GULGAN NORTH, BRUNSWICK HEADS

23RD DECEMBER 2021

CIVIL ENGINEERING REPORT

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ENGINEERED WITH PURPOSE

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1. INTRODUCTION

Ingen Consulting P/L has been engaged by Gulgan Road Property Pty Ltd to prepare a Civil Engineering Report (CER) for the proposed rezoning of Area 5 as identified in the Byron Shire Business and Industrial Lands Strategy dated October 2020.

1.1. Scope

The subject site, Lot 2 DP 1159910 located at 66 The Saddle Road, Brunswick Heads has several portions that are identified for rezoning. The subject site is shown in Figure 1 and the portion which is addressed in this report is shown in Figure 2 divided into Area A and Area B. The purpose of this report is to carry out a preliminary study of the rezoning potential of this site from a civil engineering perspective, particular consideration given to:

- Flooding and earthworks
- Stormwater Management
- Water supply
- Sewer reticulation
- Traffic impacts

Each of the items above will be assessed in accordance with relevant Australian Standards as well as local government policies and guidelines.

1.2. Site description

The subject site is located at Lot 2 DP 1159910 at 66 The Saddle Road, Brunswick Heads, see Figure 1. This 52ha site is situated between Mullumbimby and Brunswick Heads and is intersected by The Saddle Road, Gulgan Road and the Pacific Motorway. The site has been identified for potential future rezoning in Council's Business and Industrial Lands Strategy (BILS).

Figure 2 shows the areas identified in the Business and Industrial Lands Strategy, where we can see Area 'A', 3.5 hectares, which would be earmarked for a business park type zoning, typically zoned as Business Park, and Area 'B', 3.0 hectares, as a Traditional Industrial Estate. Area A is elevated, roughly between 30m and 40m AHD with ocean views. Area B is lower lying, with elevations generally between 4m AHD and 7m AHD.

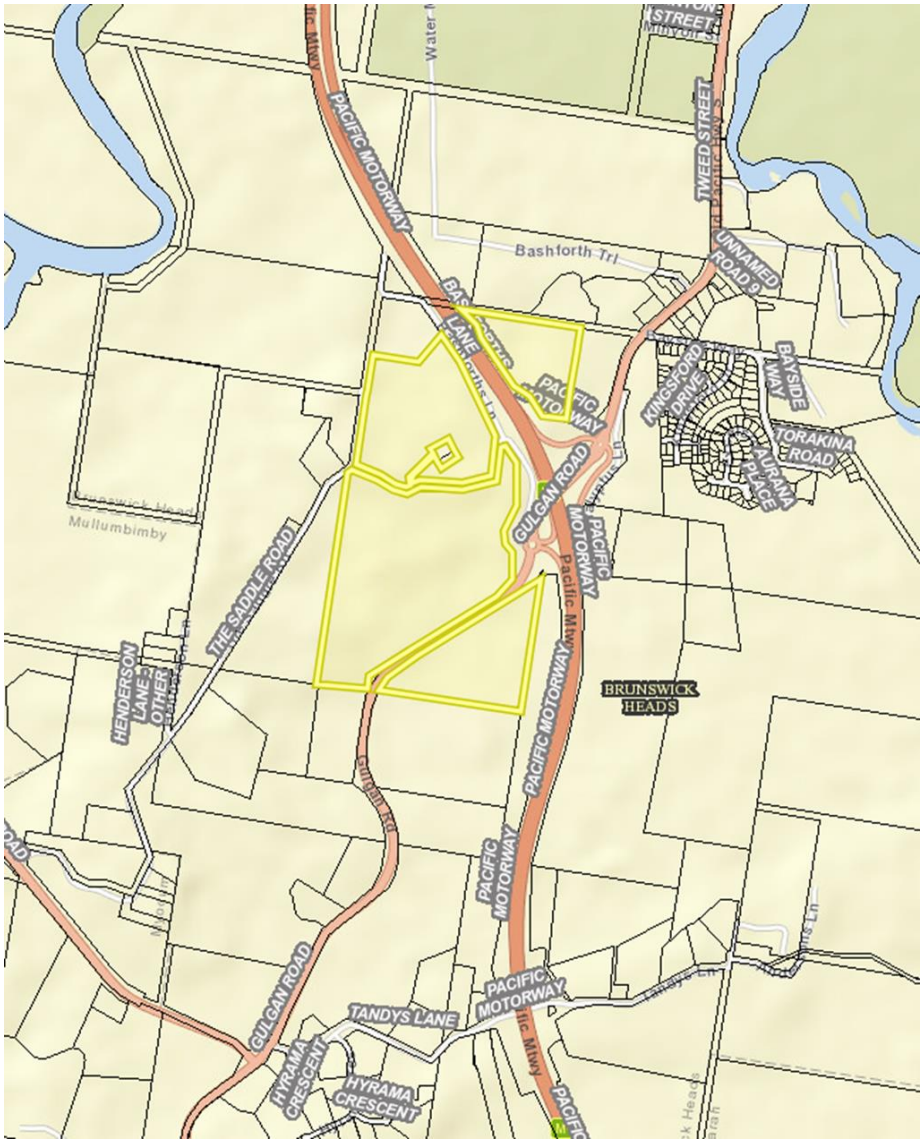


Figure 1 | Site location, *Source of the map: Byron Shire Council Online Maps 2021*

Figure 2 | Extract from BILS mapping showing the general rezoning areas, *Source: Byron Shire Council*

1.3. Proposed zoning

The proposed development is a Planning Proposal seeking to create a business park in Area A and a traditional industrial area in Area B shown in Figure 2, in general accordance with Byron Shire Council's Business and Industrial Lands Strategy. Due to the nature of a Planning Proposal, this Civil Engineering Report provides generic recommendations to demonstrate how compliance with relevant policies and disciplines can be achieved for each discipline.

2. FLOODING AND EARTHWORKS

The Business and Industrial Lands Strategy identifies the subject areas as flood free. However, a small portion of the subject site has been mapped as 'Flood 1 in 100yr – LEP / DCP controls' on Byron Council's online mapping tool. As a result, this chapter will assess flooding characteristics and any associated earthworks requirements.

2.1. Flood characteristics

We have carried out flood hazard mapping using flood modelling data provided by Byron Shire Council. The flood hazard map for the subject site and its surrounds in provided in Figure 3. In this figure, red is high hazard, green is intermediate hazard, blue is low hazard and pink is flood free but below the 2100 Flood Planning Level for the site.

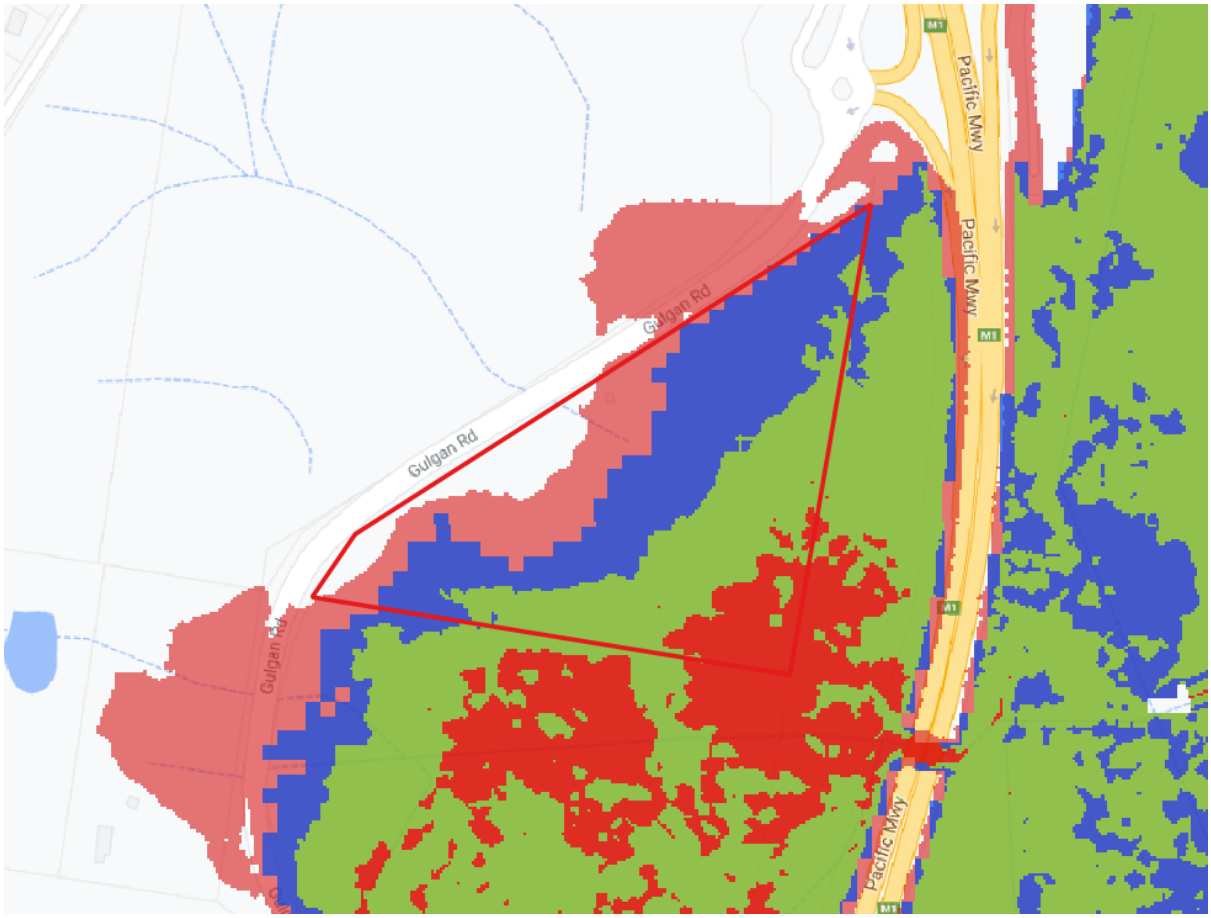


Figure 3 | Flood hazard mapping

The following can be concluded from the flood model inquiry:

- The 100-year flood level is RL 4.06m AHD
- The 2050 FPL for this site is RL 4.57m AHD
- The 2100 FPL for this site is RL 4.63m AHD
- The development areas are flood free
- Some of the eastern part of Area B is below the 2100 FPL

2.2. Flood Planning Matrix

Council's DCP chapter C2 includes a flood planning matrix that assist with determining flood-related requirements for future us of the site. The site is classed as 'No Hazard' and the zoning proposal is assessed against the Flood Planning Matrix is as shown in Table 1. It should be noted that only 'Primary Constraints' are shown since 'Additional Constraints' do not apply to a 'No Hazard' site.

Table 1 | Flood Planning Matrix assessment

Controls	Development / Building Type	Primary Constraints (No Hazard)	Clarification
Land Use Suitability & Fill Level	Development in New Release Areas, unless separately defined below	N/A	N/A
	Development in all other areas unless separately defined below	N/A	N/A
	Non-Habitable Building or Room	N/A	N/A
	Emergency Services Critical Facilities Site	N/A	N/A
	Other Special Purpose Facilities	N/A	N/A
Floor Level	Development in New Release Areas, unless separately defined below	FL3	All floor levels to be greater than or equal to the Projected 2100 Flood Planning Level (FPL3).
	Development in all other areas unless separately defined below	FL2	All floor levels to be greater than or equal to the Projected 2050 Flood Planning Level (FPL2).

	Dwelling Additions, except in New Release Areas	N/A	N/A
	Non-Habitable Building or Room	N/A	N/A
	New Critical Facilities or Special Purpose Facilities (Schools etc)	FL3a	If practical, all floor levels to be greater than or equal to the Projected 2100 Flood Planning Level (FPL3), so that these buildings will be available for accommodation / storage during and after a flood emergency.
Building Components	All	N/A	N/A
Structural Soundness	Ancillary Building	N/A	N/A
	Other Building	N/A	N/A
Flood Effect	Development in New Release Areas, unless separately defined below	N/A	N/A
	Development in all other areas unless separately defined below	N/A	N/A
	Dwelling Additions, Non-Habitable Building or Room	N/A	N/A
	Other Developments	N/A	N/A
Evacuation & Access	Development in all other areas unless separately defined below	N/A	N/A
	Development in New Release Areas, unless separately defined below	N/A	N/A
	Critical Facilities	N/A	N/A
	Other Special Purpose Facilities	N/A	N/A

Using the Flood Planning Matrix, all constraints can be summarised into this one constraint:

- All building floor levels to be equal to or greater than FPL3, being the 2100 FPL.

Based on the flood modelling provided, FPL3 for this site at the location of Area ‘B’ is determined to be RL4.63m AHD.

3. STORMWATER MANAGEMENT

Stormwater management for future use at this site will need to demonstrate compliance with Chapter B3 of the 2014 Byron Shire DCP and in particular Section B3.2.3 – Stormwater Management and the Byron Shire Council Comprehensive Guidelines for Stormwater Management (CGSM).

The purpose of this chapter is to provide a broad outline of suitable stormwater management strategies which would comply with Council's guidelines and DCP in any future development. As this Civil Engineering Report accompanies a Rezoning Application, it is anticipated that any stormwater treatment trains will be detailed further as part of a future Development Application for the site.

3.1. Site characteristics

Detailed survey of the development areas of the site was carried out by Byron Bay Surveying throughout 2021 and is attached in Appendix A.

Area A is located in the higher, northern portion of the site, at elevations ranging from approximately RL26m to RL44m AHD. According to the infiltration test results in Appendix B of this report, the hydraulic conductivity of the soil in this area is in the 6mm/hr to 35mm/hr range, which is suitable for the use of infiltration trenches in accordance with section 4.7 of the Council Guide to Stormwater Management.

With Area A located on the edge of the plateau, the land drops down relatively steeply into Area B, which is at a lower level, ranging from approximately RL4m AHD to RL7m AHD (Figure 4). The infiltration tests in Appendix B show that this soil has no infiltration potential, which is confirmed during site inspections which shows this lower lying area as waterlogged, in particular in the eastern area.

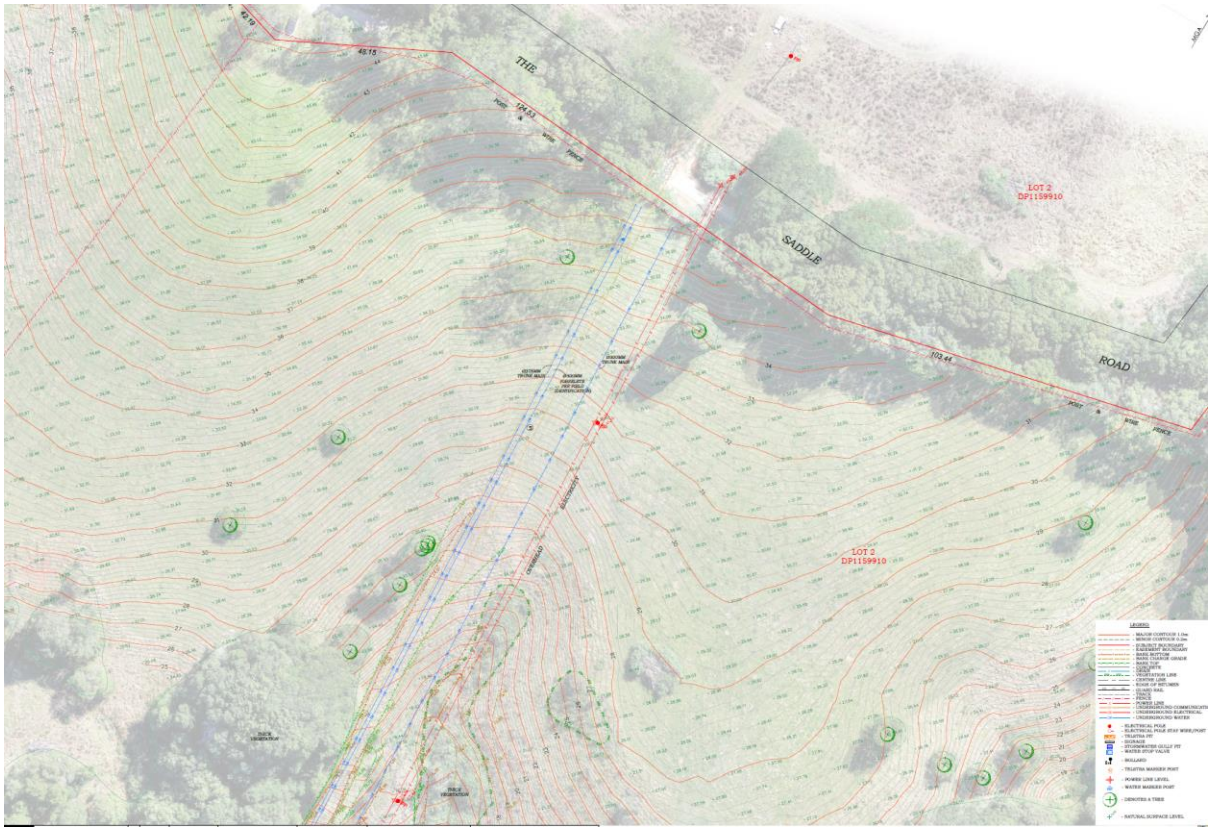


Figure 4 | Area A detail survey

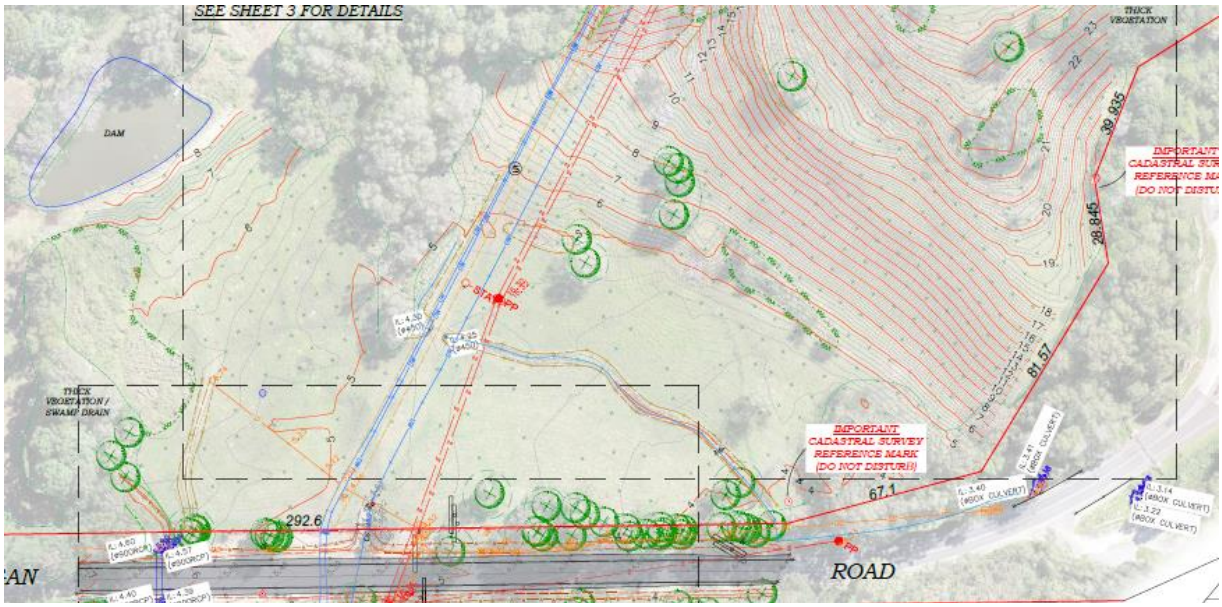


Figure 5 | Area B detail survey

Area A contains a dam to the northwest the overflow of which is directed into a watercourse that drains to the existing culvert (2 x ∅900 concrete pipes) crossing Gulgan Road in the southwestern corner of the area. The flatter portion to the east of the Rous trunk water main has an existing farm drain that drains further east, into a Gulgan Road table drain with a box culvert (3 @ 1200 x 450

RBC) crossing the approach to the western motorway overpass roundabout. The upstream end of this drain starts at the discharge point of a ∅450 culvert, which was likely constructed to create better farm access throughout the land. We estimate that the combined catchment of both culverts (shown in Figure 6) below is approximate 35 hectares, based on the Byron Shire online mapping tool.

At the time of the survey, the dam's water surface was approximately 1700m^2 in area. With an approximate average depth of 1 metre, we estimate the dam's capacity to be in the range of 1700m^3, or 1.7ML.

Figure 6 | Gulgan Road culverts catchment

3.2. Gulgan Road cross drainage

Site drainage across Gulgan Road is currently through two culverts at locations indicated in Figure 6. Survey details of these culverts is provided in Figure 7 and Figure 8.

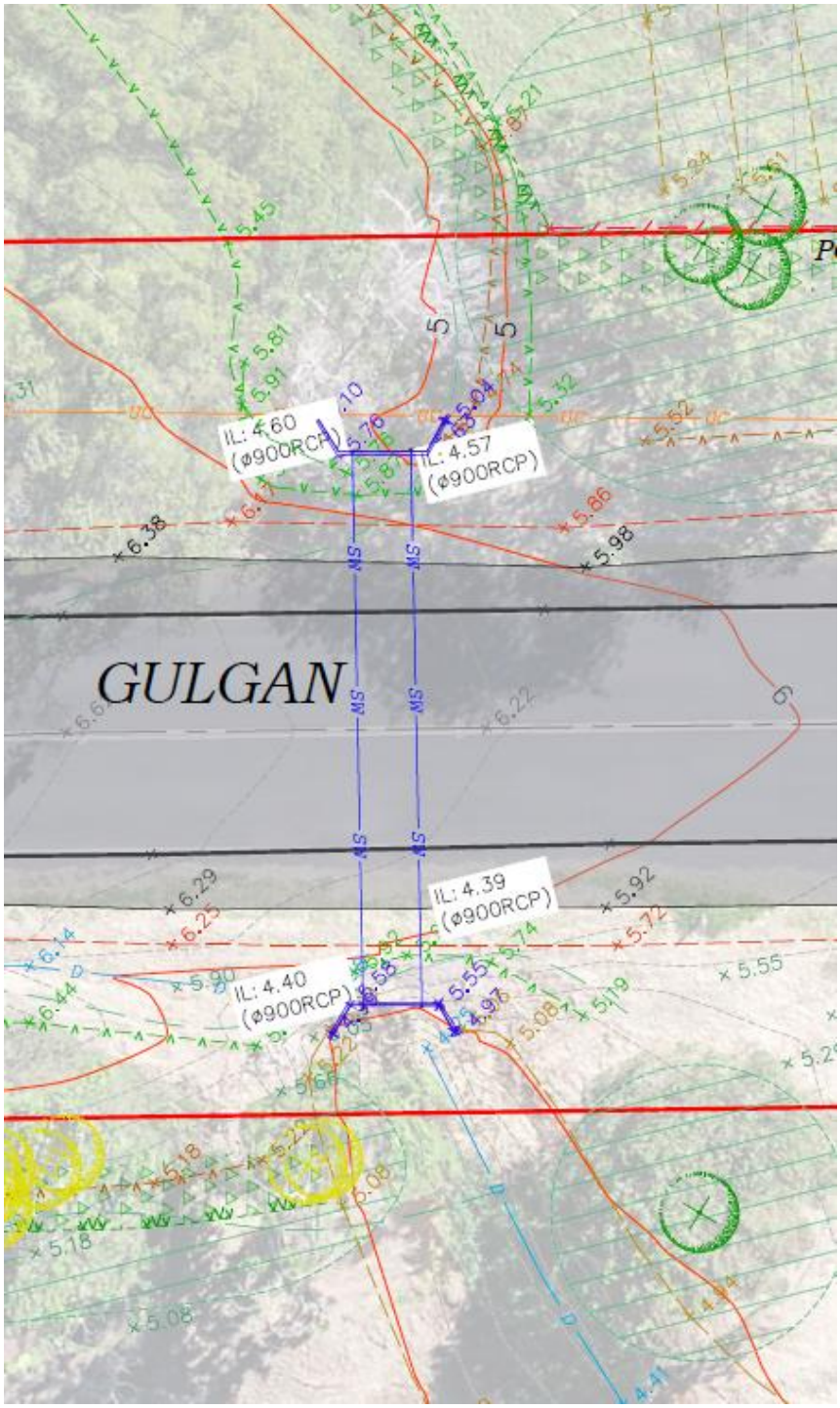


Figure 7 | Western culvert

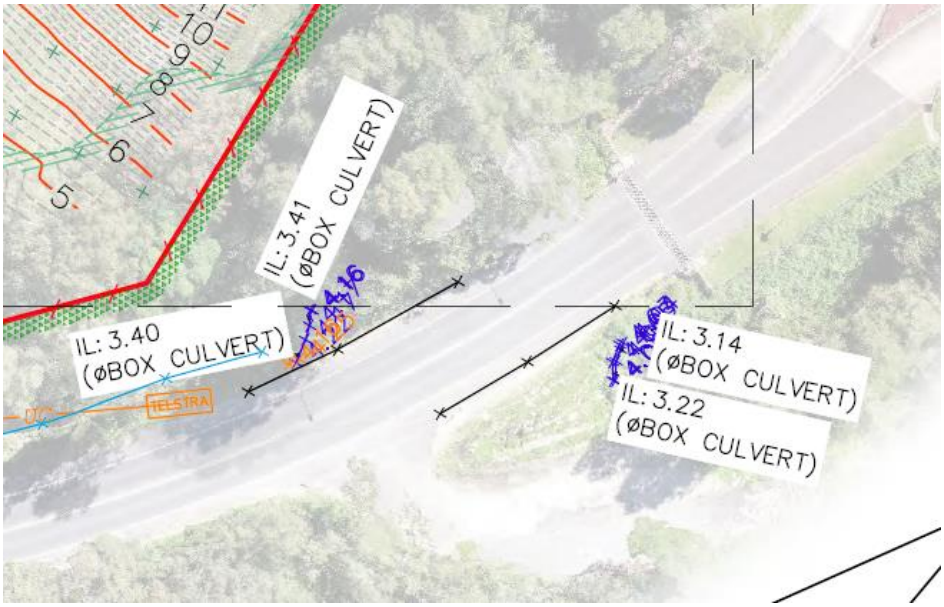


Figure 8 | Eastern culvert

The invert levels of the dual ∅900 culvert in Figure 7 is above the 100-year flood level of RL 4.09m AHD, which means that this culvert should continue to drain freely during flood events. The box culvert (three 1200 x 450 RBC's) to the east however will be partially inundated as the tops of the head walls are at approximately RL4.2m AHD, only 0.1m above the 100-year flood level. During a site inspection following rainfall in early December 2021, it was noted that at the culvert outlet, the tail water level was at approximately at half the height of the box culverts and water levels appeared constant. There was no visible flow in the downstream drainage channel, indicating high tail water levels during and after storm events.

Figure 9 | Culvert catchments, *Source aerial image: Byron Online Mapping 2021*

The capacity of these culverts is analysed using DRAINS software, based on ARR2019 rainfall routing and the latest IFD data for the site from the website of the Bureau of Meteorology. The results of a preliminary analysis are shown in Table 2. These results show that Gulgan Road will likely be subject to flash flooding during a minor storm event, between the 1EY and the 0.2EY flow as well as larger storms.

Table 2 | Preliminary culvert flows, m^3/s

Storm event		Western culvert			Eastern culvert		
informal	formal	pipe flow	overflow	Catchment peak discharge timing	pipe flow	overflow	Catchment peak discharge timing
1-year	1EY	1.8	0	35-45 mins	0.965	0	45 mins
5-year	0.2EY	2.98	1.16	40-55 mins	1.91	0	30-40 mins
10-year	10%	3.05	1.74	20-30 mins	2.22	0	20-30 mins
20-year	5%	3.14	2.74	20-30 mins	2.64	0	20-25 mins
50-year	2%	3.22	3.76	30-50 mins	3.06	0	20-25 mins
100-year	1%	3.28	4.63	30-50 mins	3.47	0	20 mins

Following this analysis, we recommend that future development at the site should not intensify peak runoff volumes during storm events. Although Council's On-site Stormwater Detention (OSD) requirements do not technically apply as the subject site is located on both sides of Gulgan Road and the part of the subject land southeast of Gulgan Road is flood storage, it would be good practice to adhere to Council's OSD policy to avoid worsening the existing drainage issues, provided OSD does not place the development runoff peak at the same time as the overall catchment runoff peak.

3.3. Lawful point of discharge

Lawful points of discharge would be the Gulgan Road cross drainage points. As stated above, the runoff intensity should not be increased to prevent worsening of any pre-existing drainage capacity issues.

3.4. Requirements for OSD

A number of circumstances are provided in which OSD is not required, that may be (partially) suitable for the subject development. These are:

- Where the site drains directly to a trunk drainage system within the tidal reach of a river or stream.
- Where infiltration is used as the means of stormwater discharge from the site.
- Where a Consulting Engineer undertakes a detailed analysis of the entire catchment by a time-area model and demonstrates that the provision of detention on the subject property, including consideration of the cumulative affect of detention provisions across the catchment, will provide no benefit to any downstream drainage system for all storm frequencies up to 100 year ARI.

The reasons why these may be applicable are:

- Area 'A' has the potential to adopt infiltration as a means to discharge stormwater. It should be noted however, that infiltrated water will likely return to surface water downhill from Area 'A'. As such, it would merely function as a 'delaying' strategy rather than a complete method of discharge.
- The parcel of the subject land southeast of Gulgan Road is subject to flooding. Generally, OSD is not required when discharging directly into a flood plain subject to tidal movements, unless that section of flood plain is earmarked for development, which is currently not the case.

The above reasons may be negated however, if the increased peak discharge due to increased hardstand without OSD negatively affects the performance of the culverts under Gulgan Road. In that case, OSD should be employed. Gulgan Road cross drainage peak characteristics are described in section 3.2.

OSD can be carried in a number of ways, such as:

- Rainwater tanks to capture and throttle back roof runoff from buildings.
- Detention in car parking areas
- Incorporate OSD in the design of bioretention basins.

3.5. Drainage modelling

The first step in determining the need for OSD is to calculate the runoff peaks from each individual catchment pre- and post-development and the impact OSD would have on the timing of runoff peaks. For the post-development impervious area percentages, the same numbers are adopted as described in table 3.6 of the MUSIC Modelling Guidelines. The catchment plan for this site is provided in Figure 10. Catchment areas are summarised in Table 3. The volume and timing of the unmitigated catchment discharges are provided in Table 4 and Table 5.

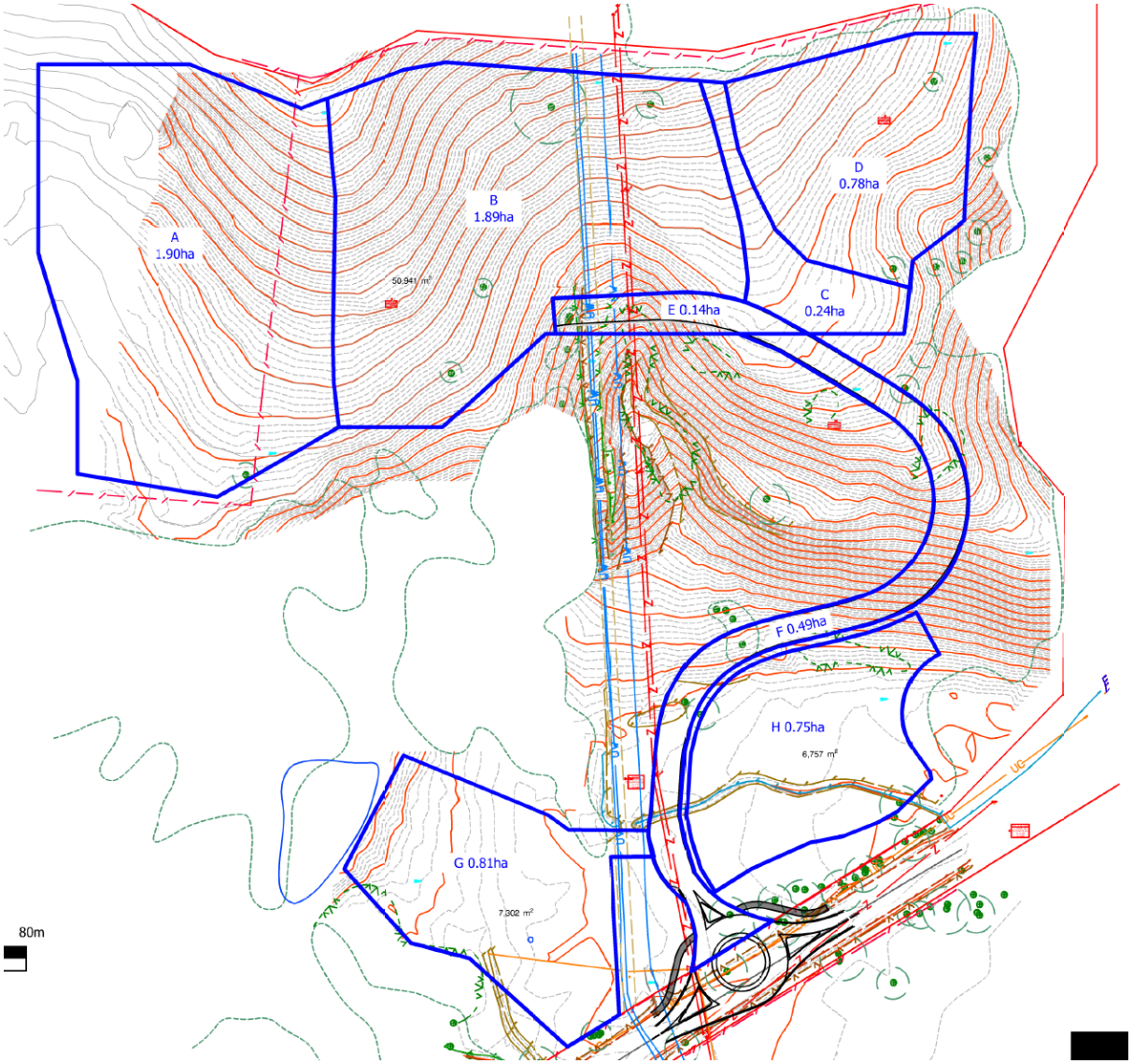


Figure 10 | Catchment plan snapshot

Table 3 | Catchment description

Parameter	Pre-development		Post-development	
	Area, ha	% impervious	Area, ha	% impervious
A	1.9	0	1.9	80
B	1.89	0	1.89	80
C	0.24	0	0.24	80
D	0.78	0	0.78	80
E	0.14	0	0.14	70
F	0.49	0	0.49	70
G	0.81	0	0.81	80
H	0.75	0	0.75	80

Table 4 | Unmitigated catchment peak discharge flow rate, m^3/s

Catchment	stage	1EY	0.2EY	10%	5%	2%	1%
A	**pre**	0.256	0.517	0.583	0.689	0.813	0.915
	post	0.442	0.697	0.799	0.914	1.06	0.116
B	**pre**	0.255	0.514	0.58	0.686	0.809	0.911
	post	0.44	0.694	0.795	0.909	1.05	0.115
C	**pre**	0.051	0.076	0.098	0.113	0.129	0.145
	post	0.059	0.096	0.115	0.132	0.157	0.177
D	**pre**	0.125	0.234	0.279	0.326	0.385	0.428
	post	0.185	0.303	0.344	0.391	0.468	0.514
E	**pre**	0.024	0.044	0.057	0.066	0.075	0.085
	post	0.032	0.053	0.066	0.075	0.089	0.1
F	**pre**	0.079	0.15	0.18	0.21	0.25	0.28
	post	0.113	0.187	0.228	0.259	0.297	0.336
G	**pre**	0.13	0.24	0.29	0.339	0.399	0.444
	post	0.192	0.314	0.335	0.404	0.484	0.532
H	**pre**	0.121	0.228	0.269	0.314	0.37	0.411
	post	0.178	0.292	0.332	0.378	0.451	0.495

Table 5 | Unmitigated catchment peak discharge timing, minutes

Catchment	stage	1EY	0.2EY	10%	5%	2%	1%
A	**pre**	40	40	15	15	10	10
	post	10	10	10	10	10	10
B	**pre**	40	40	15	15	10	10
	post	10	10	10	10	10	10
C	**pre**	10	5	15	5	5	5
	post	5	5	15	5	5	5
D	**pre**	30	10	10	10	10	10
	post	10	10	10	10	10	10
E	**pre**	10	5	15	5	5	5
	post	15	5	15	15	5	5
F	**pre**	30	10	10	10	5	5
	post	15	5	15	15	5	5
G	**pre**	30	10	10	10	10	10
	post	10	10	10	10	5	10
H	**pre**	30	10	10	10	10	10
	post	5	10	10	10	10	10

This preliminary modelling shows that the post-development runoff peaks increase in flow rate compared to the pre-development due to the increased hardstand. There is some shift in the timing of the peaks, but not sufficient to avoid coincidence with the conveyance peaks at the culverts. Therefore post-development peak-discharge when left unmitigated is likely to increase drainage issues associated with the Gulgan Road culverts. On this basis it is recommended that OSD is applied to the development to ensure post-development peak discharge the development does not exceed pre-development discharge flow rates. The details of the OSD strategy would be provided at Development Application level and would likely involve a combination of rainwater tanks and bioretention basins.

3.6. Stormwater quality and treatment

The 2014 Byron Shire DCP chapter B3, clause B3.2.3-7b states that subdivisions and developments involving an area of land greater than 2,500m^2 must address the “key” pollutants in accordance with Table B3.2 of the DCP, see Table 6.

Table 6 | Pollutants and retention criteria, *Source Byron Shire DCP 2014 Chapter B3*

Pollutant / Issue	Retention Criteria
Litter	70% of average annual load greater than 5mm.
Coarse Sediment	80% of average annual load for particles 0.5mm or less.
Fine Particles	50% of average annual load for particles 0.1mm or less.
Total Phosphorous	45% of average annual load.
Total Nitrogen	45% of average annual load.
Hydrocarbons, motor fuels, oils & grease	90% of average annual load.

There is a variety of treatment train options available for this site, including rain gardens integrated with the streetscape, bioretention basins integrated with the landscape design, proprietary treatment products, swales and stormwater pit gross pollutant traps. It is anticipated that a treatment train design will be carried out for future Development Applications for this site, to integrate with the urban and landscape design for the site.

4. WATER SUPPLY

4.1. Water supply connection point

Potable water supply is available from the reservoirs on the northern side of The Saddle Road. During preliminary discussions, Byron Shire Council have indicated they can retail the water supply to the proposed development. Due to the limited elevation difference between the more elevated areas of the BILS5 are area, there may be pumps required to ensure adequate pressure.

The reservoirs are fed by Rous water mains that traverse the site from south to north.

4.2. Water supply demand

Demand calculations are carried out in line with Byron Shire Council's 2018 Water and Sewer Equivalent Tenements Policy. It provides water ET's for various land use categories. We have selected land use categories that best approximate the intents of the Traditional Industrial zoning concept and the Business Park zoning concept. Byron Shire Council's ET policy does not provide gross hectare rates for commercial developments. We have therefore based our estimates on the Gold Coast City Plan Schedule SC3.1-3, which gives a gross EP rate of 43.7 EP per development hectare. Gold Coast City Plan water Equivalent Person (EP) is defined as 220 litres per EP per day. One EP per annum is 220 x 365 = 80,300 L/annum, which is 80.3 kL/a. The Water Directorate April 2017 defines a standard ET as an average water consumption of 230 kL/a. Thus 1 ET equates to 2.86EP. Following this method an EP rate of 43.7 becomes an ET rate of 15.28 per gross hectare.

The resulting calculations are provided in the table below. These estimates are an approximation only for preliminary planning and budgeting purposes and will be confirmed as part of future Development Applications.

Table 7 | Water ET calculations

Area	Land use category	ET rate	Area	Total ET
Traditional Industrial	Light Industrial	15 per gross hectare	1.55 hectares	23.3
Business Park	Commercial/retail	15.3 per gross hectare	4.95 hectares.	75.6
Total				**98.9**

5. SEWER RETICULATION

5.1. Proposed sewer rising main alignment

The site sewage from any development in both proposed zones would be pumped to an existing pump station in Brunswick Heads, see Figure 11. The proposed route uses the existing services corridor through the centre of the subject site, then travels along the eastern boundary until it enters the Bashforth's Lane reserve in the northeaster corner, after which it crosses the Pacific Motorway by ways of underbore. The west-to-east alignment follows an existing crown road, it then crosses the Old Pacific Highway South to then follow Bayside Way, until a suitable point is found to travel north across the sportsfields to the existing pump station in Brunswick Heads. The total length of this route is approximately 2.6km.

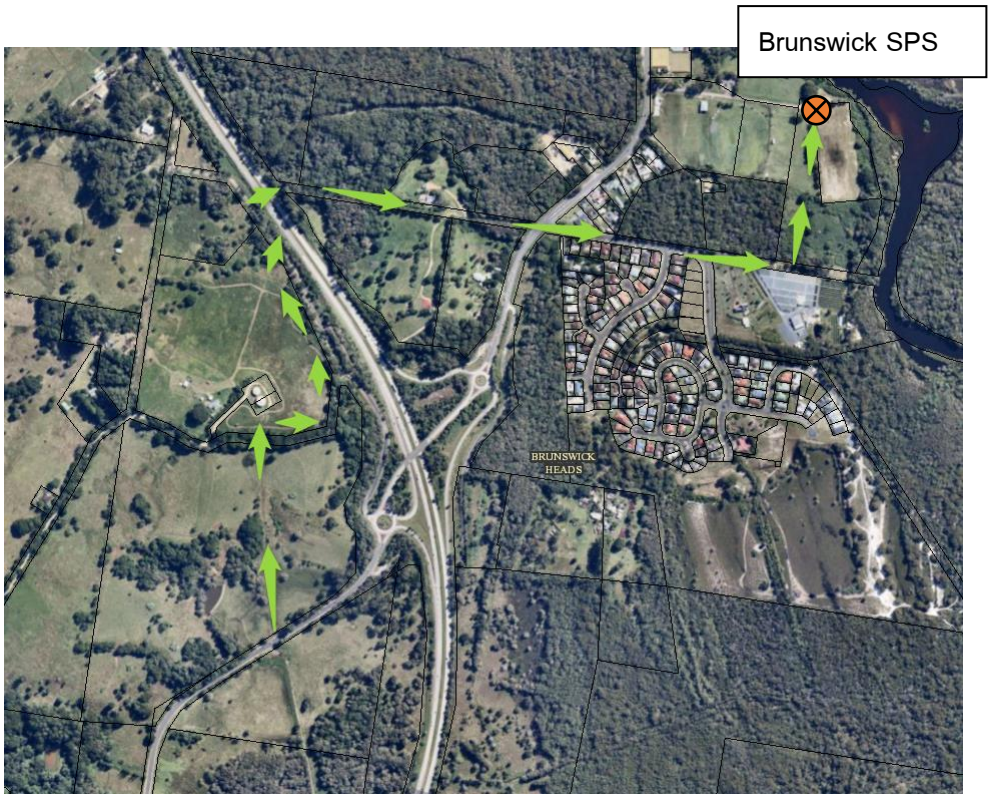


Figure 11 | Proposed pressure sewer route layout, *Source aerial photo: Byron Online Maps 2021*

5.2. Sewer demand

Demand calculations are carried out in line with Byron Shire Council's 2018 Water and Sewer Equivalent Tenements Policy. It provides water ET's for various land use categories. We have selected land use categories that best approximate the intents of the Traditional Industrial zoning concept and the Business Park zoning concept. Byron Shire Council's ET policy does not provide gross hectare rates for commercial developments. We have therefore based our estimates on the Gold Coast City Plan Schedule SC3.1-3, which gives a gross EP rate of 43.7 EP per development hectare. Gold Coast City Plan sewage Equivalent Person (EP) is defined as 140 litres per EP per day. One EP per annum is

220 x 365 = 51,100 L/annum, which is 51.1 kL/a. The Water Directorate April 2017 defines a standard ET as an average water consumption of 230 kL/a. Thus 1 ET equates to 4.50 EP. Using this method an EP rate of 43.7 becomes an ET rate of 9.71 per gross hectare.

The resulting calculations are provided in the table below. These estimates are an approximation only for preliminary planning and budgeting purposes and will be confirmed as part of future Development Applications.

Table 8 | Sewer ET calculations

Area	Land use category	ET rate	Area	Total ET
Traditional Industrial	Light Industrial	15 per gross hectare	1.55 hectares	23.3
Business Park	Commercial/retail	9.71 per gross hectare	4.95 hectares.	48.1
Total				**71.4**

6. TRAFFIC IMPACTS

A separate Traffic Impact Study has been prepared for this project. The findings are summarised in this chapter.

6.1. Proposed intersection

It is proposed to construct a new roundabout on Gulgan Road as is depicted in Figure 12. A single lane roundabout is selected as it minimises impacts on vegetation and existing services, whilst being the most efficient and safe intersction option for site access.

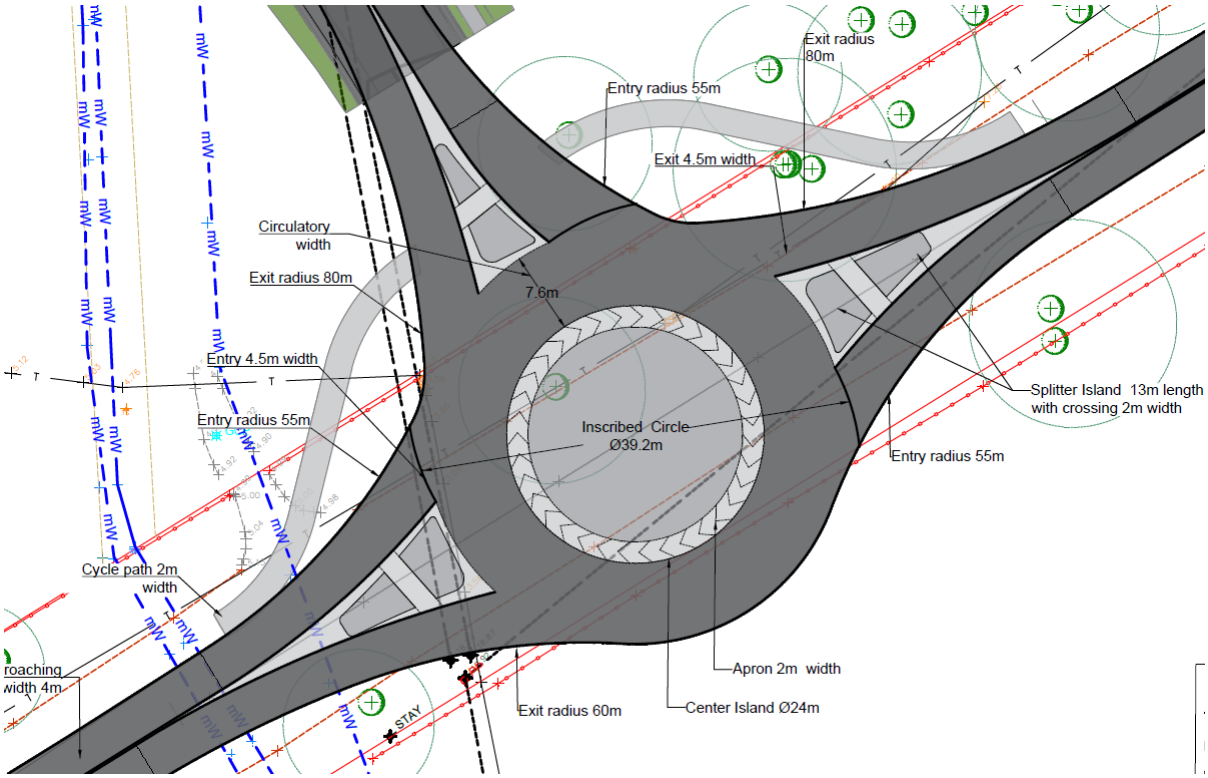


Figure 12 | Roundabout layout

6.2. Trip generation

Trip generation is estimated using traffic surveys of the Russellton Industrial Estate in Alstonville and the Manns Road Industrial Estate in Mullumbimby representing a typical ‘traditional industrial’ estate, and of Habitat in Byron, to determine a typical ‘business park’ trip generation rate. The development trip generation estimates are summarised in Table 9.

Table 9 | Development trip generation

Parameter	Traditional Industrial	Business Park	**Combined**
7-day ADT	388	3031	**3419**
AM peak hour	47.9	385	**433**
PM peak hour	44.0	331	**375**
% heavy vehicles	25%	8.7%	**10.5%**

6.3. Trip distribution

Development trip distribution is estimated using a 'gravity model'. The four main routes to and from the site are depicted in Figure 13. The resulting trip distribution per colour is:

- Red: 20.47%
- Purple: 27.84%
- Blue: 35.78%
- Green: 15.91%

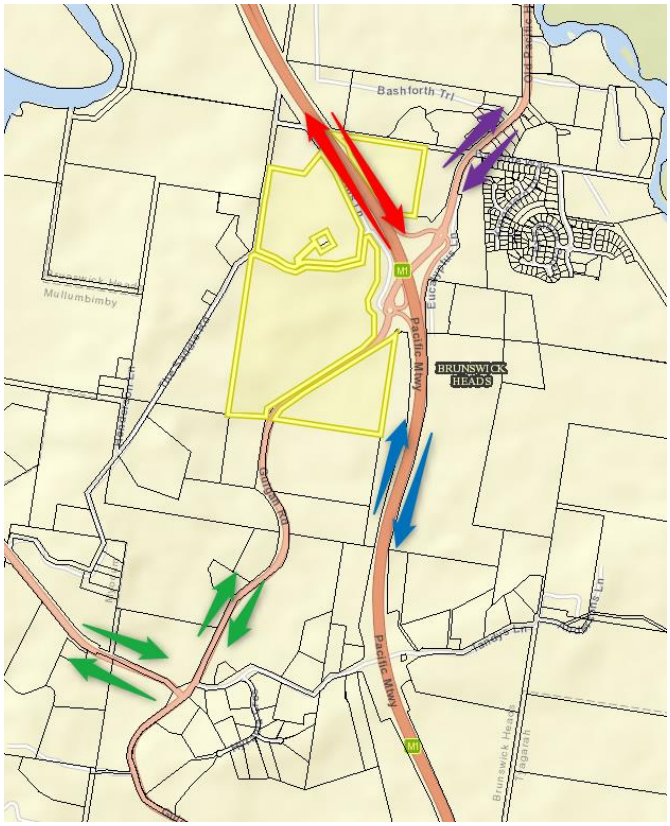


Figure 13 | Travel routes to site

This results in the following trip distribution at the site intersection:

Table 10 | Development trip distribution volumes

Parameter	Trip generation north of the site – 84.09%	Trip generation south of the site – 15.91%	Total
7-day ADT	2875	544	3419
AM peak hour	364	69	433
PM peak hour	315	60	375

6.4. Traffic impacts on road network

We have analysed three existing intersections near the subject site to determine the impact of the proposed development. The results of the SIDRA analysis of these intersections are summarised in the tables below.

Table 11 | Worst case level of service

Intersection	2021 no development	2031 no development	2031 with development
Brunswick R'bout	LOS B	LOS B	LOS B
Tandy's T-junction	LOS C	LOS D	LOS E
Mullum Rd T-junction	LOS C	LOS F	LOS F

Table 12 | Worst case 95%-ile queue length (m)

Intersection	2021 no development	2031 no development	2031 with development
Brunswick R'bout	20.6	38.4	38.8
Tandy's T-junction	3.9	10.8	12.3
Mullum Rd T-junction	38.2	587.2	656.7

Table 13 | Worst case control delay (sec)

Intersection	2021 no development	2031 no development	2031 with development
Brunswick R'bout	14.5	16.7	17.3
Tandy's T-junction	17.4	33.4	38.6
Mullum Rd T-junction	24.1	536.5	646.7

Byron Shire Council have scheduled concept development and design of conversion of the Mullumbimby Road T-junction to a roundabout for 2024/2025. If that were combined with an arrangement to remove the right turn out of Tandy's Lane, then the Level of Service issues at both intersections would be resolved. The development contribution of traffic to these intersections during peak hours is estimated at 2% to 5.5%.

7. CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis carried out in this study we conclude that the proposed development is realistic and achievable for this site.

The main findings from a civil engineering perspective are:

- Flooding and earthworks – minimum floor level for all buildings to be RL4.63m AHD, which is higher than a portion of the proposed eastern industrial area.
- Stormwater management – on-site detention should be applied to avoid worsening of existing Gulgan Road cross-drainage capacity issues. Council's water quality targets can be met by designing a treatment train that is integrated with the urban design and landscape design during Development Application stage
- Water supply – Byron Shire Council can retail potable water to the site from the existing The Saddle Road reservoirs. Demand is estimated at 99 ET.
- Sewer – Sewage is proposed to be pumped to the Brunswick Heads SPS at the sports fields. The demand is estimated at 71 ET.
- Traffic – Traffic impacts are acceptable, whoever existing capacity issues at Mullumbimby Road and Tandy's Lane are likely to be intensified due to a predicted traffic increase of approximately 2% to 5.5% during peak hours due to the subject development. These can be resolved by the construction of a roundabout at Mullumbimby Road and removal of the right turn out of Tandy's Lane in conjunction with the roundabout construction. We understand that Council have planned an upgrade of the Mullumbimby Road intersection with Gulgan Road to address these existing capacity issues.

REFERENCES

North Byron Floodplain Risk Management Study and Draft Plan, WMA Water, Sydney, October 2020

Comprehensive Guidelines for Stormwater Management, Byron Shire Council

Byron Shire Development Control Plan 2014 Chapter B3 Services

Byron Shire Development Control Plan 2014 Chapter C2 Areas Affected by Flood

Byron Shire Policy – Water and Sewer Equivalent Tenements 2018

Planning for Bushfire Protection, NSW Rural Fire Service, Granville, November 2019

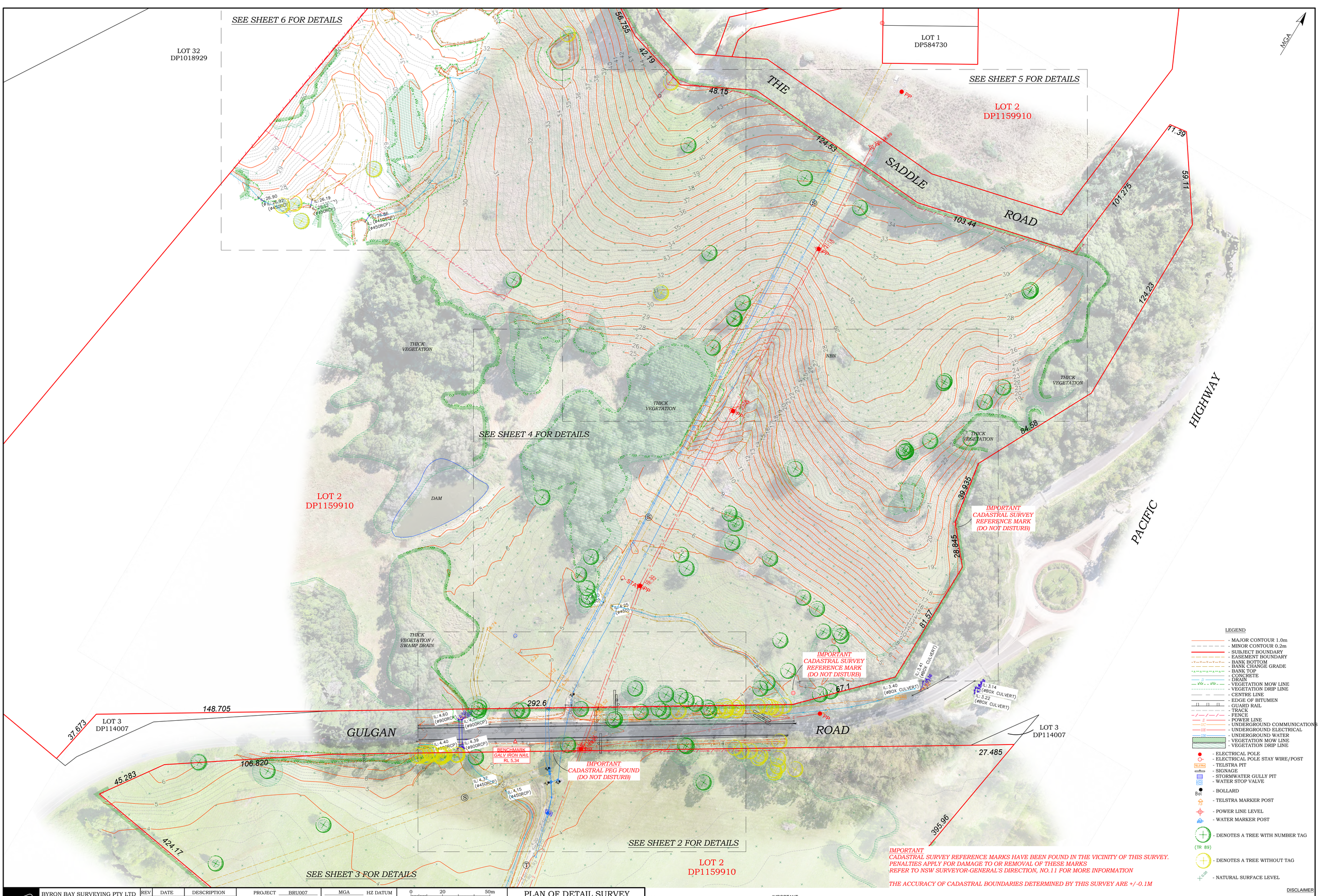
Gold Coast City Plan Schedule 3.1 Planning Assumption Tables, City of Gold Coast, 15 December 2020

Section 64 Determinations of Equivalent Tenements Guidelines, Water Directorate, Sydney, April 2017

MUSIC Modelling Guidelines, Water by design, Version 1.0, 2010

Gulgan North, Brunswick Heads, Traffic Impact Study, Ingen Consulting, Alstonville, 22nd December 2021

APPENDIX A – DETAIL SURVEY



IMPORTANT
CADASTRAL SURVEY REFERENCE MARKS HAVE BEEN FOUND IN THE VICINITY OF THIS SURVEY.
PENALTIES APPLY FOR DAMAGE TO OR REMOVAL OF THESE MARKS
REFER TO NSW SURVEYOR-GENERAL'S DIRECTION, NO.11 FOR MORE INFORMATION

THE ACCURACY OF CADASTRAL BOUNDARIES DETERMINED BY THIS SURVEY ARE +/-0.1M

LEGEND

- MAJOR CONTOUR 1.0m
- MINOR CONTOUR 0.2m
- SUBJECT BOUNDARY
- EASEMENT BOUNDARY
- BANK BOTTOM
- BANK CHANGE GRADE
- BANK TOP
- CONCRETE
- DRAIN
- VEGETATION MOW LINE
- VEGETATION DRIP LINE
- CENTRE LINE
- EDGE OF BITUMEN
- GUARD RAIL
- TRACK
- FENCE
- POWER LINE
- UNDERGROUND COMMUNICATIONS
- UNDERGROUND ELECTRICAL
- UNDERGROUND WATER
- VEGETATION MOW LINE
- VEGETATION DRIP LINE
- ELECTRICAL POLE
- ELECTRICAL POLE STAY WIRE/POST
- TELSTRA PIT
- SIGNAGE
- STORMWATER GULLY PIT
- WATER STOP VALVE
- BOLLARD
- TELSTRA MARKER POST
- POWER LINE LEVEL
- WATER MARKER POST
- DENOTES A TREE WITH NUMBER TAG (TR 89)
- DENOTES A TREE WITHOUT TAG
- NATURAL SURFACE LEVEL

DISCLAIMER

BOUNDARIES HAVE BEEN INVESTIGATED (NOT MARKED) IN ACCORDANCE WITH THE PROVISIONS OF THE SURVEYING & SPATIAL INFORMATION ACT, 2017 AND ARE BASED ON THE LATEST SURVEY RECORDS AVAILABLE FROM LAND REGISTRY AT THE TIME OF SURVEY. NO RESPONSIBILITY CAN BE TAKEN FOR SURVEYS AT A LATER DATE WHICH MAY VARY BOUNDARY DIMENSIONS. ANY EASEMENTS WHETHER REGISTERED OR IMPLIED HAVE NOT BEEN INVESTIGATED. THE POSITIONAL ACCURACY OF ANY CRITICAL FEATURE REQUIRES CONFIRMATION PRIOR TO ITS USE IN DESIGN OR CONSTRUCTION. UNDERGROUND SERVICES HAVE NOT BEEN INVESTIGATED. CONSULT WITH "DIAL BEFORE YOU DIG" PRIOR TO ANY EXCAVATION WORKS.

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REV	DATE	DESCRIPTION
01	29/04/2021	ORIGINAL ISSUE
02	24/05/2021	DETAILS ADDED
03	18/10/2021	DETAILS ADDED
04	26/11/2021	DETAILS ADDED

PROJECT	BRU007
SURVEYOR	LF & DH
SURVEY DATE	16/11/2021
FIELD BOOK ID	TSC3#2
PLAN BY	DH
APPROVED BY	LF

MGA	HZ DATUM
GNSS CORS	ORIGIN
AHD	VT DATUM
SSM84987	ORIGIN
5.026	LEVEL
22/04/2021	SCIMS

0 20 50m
1:1000 - A1

IMPORTANT NOTICE:
THIS PLAN MAY HAVE BEEN CHANGED DURING PRINTING OR REFORMATTING. THE SCALE SHOULD THEREFORE BE VERIFIED PRIOR TO USE. ANY DIMENSIONS SHOWN ON THIS PLAN OVERRULE SCALING.

PLAN OF DETAIL SURVEY
PART OF GULGAN ROAD

LOT 2 IN DP1159910
66 THE SADDLE RD
BRUNSWICK HDS 2483

CLIENT: INGEN CONSULTING
DWG No: BRU007_4.DWG
SH: 1 OF 7

(S) - H395977 EASEMENT FOR WATER PIPELINE 5.03 WIDE (DP445893)
(T) - Y943604 EASEMENT FOR WATER PIPELINE 5.03 WIDE (DP642319)

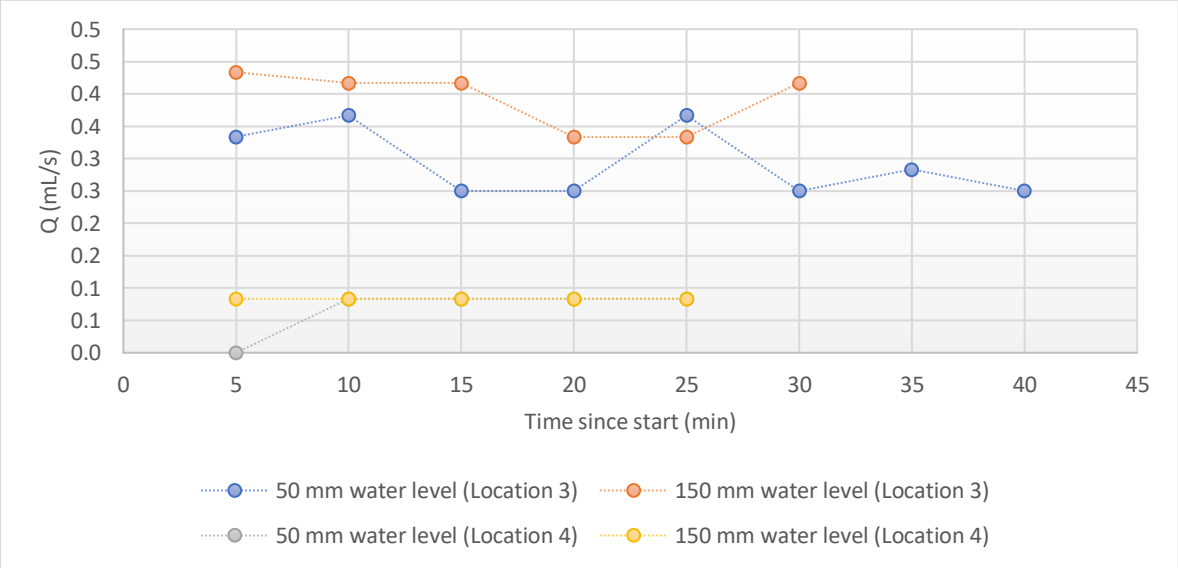
IMPORTANT
UNDERGROUND SERVICES SHOWN HAVE ONLY BEEN LOCATED TO QUALITY LEVEL C DUE TO INFRASTRUCTURE COMPOSITION (GROUND PENETRATING RADAR HAS BEEN UTILISED). POTHOLING IS ESSENTIAL FOR ACCURATE LOCATING AND DEPTHING OF ALL SERVICES SHOWN. ONLY SERVICES IDENTIFIED FROM DBYD RECORDS HAVE BEEN INVESTIGATED, OTHERS MAY EXIST THAT HAVE NOT BEEN LOCATED.

APPENDIX B – INFILTRATION TEST REPORTS

Document title: RING INFILTRATION TEST
Document number: J1143_IR
Author: Jordy Nasario da Silva, *BEng, AdvDipMgt.*
Client Name: Gulgan North Property Pty Ltd
Client's representative: Steve Connelly
Project Number: J1143
Data Issued: 27/04/2021
Number of Locations: 4 (refer to map below)
Hydraulic Conductivity (K) =

1. **Location 1 = 0 mm/h**
2. **Location 2 = 0 mm/h**
3. **Location 3 = 35 mm/h**
4. **Location 4 = 6 mm/h**

Location 3						**Location 4**					
Constant water level = 50 mm			**Constant water level = 150 mm**			**Constant water level = 50 mm**			**Constant water level = 150 mm**		
time (min)	Volume (mL)	Q (mL/s)	time (min)	Volume (mL)	Q (mL/s)	time (min)	Volume (mL)	Q (mL/s)	time (min)	Volume (mL)	Q (mL/s)
5	100	0.33	5	130	0.43	5	0	0.00	5	25	0.08
10	110	0.37	10	125	0.42	10	25	0.08	10	25	0.08
15	75	0.25	15	125	0.42	15	25	0.08	15	25	0.08
20	75	0.25	20	100	0.33	20	25	0.08	20	25	0.08
25	110	0.37	25	100	0.33	25	25	0.08	25	25	0.08
30	75	0.25	30	125	0.42	**AVERAGE LAST 5**		**0.07**	**AVERAGE LAST 5**		**0.08**
35	85	0.28	**AVERAGE LAST 6**		**0.39**						
40	75	0.25									
AVERAGE LAST 8		**0.29**									



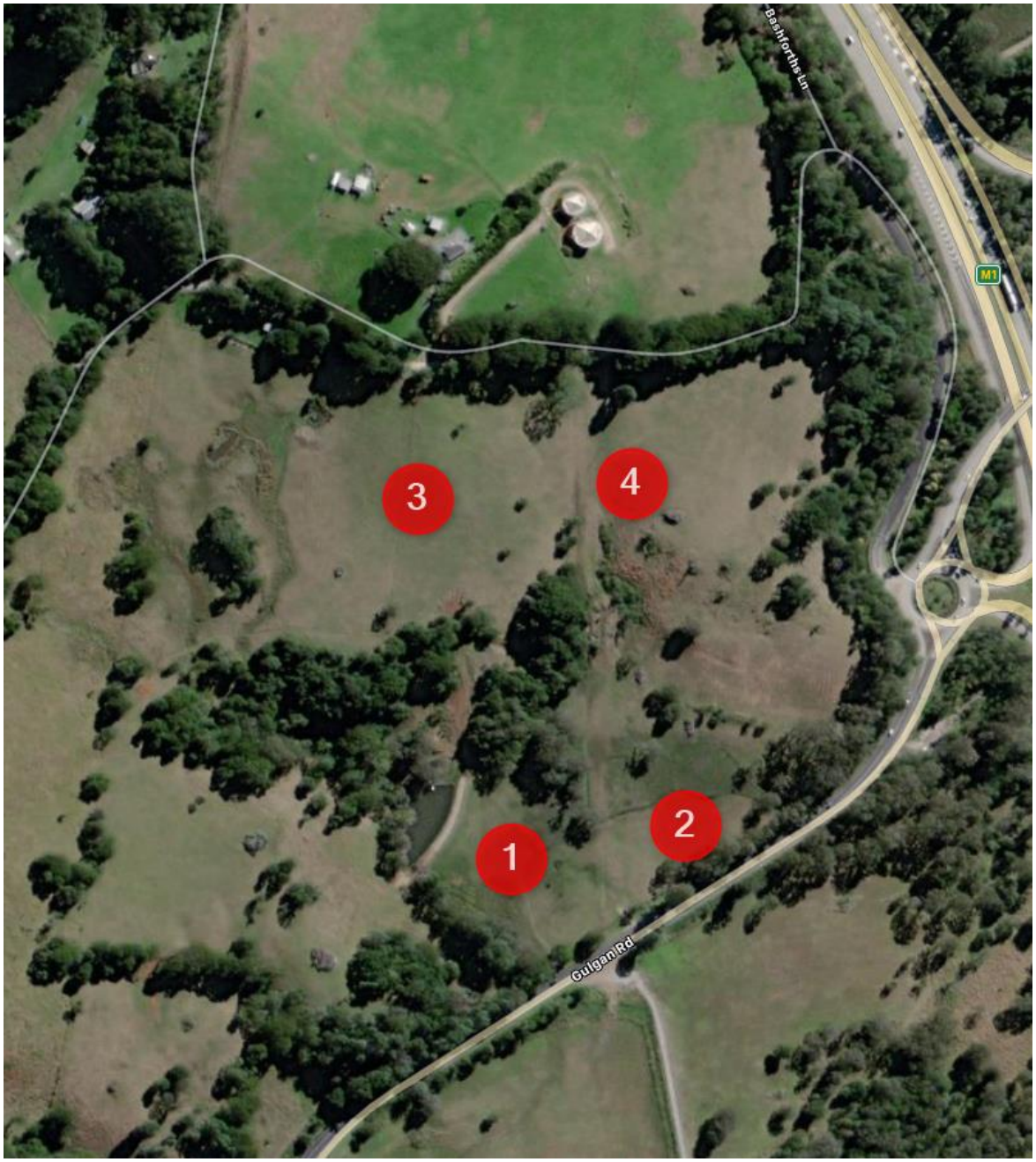


Figure 1 | Sampling locations