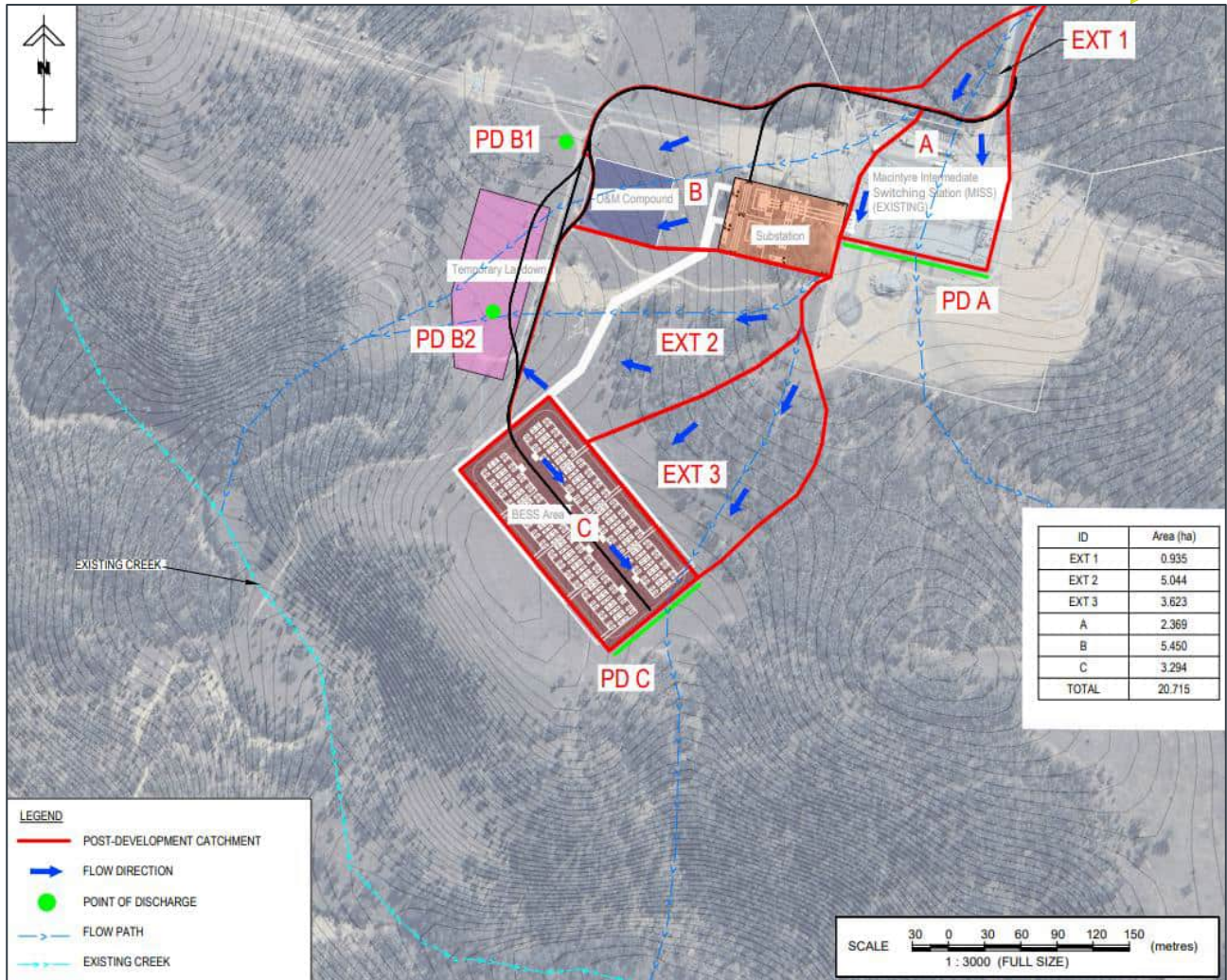


Figure 3.2 Post-Development Catchment Map

3.2.2 Internal Flows

Flows from Catchment A are conveyed via overland flow to PD A. Flows from Catchment B are conveyed either via overland flow to PD B in the southern portion of the catchment, or to the diversion channel and a cross road culvert in the northern section of the channel. Refer to Table 3.1 for more information on the diversion channel and Table 3.2 for information on the cross road culvert.

Table 3.1 Diversion Channel B1

Q100 Conveyance Flow (m ³ /s)	Base Width (m)	Flow Depth (m)	Side Batter	Slope	Freeboard (m)	Flow Velocity (m/s)	Channel Material
0.746	0.95	0.3	1 in 3	2%	0.3	1.41	Grassed Banks

**Table 3.2 Cross Road Culvert B**

Q10 Conveyance Flow (m³/s)	Culvert Size	Velocity (m/s)
0.395	1 x 450mm RCP	2.53

Runoff from Catchment C is conveyed via overland flow to PD C.

3.2.3 External Flows

Flows from External Catchment 2 are predominately conveyed via overland flow to the western catchment border, where they are conveyed beneath the proposed road and discharge to PD B via a set of culverts (as shown in Figure 3.3). Remaining flows are conveyed via the proposed diversion channel B2 and EXT2 . Refer to Table 3.3 and Table 3.4 for channel parameters and Table 3.5 for the cross-road culvert details.

Table 3.3 Diversion Channel B2

Q100 Conveyance Flow (m³/s)	Base Width (m)	Flow Depth (m)	Side Batter	Slope	Freeboard (m)	Flow Velocity (m/s)	Channel Material
1.288	1.00	0.3	1 in 3	2%	0.3	1.60	Grassed Banks

Table 3.4 Diversion Channel Catchment EXT 2

Q100 Conveyance Flow (m³/s)	Base Width (m)	Flow Depth (m)	Side Batter	Slope	Freeboard (m)	Flow Velocity (m/s)	Channel Material
0.483	0.4	0.3	1 in 3	2%	0.3	1.24	Grassed Banks

Table 3.5 Cross Road Culvert Ext 2

Q10 Conveyance Flow (m³/s)	Culvert Size	Velocity (m/s)
1.012	3 x 450mm RCP	2.46

Flows from External Catchment 3 are conveyed via overland flow to the north-eastern boarder of catchment C. This channel diverts water along that boundary to the southern corner of the catchment. Refer to Table 3.6 for the diversion channel parameters.





Table 3.6 Diversion Channel Catchment EXT 3

Q100 Conveyance Flow (m ³ /s)	Base Width (m)	Flow Depth (m)	Side Batter	Slope	Freeboard (m)	Flow Velocity (m/s)	Channel Material
0.702	0.85	0.3	1 in 3	2%	0.3	1.34	Grassed Banks

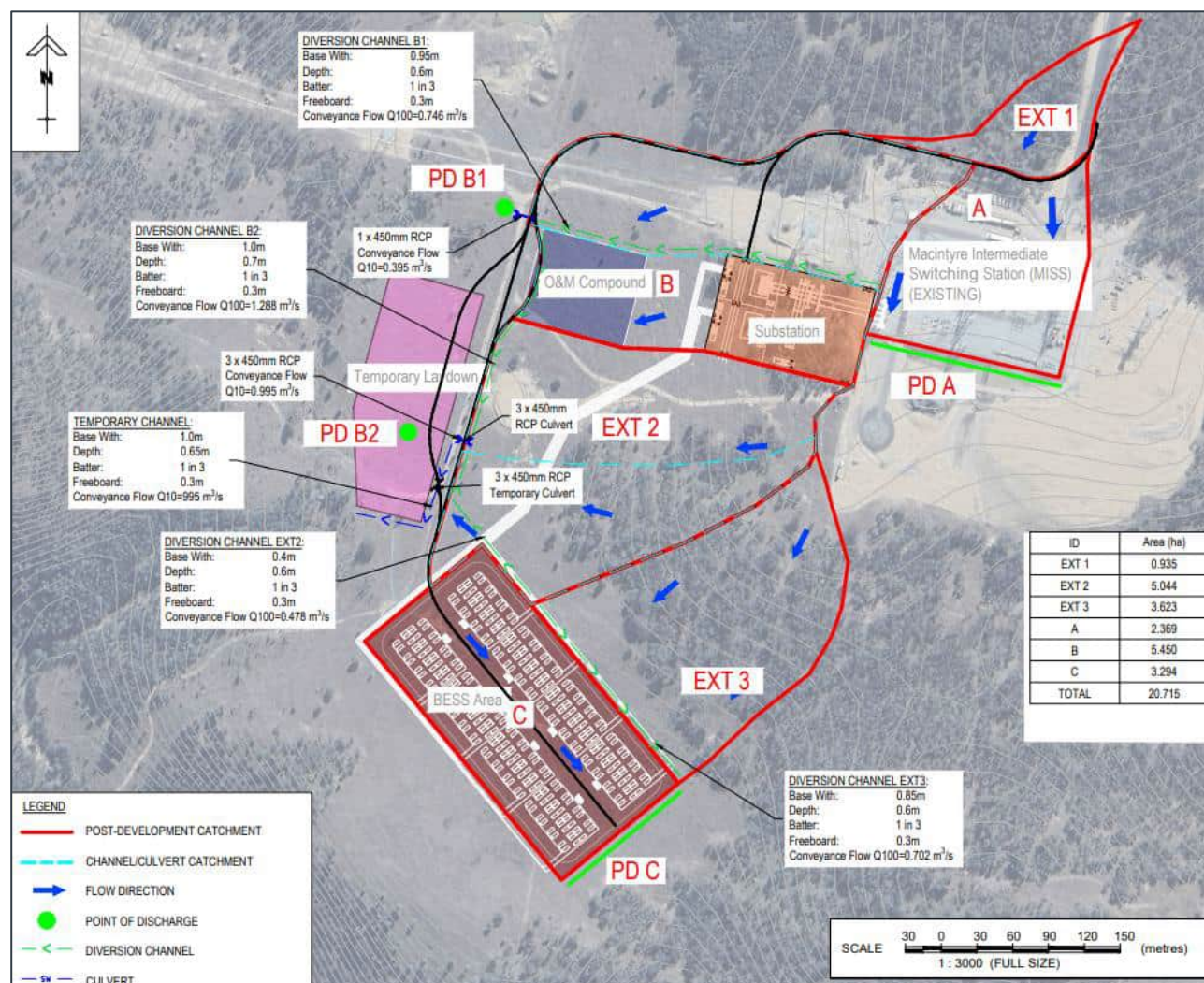


Figure 3.3 Post-developed Operational Control Plan

3.2.4 Scour

For the four (4) diversion channels outlined above, the peak velocities (at 1% AEP) through the channels are below 2.0m/s, which is the typical bank scour velocity for grassed channels, as per the Queensland Urban Drainage Manual. Therefore, no scour protection is required for those channels.

The scour protection required for the three cross road culverts is outlined below.



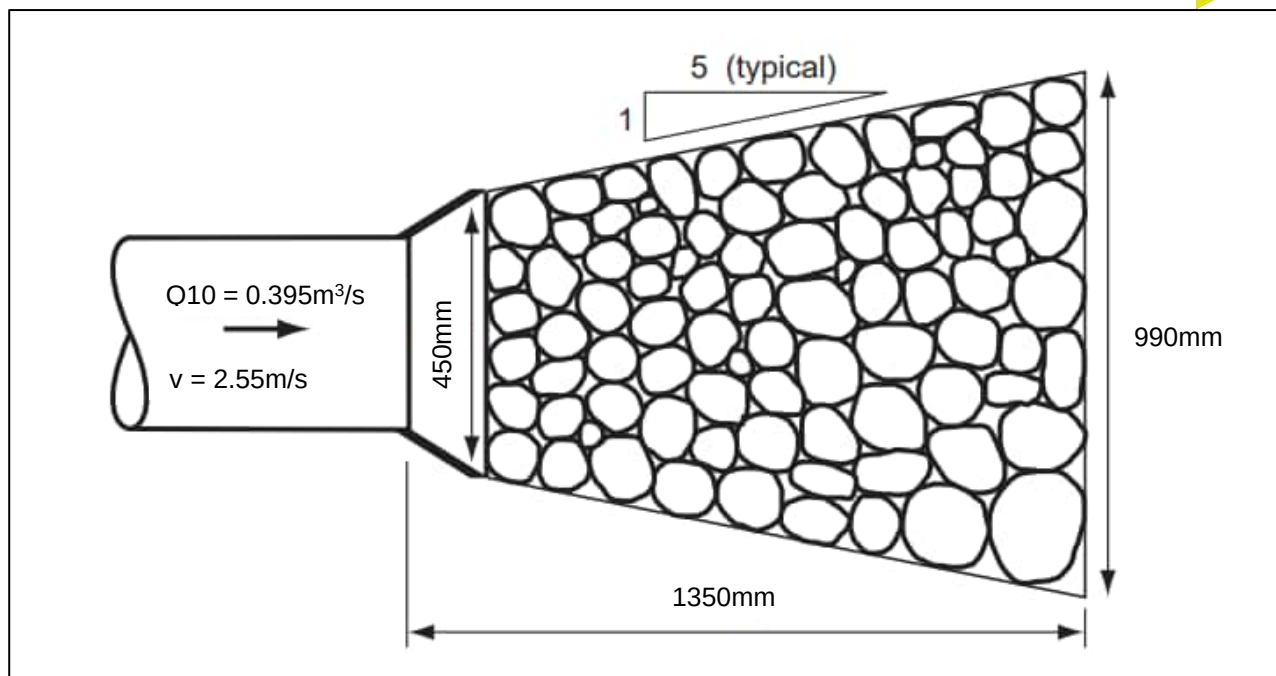


Figure 3.4 Rock Pad Outlet Structure for Culvert B

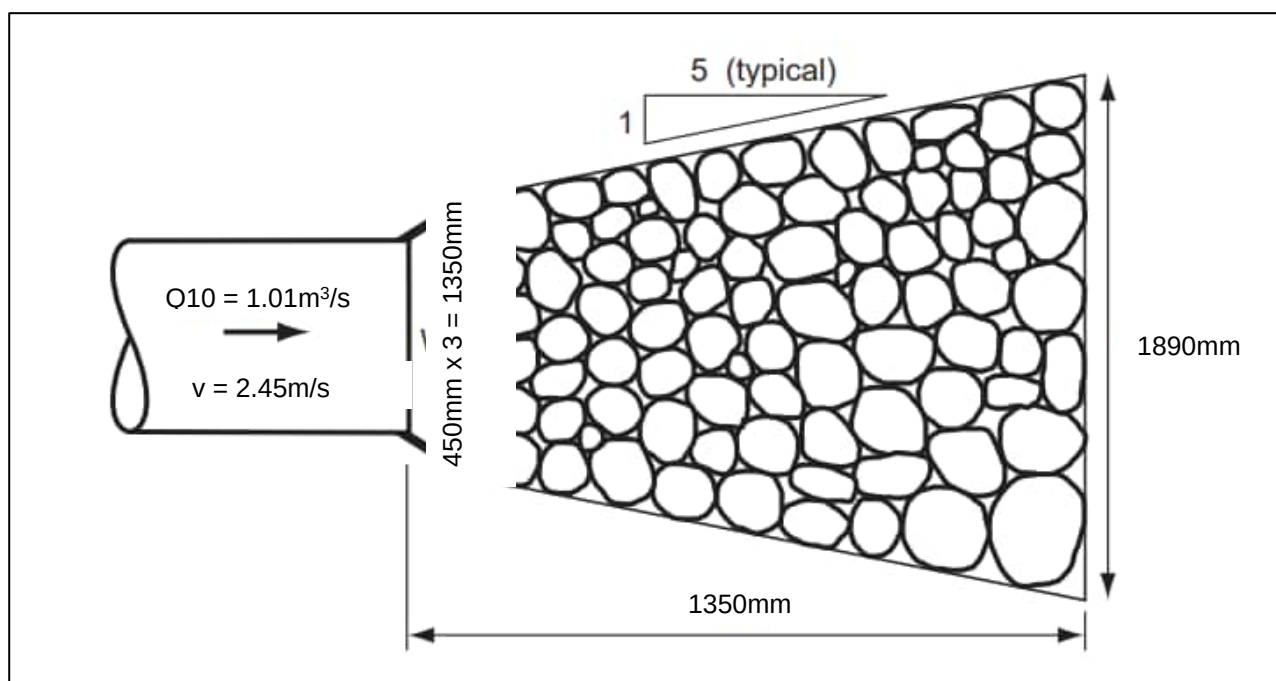


Figure 3.5 Rock Pad Outlet Structure for Culverts Ext 2/Temporary Culverts





Table 3.7 Rock Pad Outlet Parameters

Culvert ID	Culvert Size	Length of Rock Protection (mm)	D ₅₀ (mm)	Rock Pad Thickness (mm)	Width at downstream end (mm)
Culvert B	450mm RCP	1350	200	360	990
Culvert Ext 2/Temporary Culverts	3 x 450mm RCP	1350	200	360	1890

3.2.5 Rational Method Pre and Post Development

The Rational Method has been used to gain an understanding of the relative impact of the proposed development on peak flow rates at the site's LPD. The Rational Method is a basic method for assessing peak flow rates and is considered suitable given the catchment area is less than 500 ha and the time of concentration within the contributing catchments is less than 30 minutes (IPWEAQ, 2017).

Table 3.8 Catchment Parameters

Catchment ID	Area (ha)	t _c (min)	C ₁₀	Slope (%)
Ext 1	0.94	20.00	39	3
Ext 2	5.04	19.00	39	6
Ext 3	3.62	21.00	39	4
Pre A	2.37	19.00	39	4
Pre B1	5.45	23.00	39	4
Pre B2	0.88	17	39	4
Pre C	2.42	21.00	39	3
Post A	2.37	19.00	65	4
Post B	6.23	23.00	65	4
Post C	3.29	8.00	65	2

Table 3.9 Pre-Development Flows

Pre-Developed Catchment ID	1% AEP (m ³ /s)	10% AEP (m ³ /s)	39% AEP (m ³ /s)
Ext 1	0.19	0.10	0.06
Ext 2	1.03	0.54	0.31
Ext 3	0.70	0.37	0.21
Pre A	0.48	0.25	0.14
Pre B1	1.00	0.53	0.30
Pre B2	0.19	0.10	0.06
Pre C	0.47	0.25	0.14





Table 3.10 Unmitigated Post-Development Flows

Post-Developed Catchment ID	1% AEP (m³/s)	10% AEP (m³/s)	39% AEP (m³/s)
Post A	0.81	0.42	0.24
Post B	1.90	1.01	0.57
Post C	1.63	0.86	0.49

Due to the proposed development, the flows on the subject site (Catchments A, B and C) have increased by a total of 1.96m³/s in the 1% AEP flood event. No development is proposed in the external catchments, therefore no increase in flows is expected there.

Additionally, to provide scour protection, two rock pad outlets have been designed based on the calculated velocity through the proposed cross road culverts.

Further assessment has been completed within the regional catchment to determine if mitigation measures are required. See Section 3.3.





3.3 Regional Assessment

3.3.1 Regional Catchment

The LPD (legal point of discharge) for the Regional Catchment has been identified as an unnamed tributary along the lot boundary as shown below in Figure 3.6.

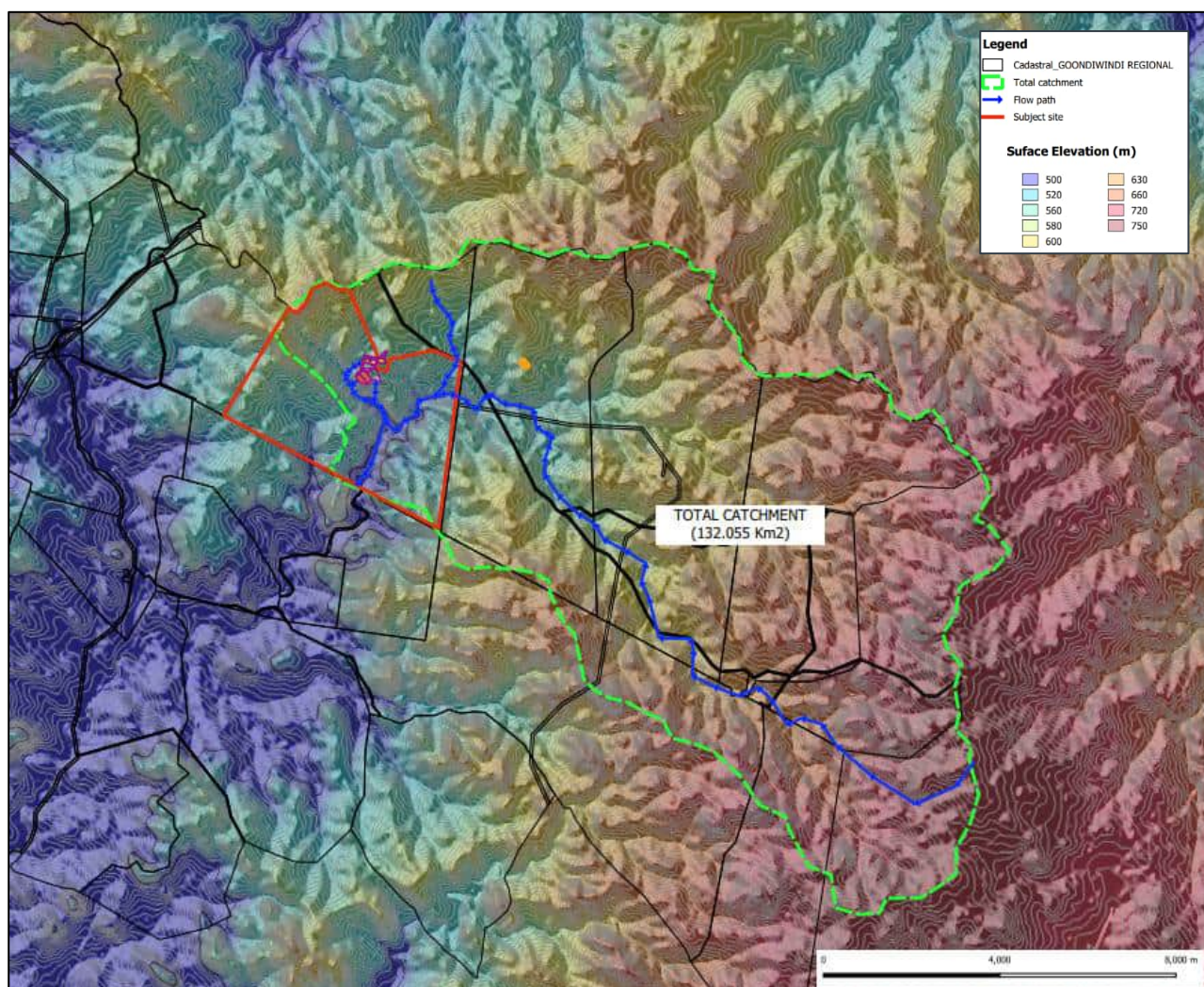


Figure 3.6 Regional Catchment Map

3.3.2 Conveyance of Flows

As shown in Figure 3.6, runoff is conveyed via overland flow, ultimately discharging at the LPD – an unnamed tributary to the west of the catchment.

3.3.3 Peak Runoff Estimation

The Regional Flood Frequency Estimation (RFFE) Model (2016 v2) has been used to gain an understanding of the peak flow rates at the site's LPD. RFFE is a basic statistical method for estimating peak flow rates in ungauged catchments and is recommended over the Rational Method when the catchment area exceeds 500ha (a catchment size of 13205.5ha was determined for this subject site). Refer to Appendix C for more information.





Table 3.11 Regional Flood Frequency Estimation Parameters

Catchment ID	Area (km ²)	Outlet (Latitude)	Outlet (Longitude)	Distance to Nearest Gauged Catchment (km)
Regional Catchment	132.055	-28.324	151.631	16.19

Table 3.12 Regional Catchment Flows

Catchment ID	1% AEP Flow Rate (m ³ /s)	10% AEP Flow Rate (m ³ /s)	39% AEP Flow Rate (m ³ /s)
Regional Catchment	912	268	62.7

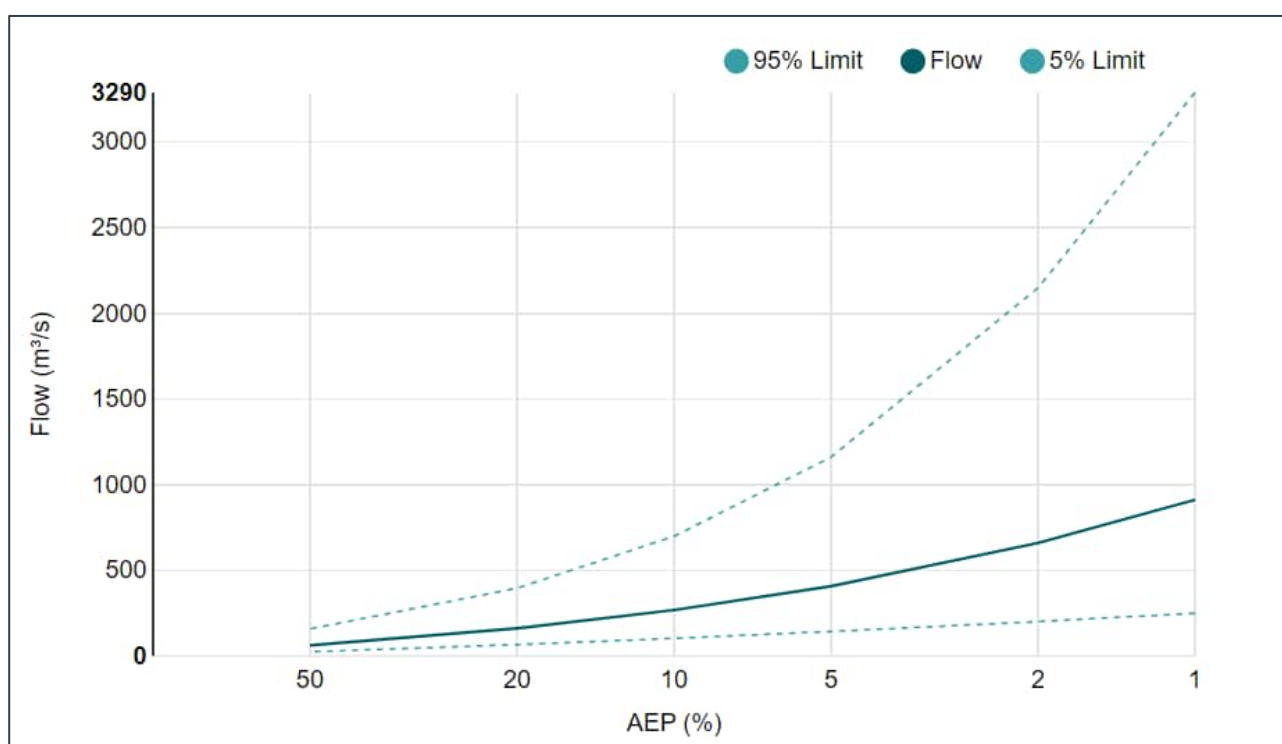


Figure 3.7 Regional Flood Frequency Estimation Results

3.4 Discussion of Results

The Regional Flood Frequency Estimation Model was utilised to determine the total flow through the 132.055km² regional catchment, while the Rational Method was used to calculate the flows through the local catchments.

The total peak flow through the regional catchment is 912m³/s. The total pre-developed peak flow produced by the local catchments is 4.06m³/s. The total post-developed peak flow through the local catchments is 6.25m³/s, therefore with a total change in flow rate of 2.19m³/s, as summarised in Table 3.13.





Table 3.13 Subject Site and Regional Catchment Flow Comparison

Flood Event	Site ID	Pre-Developed Flows (m ³ /s)	Post-Developed Flows (m ³ /s)	Increase (%)
1% AEP	Subject Site	4.06	6.25	54
	Regional Catchment	912	914.09	0.2
10% AEP	Subject Site	2.14	3.30	54
	Regional Catchment	268	269.1	0.4
39% AEP	Subject Site	1.21	1.87	55
	Regional Catchment	62.7	63.32	0.9

In comparison to the total flow of 912m³/s through the regional catchment, an increase of 2.19m³/s or 0.2% in the 1% AEP flood event due to the change in imperviousness from the proposed development, is considered negligible and therefore detention is not required for this site.

Furthermore, as shown in Table 3.8, the time of concentration for the local catchments range between 8 minutes and 25 minutes and are rather short durations. However, the time of concentration for the larger regional catchments has been calculated at about 4.5 hours. This suggests that the additional site flows should have already discharged from the site before most of the remaining flows from the regional catchment reach the subject site. Refer to Appendix B for more details on these timings.





4. Stormwater Quality Assessment

It is not proposed to provide stormwater quality treatment for the proposed development. The implementation of stormwater quality measures such as Water Sensitive Urban Design (WSUD) is not considered necessary due to the following conclusions:

- The subject site is located within the town of Karara, in the Western Queensland climatic region, which has an approximate population of 128 people;
- The Queensland Government State Planning Policy (July 2017) states that in Western Queensland, the stormwater management design objectives only apply to population centres greater than 25,000 people.





5. Erosion and Sediment Control

5.1 Best Management Practices

Stormwater runoff quality during the construction phase of this development shall be managed in accordance with Best Practice Erosion and Sediment Control (IECA, 2008), which is the current recognised construction industry best management practice (BMP) for erosion and sediment control.

Erosion and Sediment Control (ESC) plans are required to be implemented during the construction phase to minimise environmental harm to on-site stormwater treatment devices and downstream receiving waters.

It is important to note that the measures identified below are a generic approach to construction phase stormwater quality management. Erosion and sediment control is highly dependent on local site conditions and staging of the proposed earth disturbing activities. Therefore, further details of the erosion and sediment control systems and procedures will be provided for each development stage when more information is available regarding in-situ soils and development staging.

5.2 Erosion Hazard Assessment

As part of the IECA guidelines, an erosion hazard assessment is to be completed to identify low-risk and high-risk short-term land disturbances within a given region (IECA, 2008). This Erosion Hazard Assessment estimates a TASK number which triggers if a site should be treated as high or low risk in regard to erosion control measures. A trigger value for high-risk site of 200 will be adopted for future stage as recommended by IECA. High risk sites trigger further need for assessment.

Table 5.1 Erosion Hazard Assessment

Catchment ID	Area (m ²)	Duration of Disturbance (months)	Slope Factor	K Factor	TASK Number
Post A	23690	6	0.61	0.040	3468
Post B	54500	6	0.61	0.040	7978
Post C	32940	6	0.61	0.040	4822
Temporary Laydown	14519	6	0.61	0.040	2125

From Table 5.1 the results show that all four catchments requires high-risk ESC treatment. Given the development proposal is at a conceptual phase, further details of the erosion and sediment control systems and procedures will be provided at the detailed design stage.

5.3 Erosion Control Standard

The best practice erosion control measures for high-risk development as detailed in Best Practice Erosion and Sediment Control (IECA, 2008) include the following:

- All reasonable and practical steps to be taken to apply best practice erosion control measures to completed earthworks, or otherwise stabilise such works, prior to anticipated rainfall - including existing unstable, undisturbed, soil surfaces under the management or control of the building/construction works;
- Land clearing limited to maximum 4 weeks work;
- Disturbed soil surfaces stabilised with minimum 75% cover within 10 days of completion of works within any area of a work site;
- Staged construction and stabilisation of earth batters; and





- Soil stockpiles and unfinished earthworks are suitably stabilised (covered) if disturbance is expected to be suspended for a period exceeding 10 days.

5.4 Sediment Loss Estimate

The potential volume of sediment loss from the subject site has been estimated using the Revised Universal Soil Loss Equation (RUSLE).

RUSLE calculates annual soil loss rates based on:

$$A = R \cdot K \cdot LS \cdot C \cdot P$$

Where:

A = annual soil loss due to erosion (t/ha/yr)

R = rainfall erosivity factor

K = soil erodibility factor

LS = topographic factor derived from slope length and slope gradient

C = cover and management factor

P = erosion control practice factor

Table 5.2 Potential Sediment Loss (RUSLE)

Catch. ID	Area (ha)	Soil Type*	Slope Length (m)	Slope Grade (%)	Intensity I_2 (mm/hr)	R	K	LS	C	P	A (t/ha/yr)	Yield (m ³ /yr)
Post A	2.369	Silt Loam	80	4	7.82	1480	0.04	0.91	1	1.3	70.0	128
Post B	5.45	Silt Loam	80	4	7.82	1480	0.04	0.91	1	1.3	70.0	294
Post C	3.294	Silt Loam	80	4	7.82	1480	0.04	0.91	1	1.3	70.0	177
Temporary Laydown	1.4519	Silt Loam	80	4	7.82	1480	0.04	0.91	1	1.3	70.0	78

*Note soil testing will need to be carried out to confirm soil type

Table 5.3 Sediment Control Standard (default) based on soil loss rate (IECA, 2008)

Area limit (m ²) ^[1]	Soil loss rate limit (t/ha/yr) ^[2]			Soil loss rate limit (t/ha/month) ^[3]		
	Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
250	N/A	N/A	[4]	N/A	N/A	[4]
1000	N/A	N/A	All cases	N/A	N/A	All cases
2500	N/A	> 75	75	N/A	> 6.25	6.25
>2500	> 150	150	75	> 12.5	12.5	6.25





5.5 Sediment Pond Requirement

Sediment ponds are generally required during construction where:

- The disturbed area is greater than 10,000m² and the expected sediment loss is greater than 75 t/ha/yr;
- The disturbed soils are dispersive; and/or
- Where there is a need to control runoff suspended solids/turbidity.

As presented in Table 5.2, it is expected that the potential annual soil loss will not exceed 75 t/ha/yr for any of the catchments, and therefore a sediment pond is not required during construction.

5.6 Sediment Control Standard

Table B1 of the guidelines (IECA, 2018) provides a method for determining the sediment control standard for construction activities based on the estimated soil loss rate. Based on the size of the development, it is likely that Type 3 sediment controls are required for this site. A list of Type 3 and supplementary sediment control techniques is provided in Table 5.4 below based on Table 4.5.3 and Table 4.5.4 of the guidelines (IECA, 2008). These control techniques provide a guide that is recommended to be used to minimise the downstream effect of sediments.

Table 5.4 Sediment Control techniques

Techniques	Type 3	Supplementary
Sheet flow treatment	➤ Buffer Zone ➤ Excavated Drop Inlet Protection ➤ Fabric Drop Inlet Protection ➤ Fabric Wrap Field Inlet Sediment Trap ➤ Filter Fence ➤ Modular Sediment Trap ➤ Straw Bale Barrier ➤ Sediment Fence	➤ Grass Filter Strips ➤ Fibre Rolls ➤ Stiff Grass Barrier
Concentrated flow treatment	➤ Coarse Sediment Trap ➤ Modular Sediment Trap ➤ U-Shaped Sediment Trap	➤ Straw Bale Barrier ➤ Kerb Inlet Sediment Traps (on-grade and sag inlet traps, including Gully Bags) ➤ Check Dam Sediment Traps
De-watering sediment control	➤ Filter Fence ➤ Grass Filter Bed ➤ Hydrocyclone ➤ Portable Sediment Tank ➤ Sediment Fence	➤ Grass Filter bed
Instream sediment control	➤ Modular Sediment Barrier ➤ Sediment Filter Cage	➤ Straw Bale Barrier (short-term device only)
Other		➤ Construction exits (Rock Pads, Wash Bays)





5.7 Operations Erosion and Sediment Control

A maintenance management program will be prepared in the detailed design phase for post-development erosion and sediment control for the subject site. This will include assessment for additional scour protection at other critical outlets to prevent localised erosion and ensure durability of the drainage system. Additionally, regular inspections and maintenance of existing control measures will be recommended to ensure compliance.

An outline of required maintenance and mitigation actions has been provided below:

Table 5.5 Erosion and Sediment Control Maintenance Management Program

Required Maintenance	Frequency	Action
Inspect upstream inlets of cross road culverts for sediment build up or rubbish.	3 months	If sediment build up or rubbish is present, remove from culvert inlet.
Inspect diversion channels and report on condition of grass and channel. Record any indication of scour or washout throughout the channel.	3 months	If condition of channel is degrading seek advice from civil engineer or geo-tech for mitigation advice.
Inspect rock protection at culvert outlets	After major rainfall events (> 10% AEP)	Replace or reinforce rock protection immediately if displaced.
Inspect areas of runoff from BESS, O&M Compound, Temporary Laydown and Substation area. Check indication of scour or rill.	3 months	If rills or scour is present seek advice from civil engineer or geo-tech for mitigation advice.
Inspect downstream area of access road at LPD B in the event of weir flow over the road.	After major rain fall events (> 10% AEP)	Assess condition of downstream area and seek advice from civil engineer or geo-tech for mitigation advice





6. Conclusion

This Conceptual Stormwater Management Plan (CSMP) has been prepared in accordance with the Goondiwindi Regional Council Planning Scheme Version 2 and is to accompany the Development Application over this site. The following conclusions have been made as a result of this report.

Stormwater Quantity

As a result of the proposed development, the magnitude of peak stormwater discharge exiting the site has increased by 54% in the 1% AEP event. However, within the regional catchment the change in flows due to the proposed development is an increase of 0.2%. The change in flows is considered negligible in comparison to the total flows conveyed through the regional catchment and no mitigation measures are required. Scour protection has also been designed, according to QUDM for the proposed cross-road culverts.

Stormwater Quality

As per the State Planning Policy, towns with populations of less than 25,000 people in the Western Queensland climatic region, do not require stormwater management.

Erosion and Sediment Control

An Erosion Hazard Assessment has identified that the site is high-risk with regard to erosion potential. It has also been identified that the construction site will require Type 3 sediment control techniques.



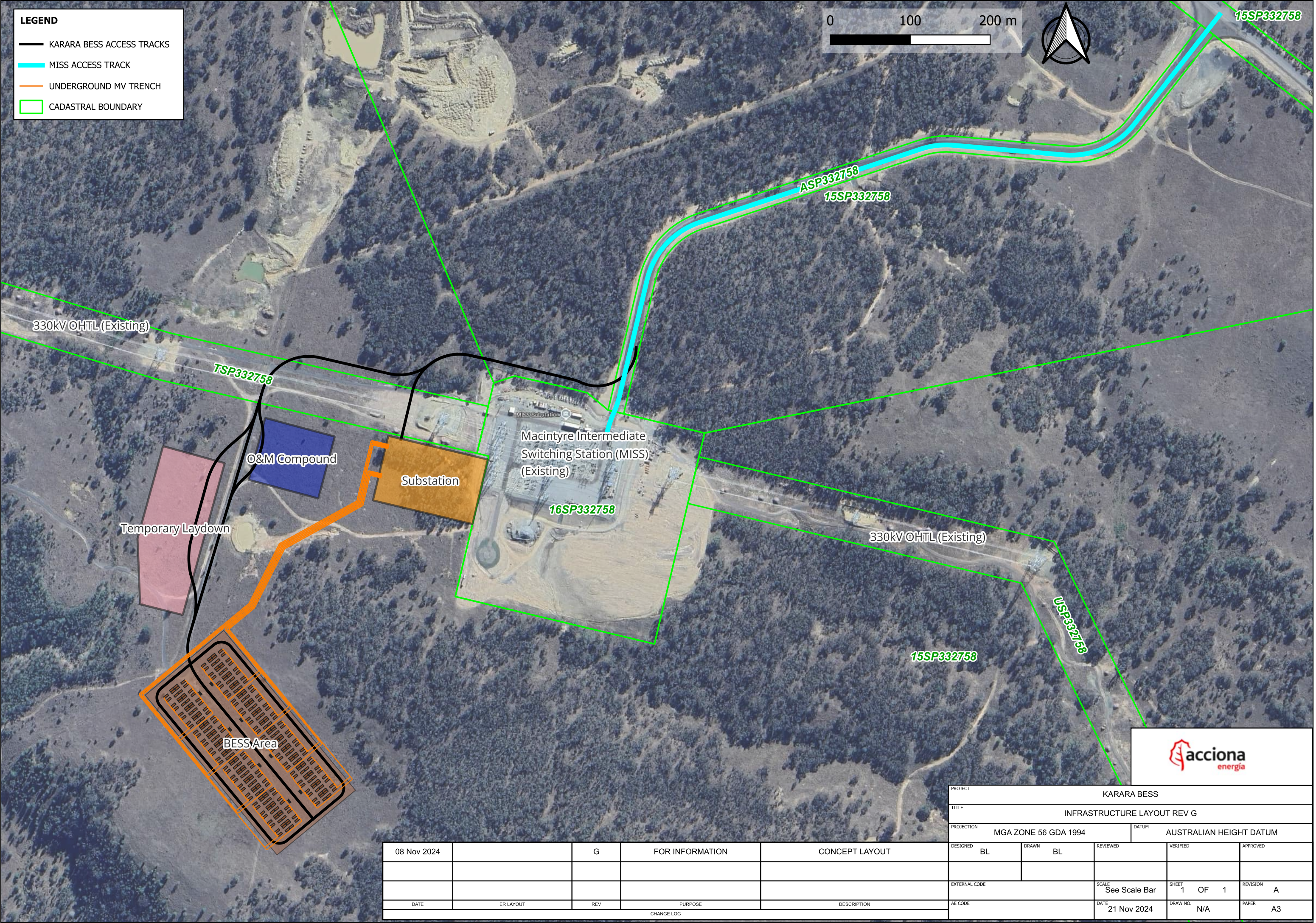


Appendix A – Proposed Plans of Development



LEGEND

- KARARA BESS ACCESS TRACKS
- MISS ACCESS TRACK
- UNDERGROUND MV TRENCH
- CADASTRAL BOUNDARY



08 Nov 2024		G	FOR INFORMATION	CONCEPT LAYOUT
DATE	ER LAYOUT	REV	PURPOSE	DESCRIPTION
CHANGE LOG				

PROJECT					KARARA BESS				
TITLE					INFRASTRUCTURE LAYOUT REV G				
PROJECTION			MGA ZONE 56 GDA 1994		DATUM		AUSTRALIAN HEIGHT DATUM		
DESIGNED	BL	DRAWN	BL	REVIEWED	VERIFIED	APPROVED			
EXTERNAL CODE			SCALE		SHEET		OF		REVISION
AE CODE			DATE		DRAW NO.		N/A		A
			21 Nov 2024						A3



Appendix B – Time of Concentration and Rational Method Calculations

Site Pre-Development Hydrology

The natural hydrology of the site has been assessed in accordance with QUDM (IPWEAQ, 2017) Section 4.1. The time of concentration for all catchments has been determined using Friend's Equation as per QUDM Section 4.6.6, combined with a channel time flow calculation.

$$\text{Friend's Equation } t_c = (107nL^{0.333})/S^{0.2}$$

Table B.6-1 presents a summary of the catchment parameters used within Friend's Equation and the calculated time of concentration for the pre-development scenario.

Table B.6-1 Time of Concentration for Pre-Development Scenario

Catchment ID	Ext 1	Ext 2	Ext 3	Pre A	Pre B1	Pre B2	Pre C
Overland Flow							
Estimated Length of Sheet (m)	100	100	100	100	100	90	100
Horton's Roughness Value	0.045	0.045	0.045	0.045	0.045	0.045	0.045
Slope (%)	3	6	4	4	4	3	3
tc (mins)	17.91	15.59	16.91	16.91	16.91	17.3	17.91
Channel/Creek Flow							
Length of Channel Flow (m)	100	200	200	100	310	-	170
Velocity (m/s)	0.9	0.9	0.9	0.9	0.9	-	0.9
tc (mins)	1.85	3.70	3.70	1.85	5.74	-	3.15
TOTAL tc (mins)	20	19	21	19	23	17	21

Site Post-Development Hydrology – Unmitigated

Table B.6-2 presents a summary of the catchment parameters used for the calculated time of concentration for the post-development scenario. The time of concentration for the external catchment is presented in Table B.6-1 above.

Table B.6-2 Time of Concentration for Post-Development Scenario

Catchment ID	Post A	Post B	Post C
Overland Flow			
Estimated Length of Sheet (m)	100	100	-
Horton's Roughness Value	0.045	0.045	-
Slope (%)	4	4	-
tc (mins)	16.91	16.91	-
Channel/Creek Flow			





Catchment ID	Post A	Post B	Post C
Length of Channel Flow (m)	100	450	-
Velocity (m/s)	0.9	0.9	-
tc (mins)	1.85	8.33	-
Standard Inlet Time (min)	-	-	5
Pipe Flow Time			
Length of Pipe Flow (m)	-	-	200
Velocity (m/s)	-	-	1
tc (mins)	-	-	3.33
TOTAL tc (mins)	19	25	8

Regional Catchment Time of Concentration

Table B.6-4 presents a summary of the catchment parameters used for the calculated time of concentration for the regional catchment.

Table B.6-3 Time of Concentration for Regional Catchment

Catchment ID	Ext 1
Overland Flow	
Estimated Length of Sheet (m)	200
Horton's Roughness Value	0.045
Slope (%)	1
tc (mins)	28.11
Channel/Creek Flow	
Length of Channel Flow (m)	21695
Velocity (m/s)	1.5
tc (mins)	241.06
TOTAL tc (mins)	269





Design storm event flows across the site were derived using the Rational Method as per the above-mentioned manuals. This involved:

- Determination of a C10 value (derived in accordance with QUDM Table 4.05.3(b) and Council guidelines). A value of 0.7 was applied to the pre-development catchment and 0.83 was applied to the post-development catchment;
- Adoption of design rainfall using BoM IFD data; and
- Calculation of design flows through the site for Q100, Q50, Q20, Q10, Q5, Q2, Q1 and Q3_{month}, where Q3_{month} is deemed to be 50% of Q1.

Summaries of the hydrologic calculations are contained in Table B.6-4 and Table B.6-5 for pre and post-development (un-mitigated) scenarios respectively.

Table B.6-4 Pre-Development Hydrology

Catch.	Area (ha)	tc (min)	I ₁₀₀ (mm/hr)	C	Q ₁₀₀ (m ³ /s)	I ₅₀ (mm/hr)	C	Q ₅₀ (m ³ /s)	I ₂₀ (mm/hr)	C	Q ₂₀ (m ³ /s)	I ₁₀ (mm/hr)	C	Q ₁₀ (m ³ /s)	I ₅ (mm/hr)	C	Q ₅ (m ³ /s)	I ₂ (mm/hr)	C	Q ₂ (m ³ /s)	I ₁ (mm/hr)	C	Q ₁ (m ³ /s)	Q _{3month} (m ³ /s)
Ext 1	0.94	20.00	153.00	0.47	0.186	135.00	0.45	0.157	113.00	0.41	0.120	96.70	0.39	0.098	82.30	0.37	0.079	64.40	0.33	0.055	51.00	0.31	0.041	0.021
Ext 2	5.04	19.00	157.00	0.47	1.029	139.00	0.45	0.873	116.00	0.41	0.666	99.30	0.39	0.543	84.60	0.37	0.439	66.20	0.33	0.307	52.40	0.31	0.229	0.115
Ext 3	3.62	21.00	149.00	0.47	0.702	132.00	0.45	0.596	110.00	0.41	0.453	94.10	0.39	0.369	80.10	0.37	0.299	62.70	0.33	0.209	49.70	0.31	0.156	0.078
pre A	2.37	19.00	157.00	0.47	0.484	139.00	0.45	0.410	116.00	0.41	0.313	99.30	0.39	0.255	84.60	0.37	0.206	66.20	0.33	0.144	52.40	0.31	0.108	0.054
pre B1	5.45	23.00	141.00	0.47	1.00	125.00	0.45	0.85	104.00	0.41	0.645	89.50	0.39	0.53	76.10	0.37	0.427	59.60	0.33	0.30	47.20	0.31	0.223	0.111
pre B2	0.88	17.00	166.00	0.47	0.19	147.00	0.45	0.16	123.00	0.41	0.12	105.00	0.39	0.10	89.60	0.37	0.08	70.10	0.33	0.06	55.50	0.31	0.042	0.021
pre C	2.42	21.00	149.00	0.47	0.47	132.00	0.45	0.40	110.00	0.41	0.30	94.10	0.39	0.25	80.10	0.37	0.20	62.70	0.33	0.139	49.70	0.31	0.104	0.052

Table B.6-5 Un-Mitigated Post-Development Hydrology

Catch.	Area (ha)	tc (min)	I ₁₀₀ (mm/hr)	C	Q ₁₀₀ (m ³ /s)	I ₅₀ (mm/hr)	C	Q ₅₀ (m ³ /s)	I ₂₀ (mm/hr)	C	Q ₂₀ (m ³ /s)	I ₁₀ (mm/hr)	C	Q ₁₀ (m ³ /s)	I ₅ (mm/hr)	C	Q ₅ (m ³ /s)	I ₂ (mm/hr)	C	Q ₂ (m ³ /s)	I ₁ (mm/hr)	C	Q ₁ (m ³ /s)	Q _{3month} (m ³ /s)
post A	2.37	19.00	157.00	0.78	0.806	139.00	0.75	0.684	116.00	0.6825	0.521	99.30	0.65	0.425	84.60	0.62	0.344	66.20	0.55	0.241	52.40	0.52	0.179	0.090
post B	5.45	23.00	141.00	0.78	1.665	125.00	0.75	1.415	104.00	0.6825	1.075	89.50	0.65	0.881	76.10	0.62	0.711	59.60	0.55	0.499	47.20	0.52	0.372	0.186
post C	3.29	8.00	228.00	0.78	1.627	202.00	0.75	1.382	169.00	0.6825	1.055	145.00	0.65	0.862	124.00	0.62	0.701	97.10	0.55	0.491	76.90	0.52	0.366	0.183





Appendix C – Regional Flood Frequency Estimation Model

Input Parameters

In this study, the Regional Flood Frequency Estimation (Version 1 2016) was utilised to determine peak flows. This method is required for flow estimations where the catchment area exceeds 500ha. The following input data was required to generate the model results.

Table C.6-6 RFFE Input Parameters

Parameter	Value
Latitude (Outlet)	-28.3238750102
Longitude (Outlet)	151.559849972
Latitude (Centroid)	-28.3220970074
Longitude (Centroid)	151.63122851
Catchment Area (km ²)	132.055
Distance to Nearest Gauged Catchment (km)	16.19
50% AEP 6 Hour Rainfall Intensity (mm/h)	7.819234
2% AEP 6 Hour Rainfall Intensity (mm/h)	17.305687
Region	East Coast
Shape Factor	0.61
Bias Correction Value	-0.016

Table C.6-7 Complete RFFE Results

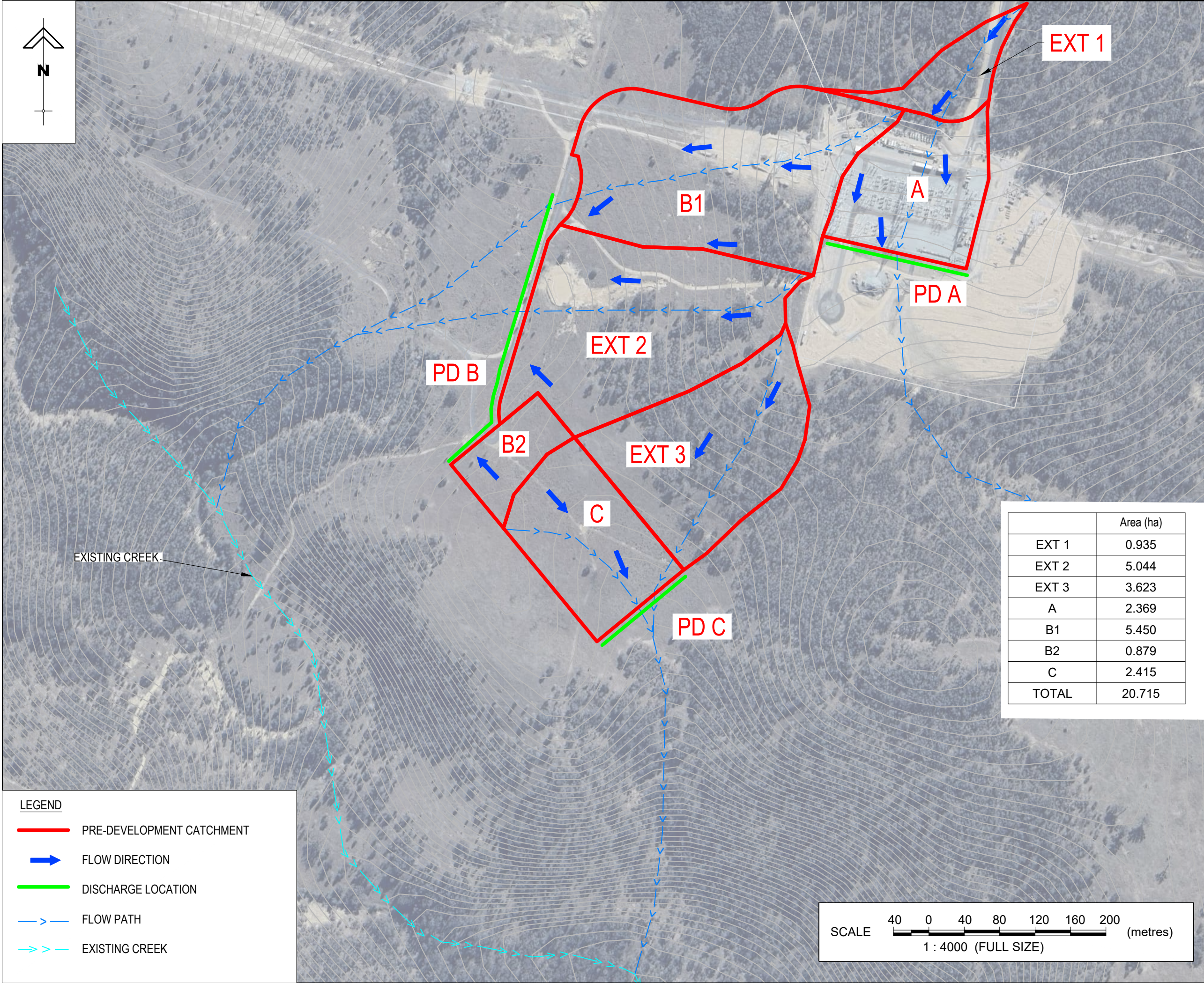
AEP (%)	Discharge (m ³ /s)	Lower Confidence Limit (5%) (m ³ /s)	Upper Confidence Limit (95%) (m ³ /s)
50	62.7	24.7	158
20	162	66.3	396
10	268	103	699
5	408	143	1160
2	660	201	2150
1	912	250	3290





Appendix D – Burchills Engineering Solutions Conceptual Stormwater Management Drawings

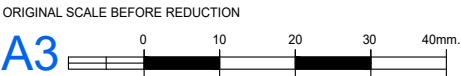




PROPOSED
DEVELOPMENT

CARBEAN ROAD,
KARARA

FOR
ACCIONA ENERGY



A	ORIGINAL ISSUE		05.12.24
VER.	DESCRIPTION	APPR.	DATE

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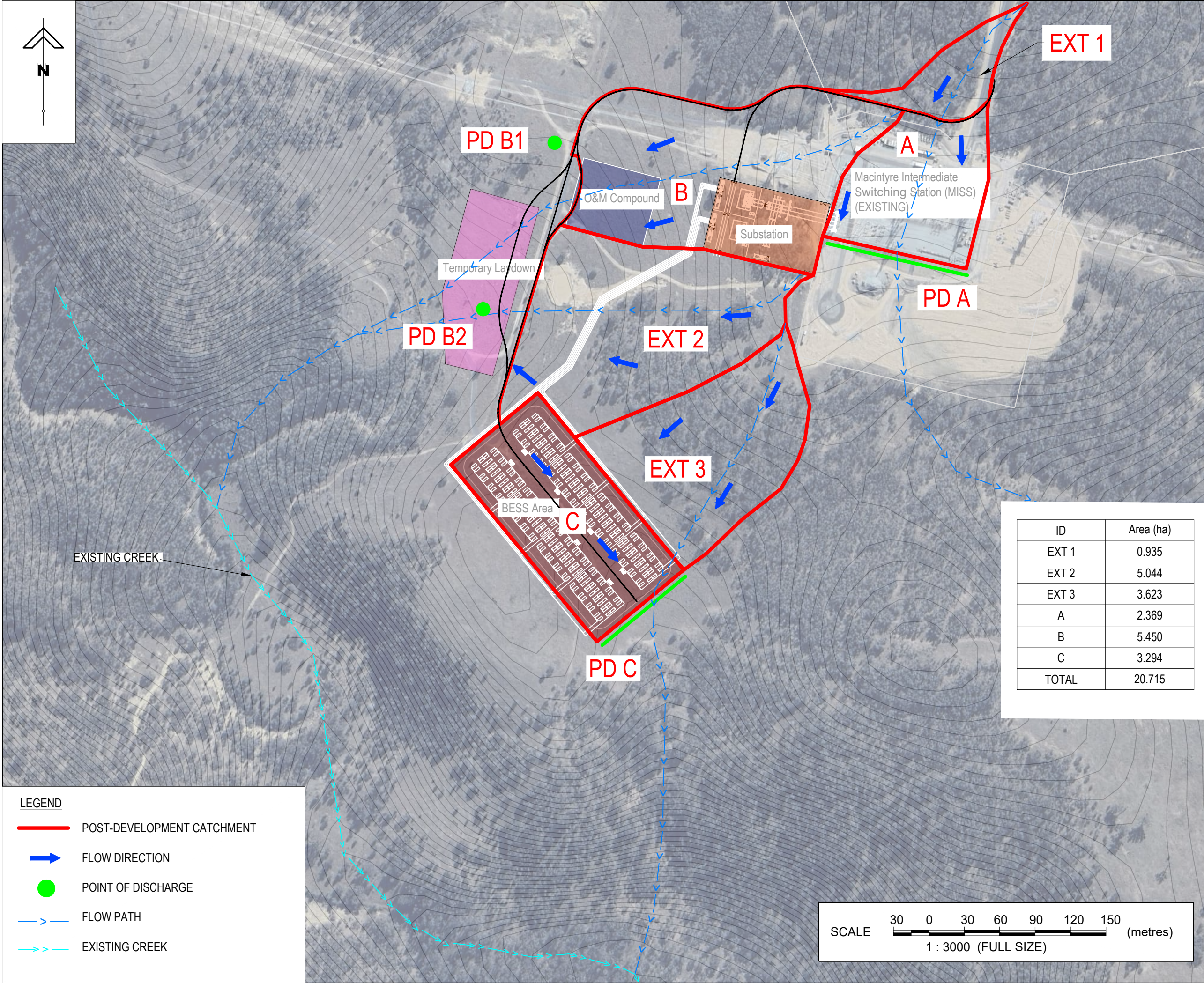


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DRAWING TITLE :

PRE-DEVELOPMENT
CATCHMENT PLAN

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PROJECT LEADER : JEREMY MOORING	
DESIGNER : JOSHUA MICALLEF	
DRAFTSPERSON :	
CHECKED : SAMUEL HUDDY	
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PROPOSED
DEVELOPMENT

CARBEAN ROAD,
KARARA

FOR
ACCIONA ENERGY

ORIGINAL SCALE BEFORE REDUCTION
A3 0 10 20 30 40mm.

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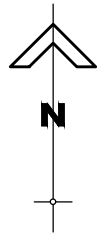


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CATCHMENT PLAN

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PROJECT No. : BE240125	DRAWING No. : N201
	VERSION: A



DIVERSION CHANNEL B1:
Base With: 0.95m
Depth: 0.6m
Batter: 1 in 3
Freeboard: 0.3m
Conveyance Flow Q100=0.746 m³/s

DIVERSION CHANNEL B2:
Base With: 1.0m
Depth: 0.7m
Batter: 1 in 3
Freeboard: 0.3m
Conveyance Flow Q100=1.288 m³/s

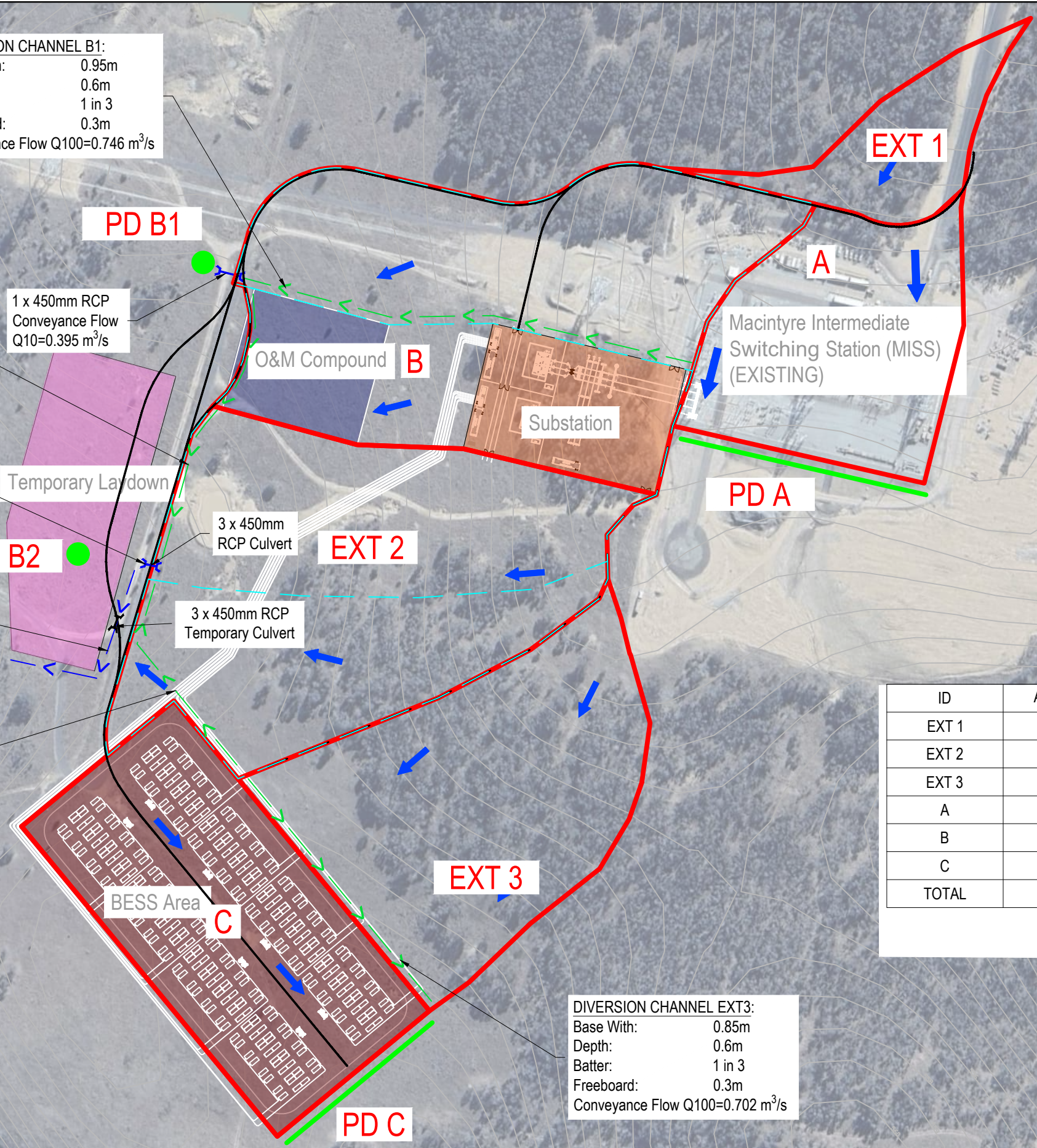
TEMPORARY CHANNEL:
Base With: 1.0m
Depth: 0.65m
Batter: 1 in 3
Freeboard: 0.3m
Conveyance Flow Q10=995 m³/s

DIVERSION CHANNEL EXT2:
Base With: 0.4m
Depth: 0.6m
Batter: 1 in 3
Freeboard: 0.3m
Conveyance Flow Q100=0.478 m³/s

DIVERSION CHANNEL EXT3:
Base With: 0.85m
Depth: 0.6m
Batter: 1 in 3
Freeboard: 0.3m
Conveyance Flow Q100=0.702 m³/s

LEGEND

- POST-DEVELOPMENT CATCHMENT
- CHANNEL/CULVERT CATCHMENT
- FLOW DIRECTION
- POINT OF DISCHARGE
- DIVERSION CHANNEL
- CULVERT



PROPOSED
DEVELOPMENT

CARBEAN ROAD,
KARARA

FOR

ACCIONA ENERGY

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm

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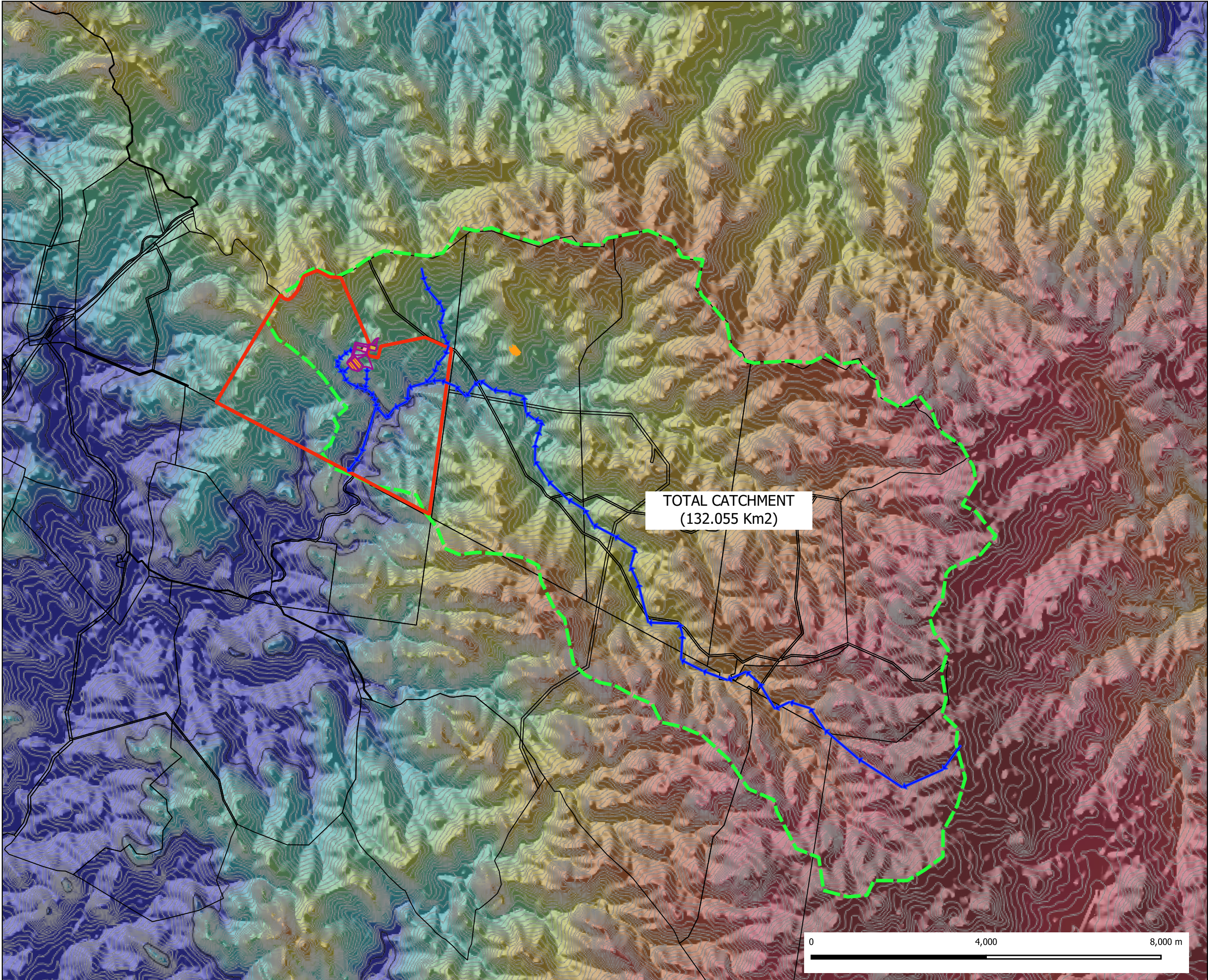
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OPERATIONAL CONTROL PLAN

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Carbean Road, Karara

FIG 01 REGIONAL CATCHMENT MAP



Location of the site within Goondiwindi Regional

Legend

- Cadastral_GOONDIWINDI REGIONAL
- Total catchment
- Flow path
- Subject site

Surface Elevation (m)

500	630
520	660
560	720
580	750
600	

Project: BE240125

Date: July 2024

Scale:1:4000 at A3

Projection: GDA 94/ MGA ZONE 56

Data Sources:



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