Order conferring biodiversity certification – Port Macquarie Airport and surrounding lands

Under section 126H of the *Threatened Species Conservation Act 1995*

Under section 126H of the *Threatened Species Conservation Act 1995*, I, Anthony Lean, Chief Executive of the Office of Environment and Heritage, as delegate of the Minister for the Environment, confer biodiversity certification on the specified land.

Under section 126L of the Act, I have determined that the adoption of a plan of management for vegetation in the "tree removal zone" within the specified land is a conservation measure for the purposes of the Act.

Under section 126P of the Act I have determined on the basis of a biodiversity certification assessment that the overall effect of biodiversity certification is to improve or maintain biodiversity values.

Under section 126Y of the Act, I specify the measures listed in Schedule 5 as approved measures under this biodiversity certification.

Under section 126Z of the Act, I identify the parties listed in Schedule 6 as parties to the biodiversity certification.

Under section 126ZA of the Act, biodiversity certification of the specified land takes effect from the date of publication of this Order in the Government Gazette and remains in force indefinitely.

Definitions

In this Order:

(a) "**Act**" means the *Threatened Species Conservation Act 1995* (NSW), as in force immediately prior to its repeal, and which continues to apply pursuant to the *Biodiversity Conservation (Savings and Transitional) Regulation 2017* (NSW);

(b) "**biodiversity certification agreement**" means the biodiversity certification agreement between the Port Macquarie—Hastings Council and the Minister administering the Act;

(c) "**biodiversity certification assessment**" means the *Port Macquarie Airport Master Plan and Port Macquarie - Hastings Council owned land within the Thrumster Area 13 Urban Release Area: Biodiversity Certification Assessment Report & Biodiversity Certification Strategy—Application to Minister'* prepared by Eco Logical Australia Pty Ltd and dated 24 October 2016;

(d) "**biodiversity conservation land**" means the land identified as the "proposed offset" in the map at Schedule 3;

(e) "**conservation measure**" has the same meaning as in section 126L of the Act;

(f) "**Council**" means Port Macquarie—Hastings Council, ABN 112 369 016 01;

(g) "**specified land**":

  (i) means the land described in Schedule 1 to this Order and marked as "Land to be certified" on the map in Schedule 2; and

  (ii) includes internal unformed roads but excludes all Crown land, including any Crown public roads.

(h) "**tree removal zone**" within the specified land means the land shown in the map at Schedule 4 as the "tree removal zone".

ANTHONY LEAN
Chief Executive, Office of Environment and Heritage
As delegate of the Minister for the Environment

Signed at Sydney, this 9th day of August 2018

Schedule 1 Description of the specified land

Lot Number	Plan number*
0	SP10135
D	20508
C	20508
B	20508
5	38134
5	38135
1	38331
657	45949
Part 4	115306
1	241486
3	241486
1	242345
3	247687
4	247687
30	263203
2	517680
1	517680
2	547484
3	552051
2	552051
1	552051
Part 3	565437
2	574816
4	613304
2	619643
3	619643
1	707988
1	709926
693	729765
147	754434
Part 206	754434
335	754434

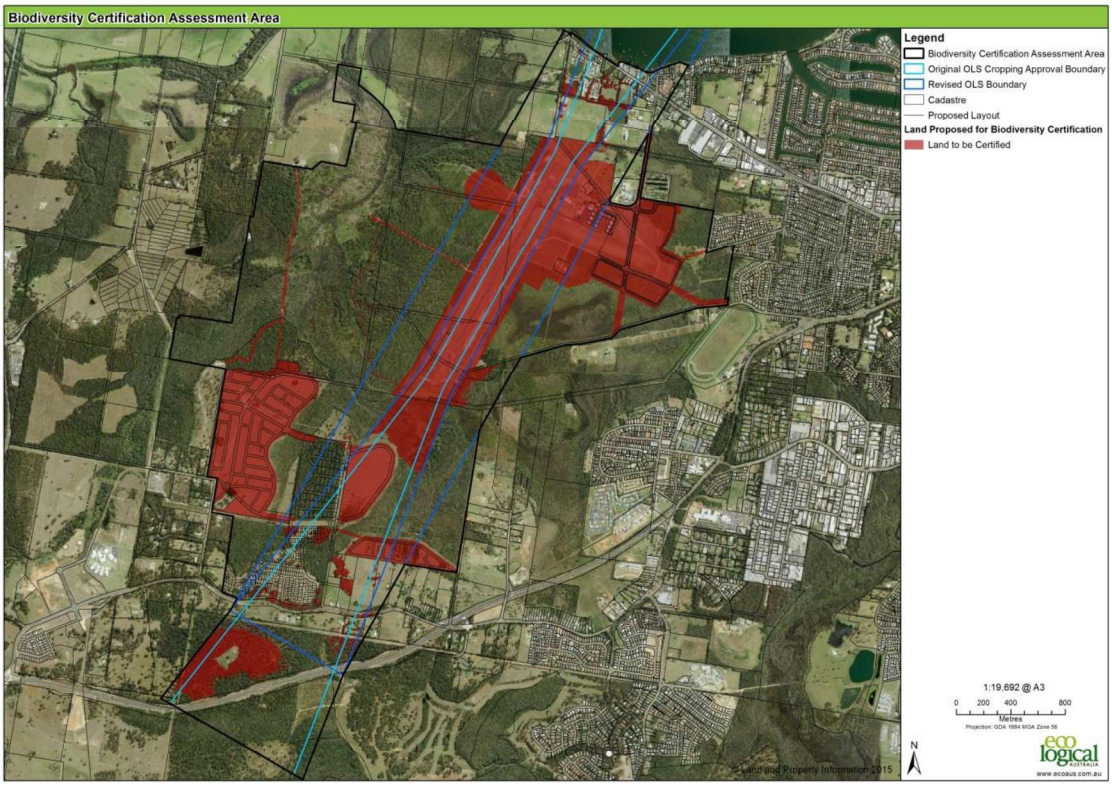
Part 238	754434
Part 239	754434
132	754434
3	805588
4	805588
5	805588
7	805588
8	805588
10	805588
15	805588
11	808496
14	813358
13	813358
12	813358
11	813358
10	813358
9	813358
8	813358
7	813358
6	813358
5	813358
3	813358
1	827134
16	848479
15	848479
11	849051
12	849051
5	871267
6	871267
22	877448
Part 2	1025083
Part 1	1025083
Part 1	1034982
1	1071193
2	1071193
2	1075873

1	1075873
Part 1	1087368
41	1094314
Part 25	1123026
24	1123026
103	1127168
Part 14	1139180
121	1156615
2	1172154
104	1173567
102	1181696
7325	1184893
298	1234443
10	1193465

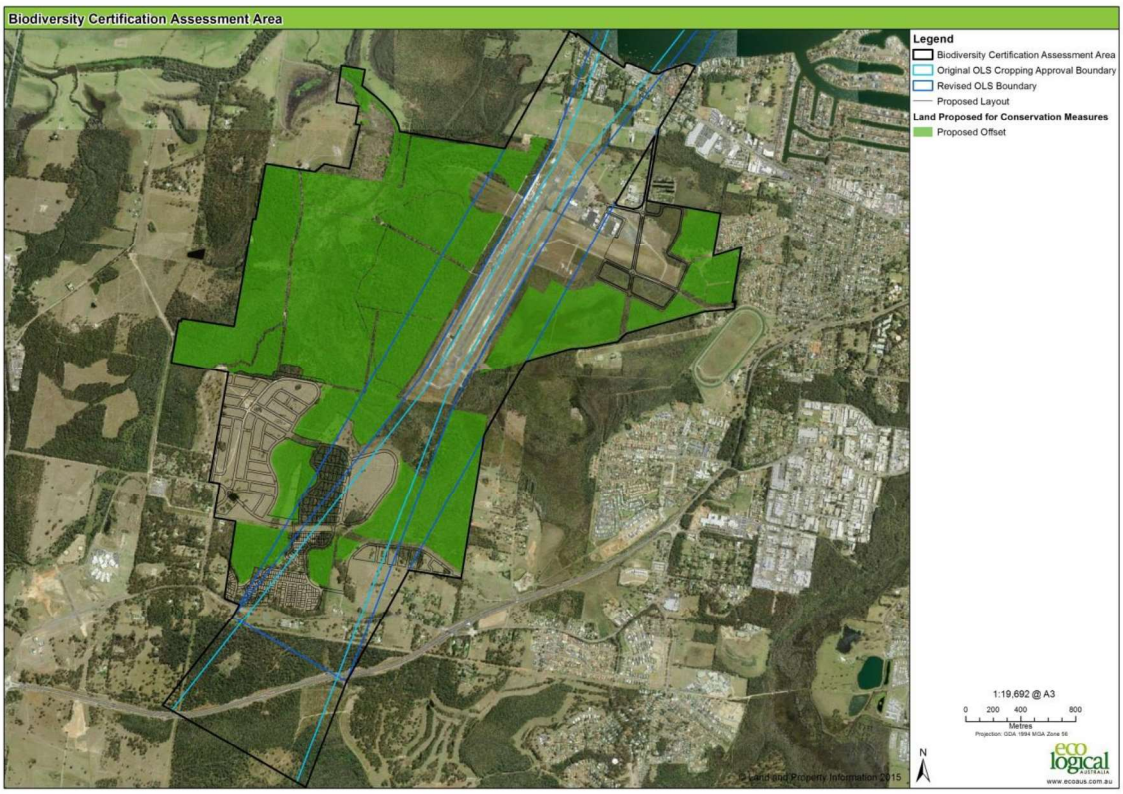
* Plan numbers are references to Deposited Plans unless otherwise indicated.

Note: The extent of the Biodiversity Certification Land is more precisely defined in the geographic information system (GIS) shape files submitted on behalf of the Planning Authority.

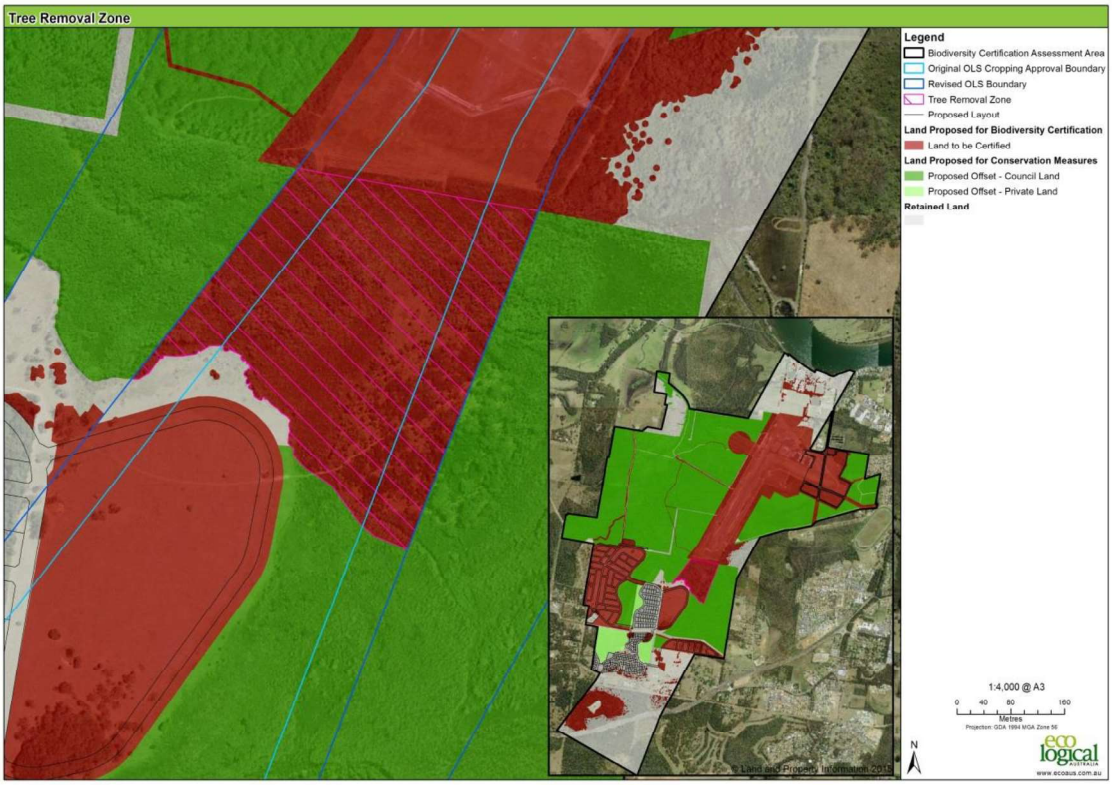
Schedule 2 Map of the specified land



Schedule 3 Map of the biodiversity conservation land



Schedule 4 Map of the tree removal zone within the specified land



Schedule 5 Approved measures

The approved measures under this Order are as follows:

Proposed conservation measures

1. The entering into of a Biobanking agreement between the Council and the Minister Administering the Act under Part 7A of the Act, over the biodiversity conservation land shown in Schedule 3 consistent with the terms specified in the biodiversity certification agreement.

2. The retirement of all credits (including surplus credits) created on the biodiversity conservation land shown in Schedule 3 under the Biobanking agreement referred to in clause 1 of this Schedule.

3. The retirement by the Council of **452** Blackbutt – Tallowwood ecosystem biodiversity credits and **323** Koala species biodiversity credits created on land other than land the subject of this Order consistent with the terms specified in the biodiversity certification agreement.

4. The adoption of a vegetation management plan by the Council in relation to that portion of the specified land shown in Schedule 4 consistent with the terms specified in the biodiversity certification agreement.

Requirements as to the timing of the implementation of the proposed conservation measures

5. An application for a Biobanking agreement for the biodiversity conservation land referred to in clause 1 of this Schedule must be submitted by the Council to OEH within 12 months of the date that this Order takes effect.

6. The Biobanking agreement referred to in clause 1 of this Schedule must be entered into within 12 months of the date of lodgement of the application for the Biobanking agreement.

7. The biodiversity credits referred to in clause 3 of this Schedule must be retired by the Council within seven (7) years of the date this Order takes effect.

8. The vegetation management plan referred to in clause 4 of this Schedule, must be adopted and implemented by the Council within 12 months of the date this Order takes effect.

Schedule 6 Parties to the biodiversity certification

Council

[n2018-2934]

All communications to be addressed to:

Headquarters
15 Carter Street
Lidcombe NSW 2141

Telephone: 1300 NSW RFS
e-mail: records@rfs.nsw.gov.au

Headquarters
Locked Bag 17
Granville NSW 2142

Facsimile: 8741 5433

The General Manager
Port Macquarie-Hastings Council
PO Box 84
PORT MACQUARIE NSW 2444

Your Ref: 2017/675
Our Ref: D17/2941
DA17083008996 PC

ATTENTION: Chris Gardiner

31 July 2018

Dear Mr Gardiner

Integrated Development Application - 1//1087368 & 2//1172154 - Thrumster Street Thrumster

I refer to your correspondence dated 24 May 2018 seeking general terms of approval for the above Integrated Development Application.

The New South Wales Rural Fire Service (NSW RFS) has considered the information submitted. General Terms of Approval, under Division 4.8 of the 'Environmental Planning and Assessment Act 1979', and a Bush Fire Safety Authority, under Section 100B of the 'Rural Fires Act 1997', are now issued subject to the following conditions:

Asset Protection Zones

The intent of measures is to provide sufficient space and maintain reduced fuel loads so as to ensure radiant heat levels of buildings are below critical limits and to prevent direct flame contact with a building. To achieve this, the following conditions shall apply:

1. At the issue of subdivision certificate for each stage and in perpetuity, the newly created lots shall be managed as an inner protection area (IPA) as outlined within section 4.1.3 and Appendix 5 of 'Planning for Bush Fire Protection 2006' and the NSW Rural Fire Service's document 'Standards for asset protection zones'.
2. The full width of the perimeter road reserves, including the access to Lot 2 DP 1224314 adjacent to Lot 829, shall be managed as an inner protection area (IPA) as outlined within section 4.1.3 and Appendix 5 of 'Planning for Bush Fire Protection 2006' and the NSW Rural Fire Service's document 'Standards for asset protection zones'.

3. The proposed parklands shall be managed as an inner protection area (IPA) as outlined within section 4.1.3 and Appendix 5 of 'Planning for Bush Fire Protection 2006' and the NSW Rural Fire Service's document 'Standards for asset protection zones'.

4. A restriction to the land use pursuant to section 88B of the 'Conveyancing Act 1919' shall be placed over part of Lot 1 DP 1087368 to ensure the provision of a 33 metre wide asset protection zone (APZ) to the north of Stage 8. The APZ shall be managed as outlined within section 4.1.3 and Appendix 5 of 'Planning for Bush Fire Protection 2006' and the NSW Rural Fire Service's document 'Standards for asset protection zones'.

5. A restriction to the land use pursuant to section 88B of the Conveyancing Act 1919 shall be placed over the following lots to prohibit the construction of a dwelling, or Class 10 building within 10m of a dwelling, on the subject area:

   • Lot 829 for a distance of 13 metres from the northern boundary; and

   • Lot 101 and Lot 104 for a distance of 20 metres from the western boundary.

6. A temporary restriction to the land use pursuant to section 88B of the Conveyancing Act 1919 shall be placed over the following lots to prohibit the construction of a dwelling, or Class 10 building within 10m of a dwelling, on the subject area. The temporary restriction to use may be extinguished upon commencement of development over the adjacent land as indicated:

   • Lot 106 and Lots 1012 to 1017 for a distance of 9 metres from the western boundary until construction of the road to the west occurs; and

   • Lots 824 to 829, Lots 901 to 908, Lots 921 to 932 and Lots 1018 to 1020 for a distance of 9 metres from the western boundary until development of the land to the west occurs.

7. A restriction to the land use pursuant to section 88B of the 'Conveyancing Act 1919' shall be placed on the residue lot around each stage for the purpose of a 50 metre wide temporary asset protection zone as indicated on the diagram titled ‘APZ Staging Plan’ prepared by MJM Consulting Engineers (Ref: 160059, Sheet No. 24, Issue C) dated 23 July 2018. The asset protection zone shall be managed as an IPA as outlined within section 4.1.3 and Appendix 5 of 'Planning for Bush Fire Protection 2006' and the NSW Rural Fire Service's document 'Standards for asset protection zones'. The restriction to land use may be extinguished upon commencement of the approved development over the affected areas.

Water and Utilities

The intent of measures is to provide adequate services of water for the protection of buildings during and after the passage of a bush fire, and to locate gas and electricity so as not to contribute to the risk of fire to a building. To achieve this, the following conditions shall apply:

8. Water, electricity and gas are to comply with section 4.1.3 of 'Planning for Bush Fire Protection 2006'.

Access

The intent of measures for public roads is to provide safe operational access to structures and water supply for emergency services, while residents are seeking to evacuate from an area. To achieve this, the following conditions shall apply:

9. Public road access shall comply with section 4.1.3 (1) of 'Planning for Bush Fire Protection 2006'.

Landscaping

10. Landscaping to the site is to comply with the principles of Appendix 5 of 'Planning for Bush Fire Protection 2006'.

General Advice – consent authority to note

Any future development application lodged within this subdivision under section 79BA of the 'Environmental Planning & Assessment Act 1979' will be subject to requirements as set out in 'Planning for Bush Fire Protection 2006'.

This Bush Fire Safety Authority, issued under s.100B of the Rural Fires Act 1997, relates to the subdivision layout indicated on the diagram titled ‘Overall Layout Plan’ prepared by MJM Consulting Engineers (Project No. 160059, Sheet 2, Issue L), dated 23 July 2018.

This letter is in response to a further assessment of the application submitted and supersedes our previous general terms of approval dated 4 January 2018.

Should you wish to discuss this matter please contact Paul Creenaune on 1300 NSW RFS.

Yours sincerely

Alan Bawden
Team Leader - Development Assessment & Planning

For general information on bush fire protection please visit www.rfs.nsw.gov.au

Department of Primary Industries
Water

Contact: JORDAN GIBSON - JGIBSON
Phone: 02 6641 6523
Email: jordan.gibson@dpi.nsw.gov.au

Our ref: IDAS1105000
Our file: IDAS1101282
Your ref: 2017/675

General Manager
Hastings Council
PO Box 84
PORT MACQUARIE NSW 2444

Attention: Chris Gardiner

13 February 2018

Dear Sir/Madam

Re: Integrated Development Referral – General Terms of Approval
Dev Ref: 2017/675
Description: 507 Lot Subdivision
Location: Thrumster Street THRUMSTER

I refer to your recent letter regarding an integrated Development Application (DA) proposed for the above location. Attached, please find DPI Water's General Terms of Approval (GTA) for part of the proposed development requiring a Controlled Activity approval under the *Water Management Act 2000* (WM Act), as detailed in the subject DA.

Please note Council's statutory obligations under section 91A (3) of the *Environmental Planning and Assessment Act 1979* (EPA Act) which requires a consent, granted by a consent authority, to be consistent with the general terms of any approval proposed to be granted by the approval body.

If the proposed development is approved by Council, DPI Water requests these GTA be included (in their entirety) in Council's development consent. Please also note DPI Water requests notification:

- if any plans or documents are amended and these amendments significantly change the proposed development or result in additional works or activities (i) in the bed of any river, lake or estuary; (ii) on the banks of any river lake or estuary, (iii) on land within 40 metres of the highest bank of a river lake or estuary; or (iv) any excavation which interferes with an aquifer.

  DPI Water will ascertain from the notification if the amended plans require review of or variation/s to the GTA. This requirement applies even if the amendment is part of Council's proposed consent conditions and do not appear in the original documentation.

- if Council receives an application under s96 of the EPA Act to modify the development consent and the modifications change the proposed work or activities described in the original DA.
- of any legal challenge to the consent.

As the proposed work or activity cannot commence before the applicant applies for and obtains an approval, DPI Water recommends the following condition be included in the development consent:

The attached GTA issued by DPI Water do not constitute an approval under the *Water Management Act 2000*. The development consent holder must apply to DPI Water for a Controlled Activity approval **after consent** has been issued by Council **and before** the commencement of any work or activity.

A completed application form must be submitted to DPI Water together with any required plans, documents, application fee, security deposit or bank guarantee (if required) and proof of Council's development consent. Finalisation of an approval can take up to eight (8) weeks from the date the application and all required supporting documentation is received.

Application forms are available from the DPI Water website at:
www.water.nsw.gov.au » Water licensing » Approvals.

DPI Water requests that Council provide a copy of this letter to the development consent holder.

DPI Water also requests a copy of the determination for this development application be provided by Council as required under section 91A (6) of the EPA Act.

Yours Sincerely

per 

Patrick Pahlow - PPAHLOW
Water Regulation Officer
Water Regulatory Operations
NSW Department of Primary Industries – Water

Department of Primary Industries
Water

General Terms of Approval

for proposed development requiring approval under s89, 90 or 91 of the Water Management Act 2000

Reference Number:	IDAS1105000
Issue date of GTA:	13 February 2018
Type of Approval:	Controlled Activity
Description:	507 Lot Subdivision
Location of work/activity:	Thrumster Street THRUMSTER
DA Number:	2017/675
LGA:	Hastings Council
Water Sharing Plan Area:	NORTH COAST FRACTURED AND POROUS ROCK GROUNDWATER SOURCES 2016

The GTA issued by DPI Water do not constitute an approval under the *Water Management Act 2000*. The development consent holder must apply to DPI Water for the relevant approval **after development consent** has been issued by Council **and before** the commencement of any work or activity.

Condition Number	Details
	Design of works and structures
GT0009-00004	Before commencing any proposed controlled activity on waterfront land, an application must be submitted to Crown Lands and Water Division, and obtained, for a controlled activity approval under the Water Management Act 2000.
GT0013-00001	A. Any proposed controlled activity carried out under a controlled activity approval must be directly supervised by a suitably qualified person. B. A copy of this approval must be: i. kept at the site where the controlled activity is taking place, and ii. provided to all personnel working on the controlled activity.
	Erosion and sediment controls
GT0014-00003	A. The consent holder must ensure that any proposed materials or cleared vegetation, which may: i. obstruct water flow, or ii. wash into the water body, or iii. cause damage to river banks, are not stored on waterfront land, unless in accordance with a plan held by Crown Lands and Water Division as part of a controlled activity approval. B. When the carrying out of the controlled activity has been completed, surplus materials must be removed from waterfront land.
GT0022-00003	During the time the proposed controlled activity is taking place or being constructed, restrictions must be imposed by Crown Lands and Water Division, such as: A. machinery must not enter the water course at anytime, B. there must be a minimum flow in the water course.
	Plans, standards and guidelines
GT0002-00152	A. This General Terms of Approval (GTA) only applies to the proposed controlled activity described in the plans and associated documents found in Schedule 1, relating to Development Application 2017.675 provided by Council to Crown Lands and Water Division. B. Any amendments or modifications to the proposed controlled activity may render the GTA invalid. If the proposed controlled activity is amended or modified, Crown Lands and Water Division, Grafton Office, must be notified in writing to determine if any variations to the GTA will be required.
	Reporting requirements
GT0016-00002	The consent holder must inform Crown Lands and Water Division in writing when any proposed controlled activity carried out under a controlled activity approval has been completed.

SCHEDULE 1

The plans and associated documentation listed in this schedule are referred to in general terms of approval (GTA) issued by DPI Water for integrated development associated with 2017/675 as provided by Council:

- Statement of Environmental Effects prepared by MJM Consulting Engineers, dated August 2017
- Overall Layout Plan prepared by MJM Consulting Engineers, dated June 2016 (Drawing No: 160059-C2, Issue: I)
- Vegetation / Koala Habitat Plan prepared by MJM Consulting Engineers dated June 2016 (Drawing No: 160059-C9, Issue: F)
- Concept Catchment Plan prepared by MJM Consulting Engineers dated June 2016 (Drawing No: 160059-C12, Issue: G)
- Environmental Management Plan prepared by MJM Consulting Engineers, dated November 2016 (Drawing No: 160059-C18, Issue: F)
- Culvert Design prepared by MJM Consulting Engineers dated December 2016 (Drawing No: 160059-C20, Issue: E)
- Acid Sulfate Soil Plan prepared by MJM Consulting Engineers. dated June 2016 (Drawing No: 160059-C22, Issue: E)
- Stormwater Management Plan prepared by MJM Consulting Engineers, dated August 2017 (Rev 2)

NATURECALL ENVIRONMENTAL

Statutory Ecological Assessment

Project:

Residential Subdivision of Lot 1 DP1087368 and Lot 2 DP 1172154, Thrumster Street, Thrumster

Client:

Port Macquarie – Hastings Council
C/- MJM Consulting Engineers

August 2017

Document Status

Version	Purpose	Author	Reviewed By	Approved By	Date
Rev 1.0	Draft	Will Steggall / Karl Robertson	Will Steggall		22/07/2017
Rev 2.0	Final	Will Steggall	Christopher Doig	Christopher Doig	17/08/2017

Document Control

Copy No.	Date	Type/Via	Issued to	Name	Purpose
1	22/07/2017	Electronic/ Email	Naturecall Environmental	Elspeth Thorpe	File Copy
2	22/07/2017	Electronic/ Email	MJM Consulting	Stephanie Anderson	Client Review
3	17/08/2017	Electronic/ Email	Naturecall Environmental	Elspeth Thorpe	File Copy
4	17/08/2017	Electronic/ Email	MJM Consulting	Stephanie Anderson	Client Copy

Project Number: EC1417

Our Document Reference: EC1417-BEC-REP-PartridgeCreekSubdivision_SEA-rev2.0

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Executive Summary

The site was assessed in accordance with the requirements of Section 5A of the *Environment Planning and Assessment Act 1979*, as amended by *the Threatened Species Conservation* (TSCA) *Act 1995*, the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBCA) *Act 1999* - Matters of National Environmental Significance and the Area 13 UIA, Koala Plan of Management (KPoM). Assessment of the relevant provisions for Koala food trees, hollow-bearing trees and Endangered Ecological Communities under the PMHC DCP 2013 is also provided.

In summary:

- One threatened flora species, the Slender Screw Fern (*Lindsaea incisa*) was detected within the study area.
- One Endangered Ecological Community is present within the study area which comprises Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- Five threatened fauna species were recorded during the survey – the Koala, Eastern Osprey, Grey-headed Flying-fox, Little Lorikeet and Powerful Owl.
- The site falls within the Area 13 KPoM and has mapped areas of Core and Potential Koala Habitat, however site surveys only found low Koala activity on site.
- A total of 17 threatened fauna species and several migratory birds were found to have at least a low potential to occur within the study area.
- Assessment under the Seven Part Tests determined that the impact, while a generic negative effect in terms of incremental loss of habitat, is unlikely to be of sufficient order of magnitude to have a significant impact. Hence a Species Impact Statement is not considered required.
- Assessment under the EPBCA – Matters of National Environmental Significance determined the cumulative impact to be negative however this is unlikely to be significant - therefore referral to DEE for approval is not considered required.
- The proposal can comply the with the PMHC DCP 2013 via installing nest boxes and planting of offset Koala food trees managed under a VMP.

1.0 Introduction

Biodiversity Australia Pty Ltd Trading as Naturecall Environmental has been commissioned to undertake the required Statutory Ecological Assessments (SEA) for a proposed residential subdivision on Lot 1 DP1087368 and Lot 2 DP 1172154, Thrumster Street, Thrumster. This assessment will form part of the Development Application to be submitted to the Joint Regional Planning Panel (JRPP).

The survey and assessment was performed in consideration of the draft *Threatened Species Survey and Assessment – Guidelines for Developments and Activities* (DEC 2004), and the *Threatened Species Assessment Guidelines – Assessment of Significance* (DECC 2007). The assessment has also been undertaken in accordance with the Ecological Consultants Association of NSW – *Code of Ethics* (2002) available at www.ecansw.org.au.

2.0 Background Information

2.1. Location of the Study Site and Key Definitions

The study site is 55ha in area and falls in the west of a larger property approximately 190ha in area, described as Lot 1 DP 1087368 and Lot 2 DP 1172154 and is located on Thrumster Street, Thrumster. The site is located approximately 1.2km northeast of the intersection of the Pacific Highway and Oxley Highway (Figure 1). Access to the study site is currently granted from Thrumster Street to the south with internal unpaved tracks providing access throughout the study site.

Most of the site is zoned R1 – General Residential, with a small area zoned B1 – Neighbourhood Centre under the PMHC Local Environmental Plan (LEP) 2011. Land to the east of the site is zoned E3 – Environmental Management and E2 – Environmental Conservation.

The study site is defined as the extent of the total development footprint which is 55ha in area (Figure 1). The study area includes the study site and land within 100m of the site. The property is defined as Lot 1 DP 1087368 and Lot 2 DP 1172154. The locality is land within 10km radius of the site. These standard definitions are in accordance with terminology derived from the *Threatened Species Assessment Guidelines – The Assessment of Significance, DECC 2007.*

2.2. Development Proposal

Port Macquarie Hastings Council propose to establish a residential subdivision in the western portion of Lot 1 DP 1087368 and on Lot 2 DP 1172154. This will comprise a total of 503 residential lots, 1 business lot, two open space areas and internal roads (Figure 2). An Asset Protection Zone (APZ) of 10-30m in width is proposed to fringe the eastern, western and northern edges of the development (Pensini 2016). Development is proposed to take place in ten stages commencing in the south.

The proposed development includes the removal of the majority of vegetation within the study site which largely comprises isolated forest patches and scattered trees. Following vegetation removal, earthworks will be carried out to level parts of the site and establish roads and drainage systems. A number of mature trees are located within the retained open space in the south of the study site and will be retained (Figure

2).

The proposed development includes the retention of the low lying swamp areas to the east of the eastern boundary of the study site. One connecting road is however proposed to pass through this vegetation in the far south eastern corner of the study site. A 4m wide easement for services (up to 15m total width required for construction) is proposed mid-way along the eastern boundary linking to the northwest corner of the adjoining property (Lot 206 DP754434).

2.3. Soils, Topography and Geology

The study site is gently undulating with minor hills occurring in the north (20m elevation) and one in the south (25m elevation) of the study site. These hills slope down to approximately 5m elevation in the east and 10m in the west.

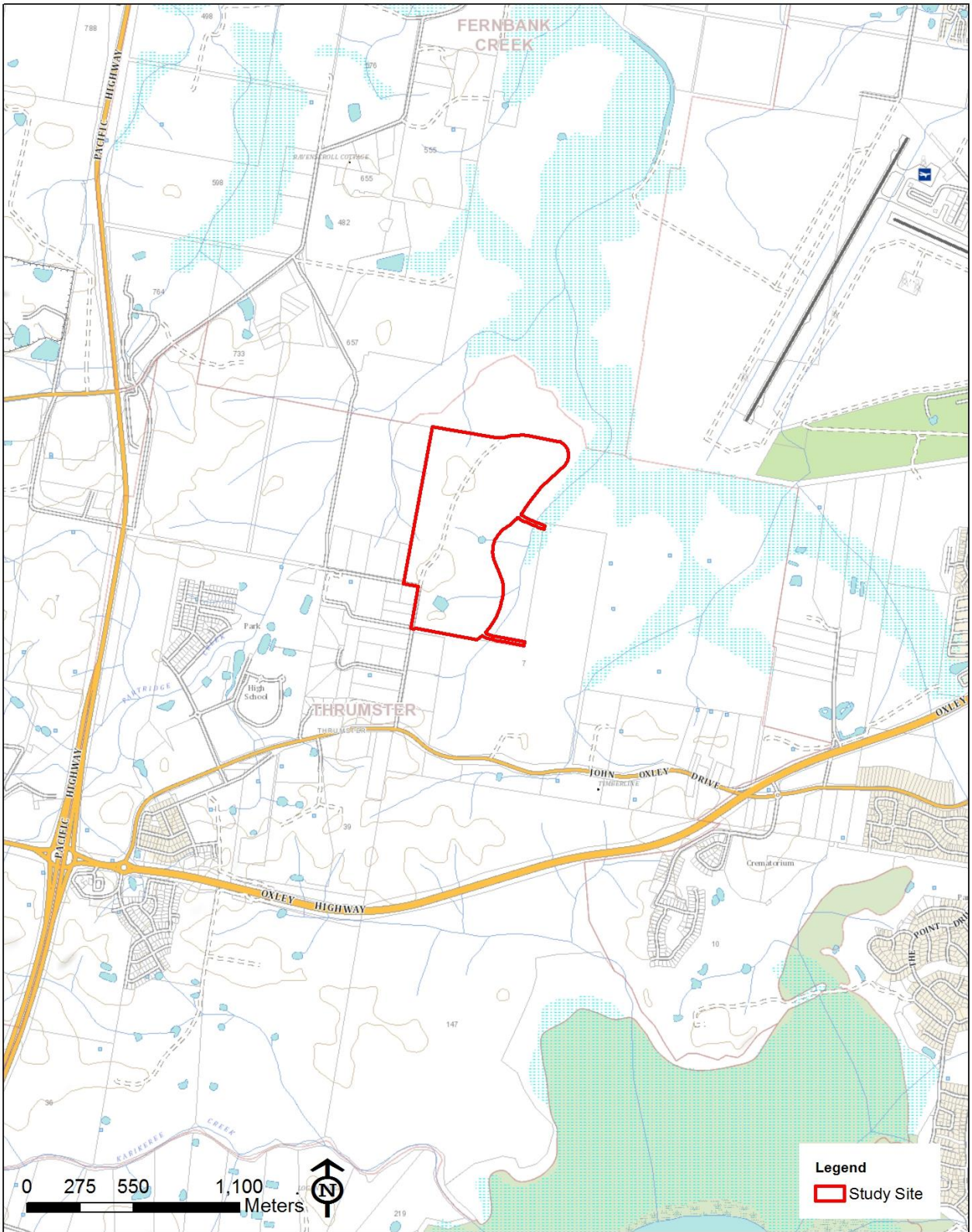
A broad ephemeral drainage depression is located to the east of the site which drains northwards to large areas of Coastal Swamp Forests which occur both within the property and adjoining land to the north. A large constructed dam has been established in the southwest (Photo 11), while a small constructed dam is located in the central east of the study site.

The majority of the study site does not fall on any mapped quaternary soils. However, a very small section on the south-eastern border, as well as the proposed south-eastern connection road both fall on an alluvial formation as shown in mapping by Troedson and Hashimoto (2008) (Figure 3).

The services easement site is underlain by a coastal barrier comprised of marine sand (Troedson and Hashimoto 2008).

As shown in Figure 3, only the connector road and services easement in the east fall within the 1:100 Average Recurrence Interval (ARI) for flood events.

Figure 1: Site locality



This mapping is to be considered indicative only and all derivations (eg of areas of EECs and vegetation communities) are at best approximations and subject to errors including individual interpretation and reliance on information provided to Naturecall which were not independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping, etc should be placed upon this map without independent validation of the information by the user. Naturecall takes no responsibility for any subsequent errors, losses, etc that may arise from use of this data without independent verification.

Project Manager: WS	Figure Name: Location of the Study Site
Drawn By: WS	
Date: 04-Jun-2017	Site: Partridge Creek Residential Subdivision
Map Projection: MGAz56	
Map Datum: GDA94	Client: MJM Consulting Engineers
Page: 1 of 1	

NATURECALL ENVIRONMENTAL

Scale:	Job Number:	Revision:
1 :22,000	EC1417	A

Figure 2: Proposed development layout

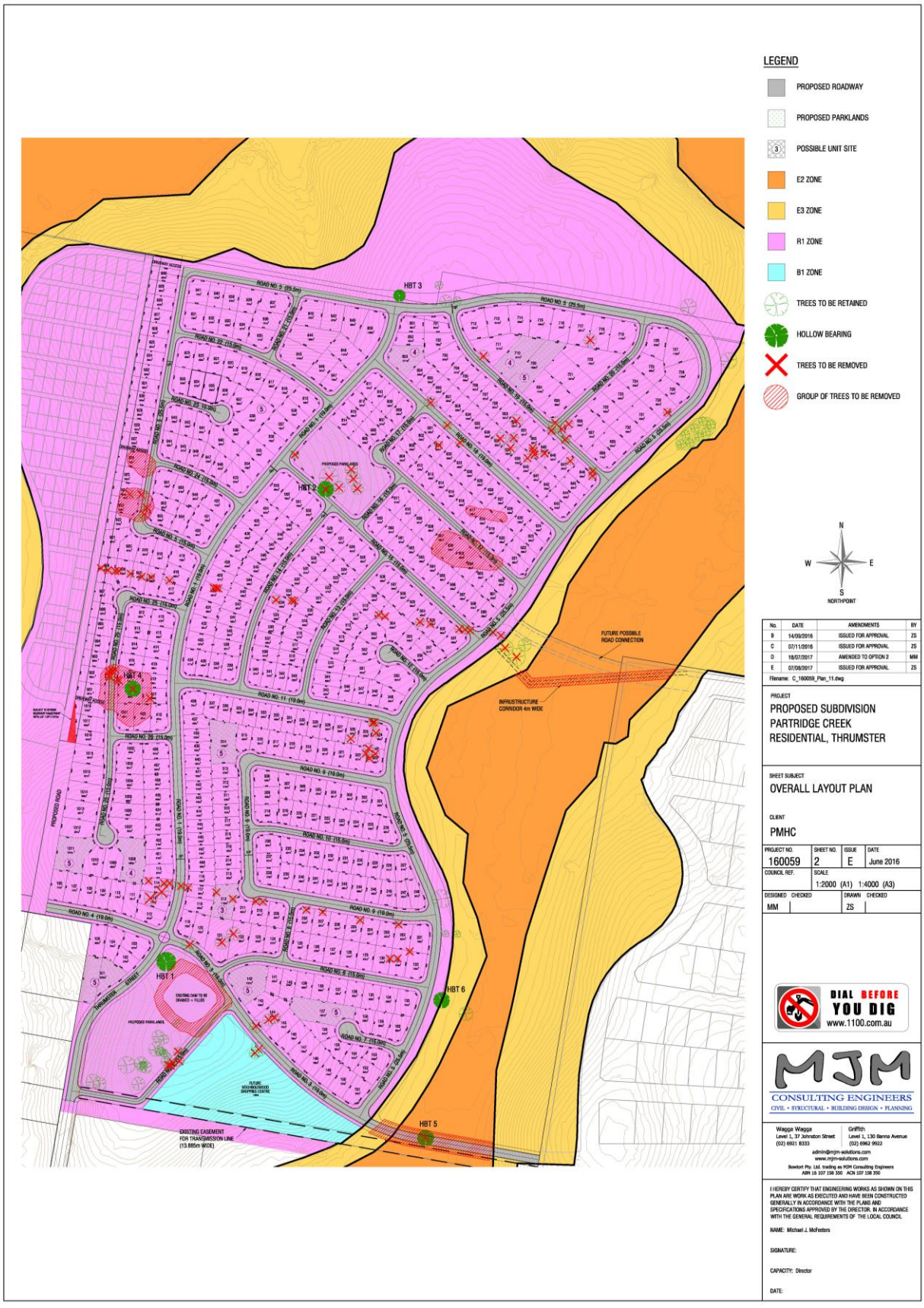
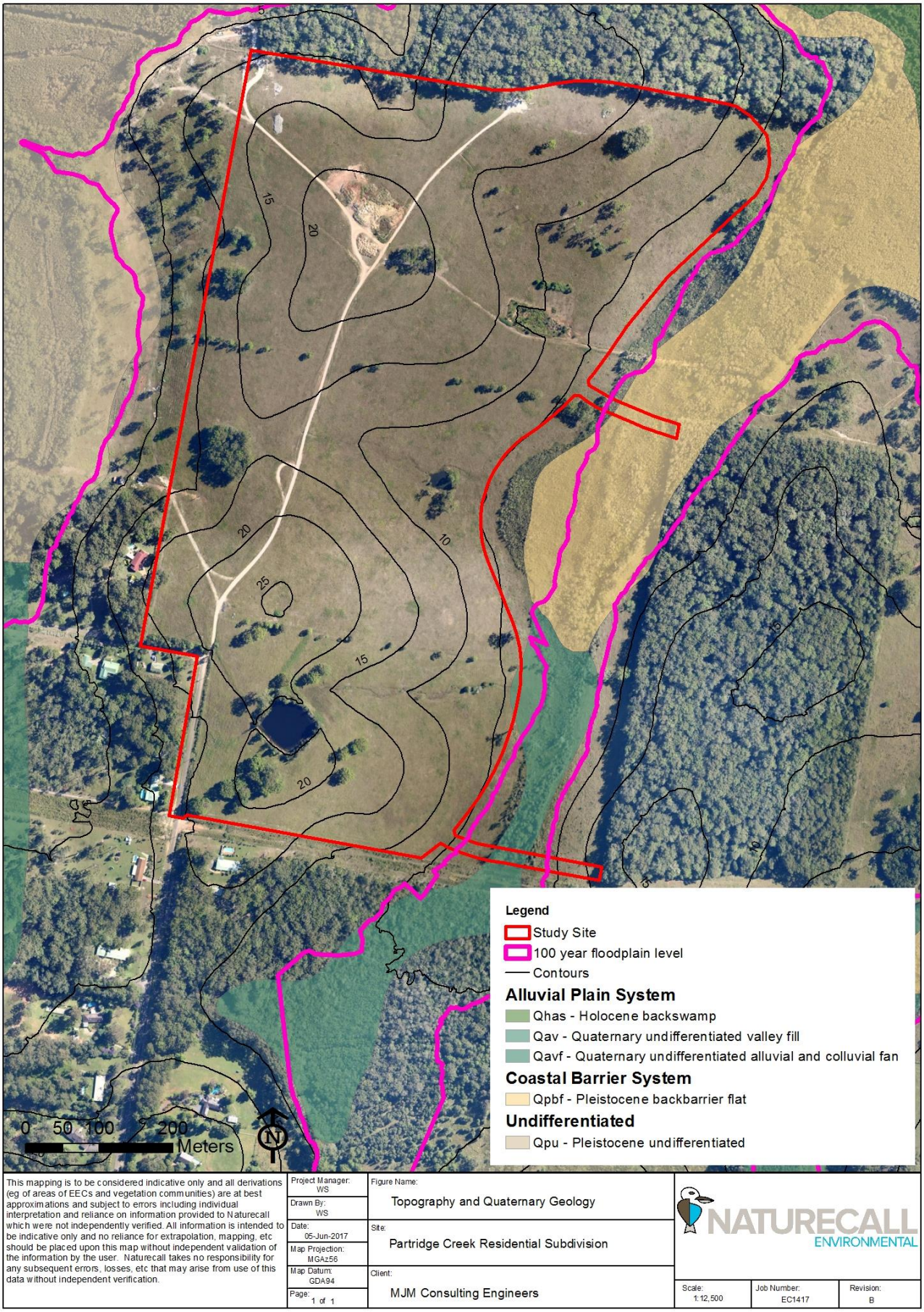


Figure 3: Quaternary geology



2.4. Disturbance History

The exact history of the site and property was not obtained, and comments on previous disturbances and landuse have been based on visual observations.

The site has been extensively cleared in the past and is likely to have been grazed by cattle for some years. Regular slashing has prevented regeneration over most of the site and maintained large areas of grassland. Small patches of vegetation have regrown in some areas, and some scattered trees have established along former fencelines.

The remainder of the property has significant areas of retained vegetation which largely comprises low-lying swamp forest. A large cleared area also occurs in an elevated area in the east of the property.

The site is currently vacant and does not have any dwellings or structures. A gravel road passes through the site to adjoining properties to the north and the eastern portion of the property.

2.5. Previous Relevant Ecological Assessments

2.5.1. Naturecall 2016

In November 2016, Naturecall conducted detailed tree identification and mapping over the study site.

This comprised identification and ground-truthing of existing surveyed trees on the site as well as identification and survey of Koala food trees and hollow-bearing trees that had not been previously surveyed.

This tree survey identified a total of 130 Koala food trees on the study site that are listed as primary browse species under the PMHC DCP 2013. Six hollow-bearing trees were recorded and scored using the PMHC Hollow-bearing Tree protocol.

The tree location data gathered during this 2016 survey has been used in the current impact assessment and report.

2.5.2. Eco Logical 2016

Port Macquarie Hastings Council engaged Eco Logical Australia to prepare a biodiversity certification assessment report to inform biodiversity outcomes as a result of developing Council land in accordance with the Airport Master Plan. This was extended to include Council land to the south proposed for residential and light industrial development in the Partridge Creek Industrial and West Lindfield neighbourhoods of the Thrumster Urban Release Area.

To progress the development proposed on the Partridge Creek residential zoned land (the current study site), Council wish to follow the traditional impact assessment process which is the purpose of this survey and report.

Eco Logical Australia also prepared a biodiversity certification strategy identifying land suitable for

biodiversity certification, and land suitable for development which includes some vegetation that will require clearing. To meet the requirements for biodiversity certification, a combination of conservation measures have been proposed such as permanently protecting and managing 444ha of land for conservation as a registered Biobanking Site under Part 7A of the Threatened Species Conservation Act 1995.

The Biodiversity Certification Assessment report provides a detailed summary of the extensive survey efforts undertaken to date over the airport precinct, which included the current study site.

Important results from these studies include a number of threatened fauna species that were detected in the current study area (but not on the site). These include:

- **Wallum Froglet** – recorded in the swamp forest to the east of the site by Biolink (2006)
- **Eastern Chestnut Mouse** - recorded in the swamp forest to the east of the site by ELA (2014, 2016)
- **Koala** – recorded in dry sclerophyll forest habitats to the north, east and south of the site by Darkheart (2005), Biolink (2006, 2008, 2012) and ERM (2008)
- **Eastern Freetail Bat** – recorded on the northern site boundary by ERM (2008)
- **Little Bent-wing Bat** – recorded in various habitats to the east of the site by GHD (2007) and Biolink (2006)
- **Brown Treecreeper** - recorded in dry sclerophyll forest to the east of the site by Biolink (2006)

The results of these previous surveys have been considered when assessing threatened species for their potential to occur on the study site and in the study area (see Appendix 1) and the potential impacts of the proposed development on threatened species.

3.0 Methods

3.1. Desktop Study and Literature Review

A desktop study was carried out prior to the field survey to gather relevant information and data. The following databases and Geographic Information System (GIS) layers were searched/obtained:

- Department of Environment and Energy Protected Matters Search Tool (DEE 2017)
- Office of Environment and Heritage NSW Atlas of Wildlife (OEH 2017a)
- Port Macquarie LGA Vegetation Communities and EECs digital data layer (Biolink 2013)
- Coastal Quaternary Geology – North and South Coast of NSW digital data layer (Troedson & Hashimoto 2008)

A literature review of the following reports was also undertaken:

- Naturecall (2017a). Statutory Ecological Assessment for Vegetation Removal and Earthworks on Lot 3 DP 1112929, Barton Ridge East, Thrumster.
- Naturecall (2016a). Statutory Ecological Assessment for Proposed Sewer and Rising Main, Thrumster Street, Thrumster.
- Naturecall (2016b). Statutory Ecological Assessment for Large Lot Residential Subdivision of Lot 1 DP 788535, Thrumster St, Thrumster.
- Naturecall (2014). Statutory Ecological Assessment for Proposed Rural-Residential Dwelling on Lot 14 DP 788535, The Grange, Thrumster.
- Eco-logical (2016). Port Macquarie Airport Master Plan and Port Macquarie – Hastings Council owned land within the Thrumster Area 13 Urban Release Area: Biodiversity Certification Assessment Report and Biocertification Strategy – Application to Minister.

3.2. Flora Survey

The flora survey consisted of three main components:

- Identification, description and mapping of the major vegetation communities on the site.
- Identification, mapping and condition assessment of any Endangered Ecological Communities listed under the *Threatened Species Conservation Act 1995* (TSC Act), and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Searches for and (if found) mapping of threatened species listed under the *Threatened Species Conservation Act 1995* (TSC Act), and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) undertaken in accordance with NSW OEH, NSW Guide to Surveying Threatened Plants 2016.

These are described in detail in the following sections.

3.2.1. Vegetation Classification and Mapping

3.2.1.1. Data Review

Existing vegetation mapping of the site produced by Biolink (2013a) was initially reviewed. This mapping was used to identify vegetation types and potential Threatened Ecological Communities present on the study site. Field survey was then implemented to verify the accuracy of this mapping.

3.2.1.2. Survey Methodology

Vegetation communities were sampled by walking random meander transects. Due to the limited extent of vegetation on the study site this provided 100% coverage.

The vegetation communities were described from data collected during random meander transect studies. The vegetation classification is based on the NSW Plant Community Type (PCT) Classification and LGA wide vegetation community classification (Biolink 2013).

Plant species were identified to species or subspecies level and nomenclature conforms to that currently recognised by the Royal Botanic Gardens and follows Harden and PlantNET for changes since Harden.

3.2.2. Conservation Status Assessment

Identification of possible Threatened Ecological Communities (TECs) was based on the data collected by the survey and review of the relevant listings on the OEH website (www.environment.nsw.gov.au) and Department of Environment – MNES SPRAT website (DEE 2017a).

3.2.3. Threatened Flora Species Searches and Occurrence Assessment

3.2.3.1. Searches

Searches for threatened flora recorded in the LGA and regionally (OEH 2017a, DEE 2017b) in similar habitats to those occurring on the site were carried out over the survey period.

Threatened plant searches consisted of undertaking random meanders throughout the site for locally and regionally recorded threatened species as part of the overall vegetation survey. The meanders were undertaken throughout the study site and study area with particular focus on habitats with the greatest potential to support the threatened flora which may occur such as the forested wetlands along the eastern boundary of the study site.

3.2.3.2. Potential Occurrence Assessment

Potential occurrence assessment of threatened flora species is provided in Appendix 1. This section assesses threatened species listed under the *TSC Act 1995* and *EPBC Act 1999* for their potential to occur on site based on the following factors (DEC 2004, DECC 2007):

- Presence/absence of suitable habitat.
- Condition and disturbance history of habitat.
- Local and regional records.

- Location of site within known distribution of the species.
- Connectivity with habitat where species is known to occur.

3.3. Fauna Survey

In consideration of the habitats present on the site and potentially occurring threatened fauna species, the following survey methods were utilised:

- Habitat evaluation.
- Searches for secondary evidence e.g. scats and tracks.
- Incidental diurnal reptile and bird survey.
- Hollow-bearing tree survey.
- Koala scat survey.
- Diurnal reptile and bird survey.
- Spotlighting and torch searches.
- Call playback and detection.

The surveys were undertaken on 5th – 6th June 2017 by a Principal Ecologist and Ecologist under Naturecall's scientific license and animal research authority. The methods per survey measure are detailed below.

It is acknowledged that the full range of techniques (e.g. Elliot Trapping, Harp Netting etc.) which could have been used was not fully utilised. However, as provided for in the guidelines, use of these techniques and effort is not considered warranted in this instance given the number of previous surveys within the area and hence volume of information on locally occurring threatened species.

3.3.1. Habitat Evaluation

This was the main survey method employed to assess the suitability of site habitats for threatened species recorded in the locality, or in broadly similar habitats in the region.

Habitats on and adjacent to the study site were defined and assessed according to parameters such as:

- Structural and floristic characteristics of the vegetation e.g. understorey type and development, crown depth, groundcover density, etc.
- Degree and extent of disturbance e.g. fire, logging, weed invasion, modification to structure and diversity, etc.
- Soil type and suitability e.g. for digging and burrowing.
- Presence of water in any form e.g. rivers, dams, creeks, drainage lines, soaks.
- Size and abundance of hollows and fallen timber.

- Presence of sandbanks, shallow wading areas, rock walls, saltmarsh, roost areas, etc.
- Availability of shelter e.g. rocks, logs, hollows, undergrowth.
- Wildlife corridors, refuges and proximate habitat types.
- Presence of mistletoe, nectar, gum, seed, sap, etc. sources.

This information is considered in Appendix 1 for evaluation of the potential occurrence of threatened species on or adjacent to the site based on cited ecology and personal experience/knowledge of the species.

3.3.2. Diurnal Reptile and Bird Survey

This involved passive and active observation and searches on or directly adjacent to the site. Birds and reptiles were the main focus as those considered likely to be present on or near the site are generally most active diurnally.

Bird surveys were undertaken primarily within two hours of dawn or dusk, with reptile searches occurring during either mid-morning or late afternoon to coincide with periods of peak activity. A total of four hours was spent on these activities over two days.

3.3.3. Secondary Evidence/Habitat Searches

Physical habitat searches involved lifting up of any timber, rocks and debris, and inspection of dense vegetation and leaf litter for frogs and reptiles; binocular inspection of trees for potential hollows and if found – inspection of the opening for signs of usage e.g. chewed or worn edges; observation of likely basking sites; searches for nests; and searches for scats, owl regurgitation pellets, tracks and scratches.

A total of two hours was spent on habitat and secondary evidence searches.

3.3.4. Koala Scat Survey

The Spot Assessment Technique (SAT) method was utilised on site to detect Koalas and determine activity levels. Two SAT plots were undertaken on site during the survey. The location of these is shown in Figure 4.

The SAT surveys consisted of checking the ground and leaf litter in a 1m radius around 30 trees for a period of two minutes per tree or until a scat was found. This technique is recognised as a very efficient method of detecting Koala presence, and in some instances, is a method used to identify areas of major Koala activity/significance eg Core Koala Habitat (Phillips and Callahan 1995, Jurskis and Potter 1997, NPWS 2001).

The method is used by the Australian Koala Foundation primarily for mapping Koala habitat at a landscape scale (Phillips and Callahan 1995, 2011, Jurskis and Potter 1997, NPWS 2001). The methodology uses a specific sampling technique to gauge the level of Koala activity at a sampling site, by the number of trees recording Koala scats divided by the total number of trees in the sampling area expressed as a percentage (Phillips and Callaghan 2011).

The SAT designates activity levels within certain ranges (see table below) to be considered "areas of major activity" which are considered to be a fundamental component of the SEPP 44 definition of Core Koala Habitat i.e., indicates resident Koalas (Phillips and Callaghan 2011). In balance with other indicators (e.g., historical records), the SAT can be used to identify Core Koala Habitat.

The revised SAT has come about following several years of Koala habitat mapping using the SAT with associated studies. This has resulted in a large database from which the activity level ranges provided in the table below have been derived (Phillips and Callaghan 2011). These variable levels of usage are considered by Phillips and Callahan to reflect actual differences in habitat quality. Thus the range in activity levels have been determined for areas on the East Coast where primary browse species occur in low abundance or on poor soils, as well as for areas on nutrient rich soils (Phillips and Callaghan 2011, Biolink 2008b).

Table 1: SAT activity level classes

(Phillips and Callaghan 2011)

Area (Density)	Low Use	Medium (Normal Use)	High Use
East Coast (low)	<9.47%	>/= 9.47% but </= 12.59%	>12.59%
East Coast (med-high)	<22.52%	>/= 22.52% but </= 32.84%	>32.84%
Western areas (med-high)	<35.84%	>/= 35.84% but </= 46.72%	>46.72%

3.3.5. Hollow-bearing Tree Survey

All hollow-bearing trees (HBTs) on the site were located and recorded using a GPS enabled tablet with GIS software (GIS Kit Pro) installed during tree surveys in November 2016 and during the surveys in June 2017. Each tree was marked with flagging tape and given an identifier number with orange spray paint. Each tree was subsequently assessed using the PMHC DCP 2013 HBT protocol. The results of this assessment are presented in Section 7.

3.3.6. Koala Food Tree Survey

All primary Koala food trees listed under the PMHC Development Control Plan (DCP) 2013 and Area 13 KPoM were GPS located and assigned an identifier number during previous surveys in November 2016. The details are presented in Section 7.2 and Appendix 3.

3.3.7. Spotlight Survey

Spotlighting was conducted for 1.5 hours per night over 2 nights. The procedure involved walking with a hand held 1100 lumen LED spotlight over the site, targeting the trunks and branches of canopy trees and understorey, and periodically scanning the ground. Torch searches were conducted in wetland areas and around dams for amphibians. The approximate location of the spotlighting transects is shown in Figure 4.

3.3.8. Call Playback Survey

Recorded calls of the following species were broadcast during the survey:

- Masked Owl, Barking Owl and Powerful Owl
- Squirrel Glider
- Yellow-bellied Glider
- Koala
- Wallum Froglet

Calls for the birds and arboreal mammals were played through a portable MP3 player via a 55W PA system from two separate locations (Figure 4) at a sound level approximating natural intensities for the target species. The general methodology involved an initial period of listening and spotlighting; followed by playback of the calls simulating a natural pattern. This was followed by 10 minutes of listening and 10-15 minutes spotlighting for fauna attracted by the calls (but not responding vocally), within 100m radius of the playback point. Calls were generally played soon after dusk, when such calls are normally heard.

Playback was utilised in study area over 2 nights for a total of 2 hours of this activity.

Figure 4: Location of fauna surveys

4.0 Results

4.1. Desktop Search Results

4.1.1. Locally Recorded Threatened Species

The following table lists the threatened flora and fauna species identified in database and literature searches.

Table 2: Locally recorded threatened species

Common Name	Scientific Name	TSC Act	EPBC Act	Source
Flora				
Scented Acronychia	*Acronychia littoralis*	E	E	BioNet (OEH 2017a)
Trailing Woodruff	*Asperula asthenes*	V	V	Naturecall (2016a)
Dwarf Heath Casuarina	*Allocasuarina defungens*	E	E	BioNet (OEH 2017a)
Sand Spurge	*Chamaesuce psammogeton*	E	-	BioNet (OEH 2017a)
White-flowered Wax Plant	*Cynanchum elegans*	E	E	BioNet (OEH 2017a)
Spider Orchid	*Dendrobium melaleucaphilum*	E	-	BioNet (OEH 2017a)
Narrow-leaved Peppermint	*Eucalyptus nicholii*	V	V	BioNet (2017a)
Slender Marsdenia	*Marsdenia longiloba*	E	V	Naturecall (2016b)
-	*Maundia triglochinoides*	V	-	Bionet (2017a)
Biconvex Paperbark	*Melaleuca biconvexa*	V	V	BioNet (2017a)
Red-flower King of the Fairies	*Oberonia titania*	V	-	BioNet (2017a)
-	*Peristeranthus hillii*	V	-	BioNet (2017a)
Southern Swamp Orchid	*Phaius australis*	V	E	BioNet (2017a)
Rainforest Cassia	*Senna acclinis*	E	-	BioNet (2017a)
Silverbush	*Sophora tomentosa*	E	-	BioNet (2017a)
Fauna				
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*	V	-	BioNet (OEH 2017a), DLWC (2002)

Common Name	Scientific Name	TSC Act	EPBC Act	Source
				ELA (2014)
Common Planigale	*Planigale maculata*	V	-	BioNet (OEH 2017a)
Spotted-Tailed Quoll	*Dasyurus maculatus*	V	E	BioNet (OEH 2017a)
Brush-tailed Phascogale	*Phascogale tapoatafa*	V	-	BioNet (OEH 2017a)
Rufous Bettong	*Aepyprymnus rufescens*	V	-	BioNet (OEH 2017a)
Koala	*Phascolarctos cinereus*	V	V	BioNet (OEH 2017a) Naturecall (2014) Biolink (2006, 2008, 2012) Peter Parker (2014) ERM (2008) GHD (2007) ELA (2014, 2015)
Squirrel Glider	*Petaurus norfolcensis*	V	-	BioNet (OEH 2017a), ELA (2014) Darkheart 2005
Yellow-bellied Glider	*Petaurus australis*	V	-	BioNet (OEH 2017a)
Little Bent-wing Bat	*Miniopterus australis*	V	-	BioNet (OEH 2017a), Biolink (2012, 2006) ERM (2008) ELA (2014)
Eastern Bent-wing Bat	*Miniopterus schreibersii oceanensis*	V	-	BioNet (OEH 2017a), Biolink (2012, 2006) GHD 2007
Eastern False Pipistrelle	*Falsisitrellus tasmaniensis*	V	-	BioNet (OEH 2017a)
Eastern Freetail Bat	*Micronomus norfolkensis*	V	-	BioNet (OEH 2017a),

Common Name	Scientific Name	TSC Act	EPBC Act	Source
				ELA (2014) Biolink (2012, 2006) ERM (2008)
Eastern Cave Bat	*Vespadelus troughtoni*	V	-	BioNet (OEH 2017a)
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	BioNet (OEH 2017a), Biolink (2006)
Hoary Wattled Bat	*Chalinolobus nigrogriseus*	V	-	BioNet (OEH 2017a)
Southern Myotis	*Myotis macropus*	V	-	BioNet (OEH 2017a), Biolink (2006) ELA (2014)
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*	V	-	BioNet (OEH 2017a)
Golden-tipped Bat	*Kerivoula papuensis*	V	-	BioNet (OEH 2017a)
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	BioNet (OEH 2017a) Naturecall (2016c) ELA (2015)
Common Blossom Bat	*Syconycteris australis*	V	-	BioNet (OEH 2017a)
Glossy Black Cockatoo	*Calyptorhynchus lathamii*	V	-	BioNet (OEH 2017a), GHD (2007) Biolink (2006)
Swift Parrot	*Lathumus discolour*	E	E,M	BioNet (OEH 2017a)
Regent Honeyeater	*Anthochaera phrygia*	E	E	BioNet (OEH 2017a)
Little Lorikeet	*Glossopsitta pusilla*	V	-	BioNet (OEH 2017a), ELA (2015)
Varied Sittella	*Daphoenositta chrysoptera*	V	-	BioNet (OEH 2017a)
Brown Treecreeper	*Climacteris picumnus*	V	-	BioNet (OEH 2017a), Biolink (2006)
Barred-cuckoo Shrike	*Coracina lineata*	V	-	BioNet (OEH 2017a)
Bush-stone Curlew	*Burhinus grallarius*	V	-	BioNet (OEH 2017a)

Common Name	Scientific Name	TSC Act	EPBC Act	Source
Dusky Woodswallow	*Artamus cyanopterus*	V	-	BioNet (OEH 2017a)
Wompoo Fruit-Dove	*Ptilinopus magnificus*	V	-	BioNet (OEH 2017a)
Rose-crowned Fruit Dove	*Ptilinopus regina*	V	-	BioNet (OEH 2017a)
Scarlet Robin	*Petroica boodang*	V	-	BioNet (OEH 2017a)
Powerful Owl	*Ninox strenua*	V	-	BioNet (OEH 2017a)
Barking Owl	*Ninox connivens*	V	-	BioNet (OEH 2017a)
Masked Owl	*Tyto novaehollandiae*	V	-	BioNet (OEH 2017a), Peter Parker (2014)
Eastern Grass Owl	*Tyto longimembris*	V	-	BioNet (OEH 2017a)
Sooty Owl	*Tyto tenebricosa*	V	-	BioNet (OEH 2017a),
Little Eagle	*Hieraaetus morphnoides*	V	-	BioNet (OEH 2017a)
Square-tailed Kite	*Lophoictinia isura*	V	-	Bionet (OEH 2017a), Biolink (2012)
Eastern Osprey	*Pandion cristatus*	V	M	BioNet (OEH 2017a) ELA 2014 GHD (2007)
White-bellied Sea Eagle	*Haliaeetus leucogaster*	V	-	BioNet (OEH 2017a)
Spotted Harrier	*Circus assimilis*	V	-	BioNet (OEH 2017a)
Australasian Bittern	*Botaurus poiciloptilus*	E	E	BioNet (OEH 2017a)
Black Bittern	*Botaurus poiciloptilus*	V	-	BioNet (OEH 2017a), Biolink (2012)
Black Necked Stork	*Ephippiorhynchus asiaticus*	E	-	BioNet (OEH 2017a) ERM (2008)
Brolga	*Ephippiorhyncus asiaticus*	V	-	BioNet (OEH 2017a)
Magpie Goose	*Anseranas semipalmata*	V	-	BioNet (OEH 2017a)

Common Name	Scientific Name	TSC Act	EPBC Act	Source
Blue-billed Duck	*Oxyura australis*	V	-	BioNet (OEH 2017a)
Freckled Duck	*Stictonetta naeyosa*	V	-	BioNet (OEH 2017a)
Comb-crested Jacana	*Irediparra gallinacea*	V	-	BioNet (OEH 2017a)
Wallum Froglet	*Crinia tinnula*	V	-	BioNet (OEH 2017a), ELA (2014) ERM (2008) GHD (2007) Biolink (2006)
Green-thighed Frog	*Litoria brevipalmata*	V	-	BioNet (OEH 2017a)
Green and Golden Bell Frog	*Litoria aurea*	E	V	BioNet (OEH 2017a)

The following species are considered likely to occur in the locality due to suitable habitat and regional records (some have been recorded within 20km).

Table 3: Threatened species which may occur in the locality

Common Name	Scientific Name	TSC Act	EPBC Act
Fauna			
Flame Robin	*Petroica phoenicea*	V	-
Eastern Ground Parrot	*Pezoporus wallicus wallicus*	V	-
New Holland Mouse	*Pseudomys novaehollandiae*	-	V
Dwyer's Bat	*Chalinolobus dwyeri*	V	V
Giant Barred Frog	*Mixophes iteratus*	E	E
Stuttering Frog	*Mixophes balbus*	E	V

4.1.2. Matters of National Environmental Significance

The results of the MNES search are provided in Table 4. The search was undertaken using a 10km search radius from the study site. See Appendix 6 for the full report.

Table 4: Matters of National Environmental Significance search results

Category	Result	Description
World Heritage Properties	No	-
National Heritage Places	No	-
Wetlands of International Importance	No	-
Great Barrier Reef Marine Park	No	-
Commonwealth Marine Area	No	-
Listed Threatened Ecological Communities	3	Three listed threatened ecological communities are listed as likely to occur within the area.
Listed Threatened Species	66	Species or species habitat known/likely/may occur within the area.
Listed Migratory Species	60	Migratory wetland, terrestrial and marine species or species habitat known/likely/may occur within the area
Other matters protected by the EPBC Act		
Commonwealth Land	6	Refer to full report in Appendix 6
Commonwealth Heritage Places	No	-
Listed Marine Species	88	Species or species habitat known/likely/may occur within the area.
Whales and other Cetaceans	13	Species or species habitat known/likely/may occur within the area.
Critical Habitats	No	-
Commonwealth Reserves Terrestrial	No	-
Commonwealth Reserves Marine	No	-

4.2. Flora Survey Results

4.2.1. Site Vegetation Communities

The vegetation communities on site are mapped by Biolink (2013) as Blackbutt Grassy Forest and Broad Leaved Paperbark Swamp Woodland Forest. The site vegetation survey confirmed the presence of these two communities on site. A derived exotic/pasture grassland community with scattered trees covers all other areas of the study site.

The following table provides a description of each of the site's vegetation communities. Refer to the site photos following and PMHC vegetation community map in Figure 5. A flora species list is provided in Appendix 2.

Table 5: Blackbutt Grassy Forest community description

Vegetation Community (NSW PCT)	Blackbutt – Tallowwood dry grassy open forest of the southern NSW North Coast Bioregion
PMHC Community	No. 26: Blackbutt Grassy Forest
Location and Area	The only mapped area occurs in the west of the study site, however three other isolated stands are located further north. This community also adjoins the site to the north. The community covers an area of approximately 0.7ha within the study site.
Description	**a) Canopy:** *Structure and Species:* The canopy consists of an open to mid-dense layer of eucalypts 18-25m high. The dominant species are Tallowwood (*Eucalyptus microcorys*) and White Stringybark (*Eucalyptus globoidea)* with lesser associates including Pink Bloodwood (*Corymbia intermedia*) and White Mahogany (*Eucalyptus acmenoides)*. **b) Understory:** *Structure and Species:* The understorey comprises a sparse small tree layer ranging from 6-10m in height. Dominant species are juvenile canopy species, Black Oak (*Allocasuarina littoralis*). **c) Shrub Layer:** *Structure and Species:* Comprises an open layer of shrubs ranging from 0.5-2m in height. Species recorded in this layer include Fringed Wattle *(Acacia fimbriata),* Maiden's Wattle *(Acacia maidenii)*, Notched Bush Pea (*Pultenaea retusa*), *Persoonia stradbrokensis,* Coffee Bush *(Breynia oblongifolia)* and Hop Bush (*Dodonaea triquetra*). **d) Ground Layer:** *Structure and Species:* Groundcover is moderately dense throughout. Height ranges from 0.1-0.7m. Species largely comprise Blady Grass (*Imperata cylindrica*), Spiny-

	headed Matrush (*Lomandra longifolia*), Wiry Panic (*Entolasia stricta*) and Blue Flax Lily (*Dianella caerulea).* **e) Lianas, scramblers, twiners:** Occasional climbers are present in this community. These include Wombat Berry (*Eustrephus latifolius*), Scrambling Lily (*Geitonoplesium cymosum*), Glycine (*Glycine clandestina*) and False Sarsaparilla (*Smilax glyciphylla*).
Condition	This community only occurs on site as isolated regrowth patches. These areas are not slashed which has allowed native species in the understorey and groundcover to establish. They were found to be in good condition overall with low weed cover and a well-developed understorey.

* Denotes introduced species

Table 6: Swamp Forest community description

Vegetation Community (NSW PCT)	No 1064: Paperbark Swamp Forest of the Coastal Lowlands of the NSW North Coast Bioregion
PMHC Vegetation Community	No. 62: Broad-leaved Paperbark - Swamp Mahogany Swamp Forest Complex
Location and Area	Occurs to the east of the residential area footprint. The connector road and services easement pass through this community and cover an area of 0.3ha.
Description	**a) Canopy:** *Structure and species:* The canopy consists of an open canopy of Broad-leaved Paperbark (*Melaleuca quinquenervia*) with occasional Swamp Mahogany (*E. robusta*) and Swamp Oak (*Casuarina glauca*) throughout. Height ranges from 8-12m. Some areas of this community in the north only have a very sparse canopy of Paperbarks/Swamp Mahogany and have a well-developed shrub layer. **b) Understorey:** *Structure and species*: The understory generally consists of an open layer of small trees. Common to dominant species include Tantoon (*Leptospermum polygalifolium*) Flax-leaved Paperbark (*Melaleuca linariifolia*), Sieber's Paperbark (*Melaleuca sieberi*), Willow Bottlebrush (*Callistemon salignus*), Prickly Tea Tree (*Leptospermum juniperinum*) and canopy juveniles. Height ranges from 3-6m. In the south of the site, young Swamp Oak are more common in the understorey. **c) Shrub Layer:** *Structure and Species*: Comprises an open layer of shrubs ranging from 1-2m in height. Dominant species are Wallum Bottlebrush (*Callistemon pachyphyllus*), Heath-leaved Banksia (*Banksia ericifolia*), Thyme Honey Myrtle (*Melaleuca thymifolia*) and Hairpin Banksia (*Banksia spinulosa*).

	Groundsel Bush (*Baccharis hamilifolia**) is a common weed in the south of this community. **d) Ground Layer:** *Structure and Species*: A dense groundcover occurs throughout and is dominated by sedges, ferns and occasional grasses and herbs. Height ranges from 0.2-0.7m. Species dominance varies with location. Commonly recorded species included Tall Saw-sedge (*Gahnia clarkei*), Coral Fern (*Gleichenia dicarpa*), Swamp Water Fern (*Blenchum indicum*), *Baumea rubiginosa, Chorizandra cymbaria, Casutis recurvata* and *Dampiera stricta.* A mix of native and exotic grasses dominate the edges of this community. Common species include Whisky Grass (*Andropogon virginicus**), Carpet Grass (*Axonopus fissifolius**), Blady Grass and Red Grass (*Bothriochloa decipiens)*. **e) Lianas, scramblers, etc:** Limited to occasional Monkey Rope climbing on canopy trees.
Condition	While areas of this community in the south have evidently been cleared in the past, it is unknown whether the remainder of the community has been subject to clearing or grazing. The community is currently in good condition with high species diversity and well developed structure. Weed cover was only low to moderate along the exposed edges of the community with occasional Groundsel Bush* and Camphor Laurel* and exotic grasses including Whisky Grass* and Carpet Grass*.

* Denotes introduced species

Table 7: Derived grassland community description

Vegetation Community (NSW PCT)	Derived Grassland with Scattered Trees – No matching community
PMHC Community	NA
Location and Area	This is the dominant vegetation community on site and covers an area of approximately 53.8ha or 97.8% of the site.
Description	**a) Canopy:** *Structure and Species*: Scattered trees occur along old fencelines and in the northeast of the site. These consist of Tallowwood, Blackbutt, White Stingybark, Pink Bloodwood, Broad-leaved Paperbark and Black Oak ranging in height from approximately10-20m. **b) Understory:**

	Absent aside from young Broad-leaved Paperbark Black Oak and Swamp Oak along old fencelines and in a disturbed area with imported fill in the northwest. **c) Shrub Layer:** Absent **d) Ground Layer:** *Structure and Species:* The groundcover forms a dense layer throughout the site. It exists in a highly derived state due to historic clearing, grazing and current regular slashing activity. Height ranges from 0.01-0.5m, depending on the time since slashing. Species dominance varies with location but it generally comprises a mix of native grasses and common introduced pasture grasses and weeds. Common to dominant species include Blady Grass, Common Couch (*Cynodon dactylon*), Spiny-headed Matrush, Red Grass, Kangaroo Grass, Kidney Weed (*Dichondra repens*), Rice Flower (*Pimelea linifolia*), Carpet Grass*, Whiskey Grass*, Common Paspalumn*, Purpletop (*Verbena bonariensis**) Supressed shrub species such as Tantoon, Mock Olive (*Notelaea sp.*), Red-stemmed Wattle (*Acacia myrtifolia*) and Crinkle Bush (*Lomatia silafolia*) are also common.
Condition	This community exists in a highly derived condition. Weed content is high and primarily consists of exotic pasture species.

* Denotes introduced species

Photo 1: Blackbutt Grassy Forest vegetation community present on site

Photo 2: Swamp Forest vegetation community present in the study area

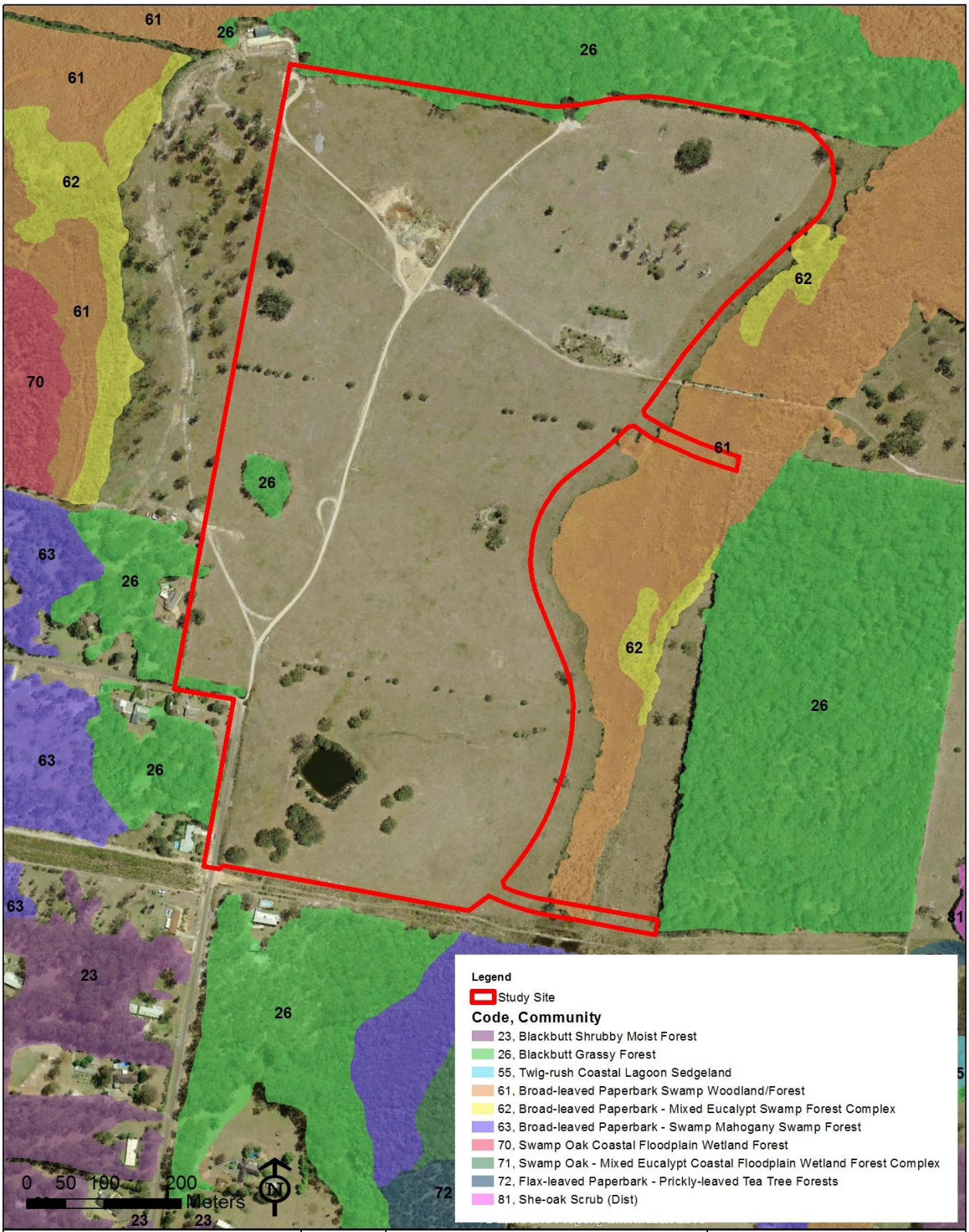
Photo 3: Swamp Forest present within footprint of proposed connector road

Photo 4: Derived pasture vegetation community present on site

Photo 5: Scattered trees in grassland community

Photo 6: Large dam in south of study site

Figure 5: Site vegetation communities



This mapping is to be considered indicative only and all derivations (eg of areas of EECs and vegetation communities) are at best approximations and subject to errors including individual interpretation and reliance on information provided to Naturecall which were not independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping, etc should be placed upon this map without independent validation of the information by the user. Naturecall takes no responsibility for any subsequent errors, losses, etc that may arise from use of this data without independent verification.

Project Manager: WS	Figure Name: PMHC Vegetation Mapping
Drawn By: WS	
Date: 04-Jun-2017	Site: Partridge Creek Residential Subdivision
Map Projection: MGAz56	
Map Datum: GDA94	Client: MJM Consulting Engineers
Page: 1 of 1	

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Scale:	Job Number:	Revision:
1:6000	EC1417	A

4.2.2. Threatened Flora

4.2.2.1. Results of Threatened Flora Survey

Vegetation surveys over the study area detected the Slender Screw Fern (*Lindsaea incisa*) which is listed as Endangered under the TSC Act. A population of this species was found in the northeast of the study area growing on the edge of the swamp forest community (Figure 6).

The fern was found growing on the edges of a swamp forest dominated by *Leptospermum juniperinum* with occasional stunted *Melaleuca quinquenervia*, *Eucalyptus robusta* (juvenile), *Melaleuca linariifolia*, *Melaleuca sieberi* and *Callistemon pachyphyllus.* This tree/shrub layer reached approximately 8m in height and 30% cover.

The groundcover was very dense and dominated by a range of sedges, herbs and ferns including *Gleichenia dicarpa, Blechnum indicum, Dampiera stricta, Baumea rubiginosa, Chorizandra cymbaria* and *Casutis recurvata*.

It was difficult to determine the population size given the physiology of the plant (multiple fronds arising along lengthy and intertwined rhizomes), however it appears there are several hundred plants over an area of approximately 450 m^2.

A sample of this plant was sent to the NSW Herbarium. The Herbarium initially identified it as *Lindsaea dimorpha*. A further sample was sent which confirmed that the species is *Lindsaea incisa* (see correspondence in Appendix 5).

This is the first record of the species in the Port Macquarie-Hastings LGA and is also the first record south of Coffs Harbour. Available literature and databases have found that this species is previously only known from a few locations in NSW between Grafton and just south of Coffs Harbour (OEH 2017b, Plantnet 2017, NPWS 2002). The ferns on site are thus considered an important population at the geographical limit of the species.

Large areas of potential habitat for this species occurs north of the site in the Partridge Creek/Fernbank Creek wetland areas, however surveys to determine the extent of the local population have not been undertaken and are beyond the scope of this project.

4.2.2.2. Potential Occurrence Assessment

Searches of relevant literature and databases (OEH 2017a) found records of 15 threatened flora species in the locality. These species are individually assessed in Appendix 1 for their potential to occur on site (OEH 2017a). This assessment has determined that no threatened flora species are considered potential occurrences in the study area.

Photo 7: Habitat of Slender Screw Fern

Photo 8: Detailed view of Slender Screw Fern

Photo 9: Pressed sample of Slender Screw Fern

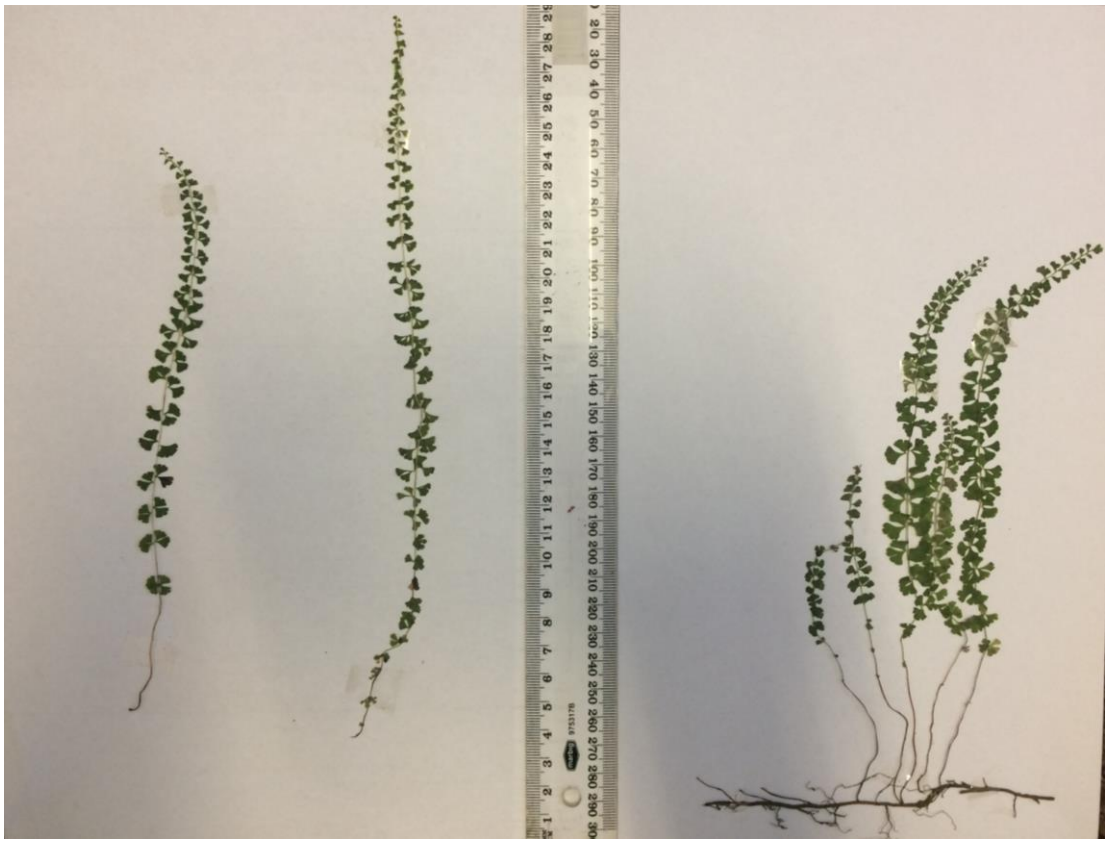
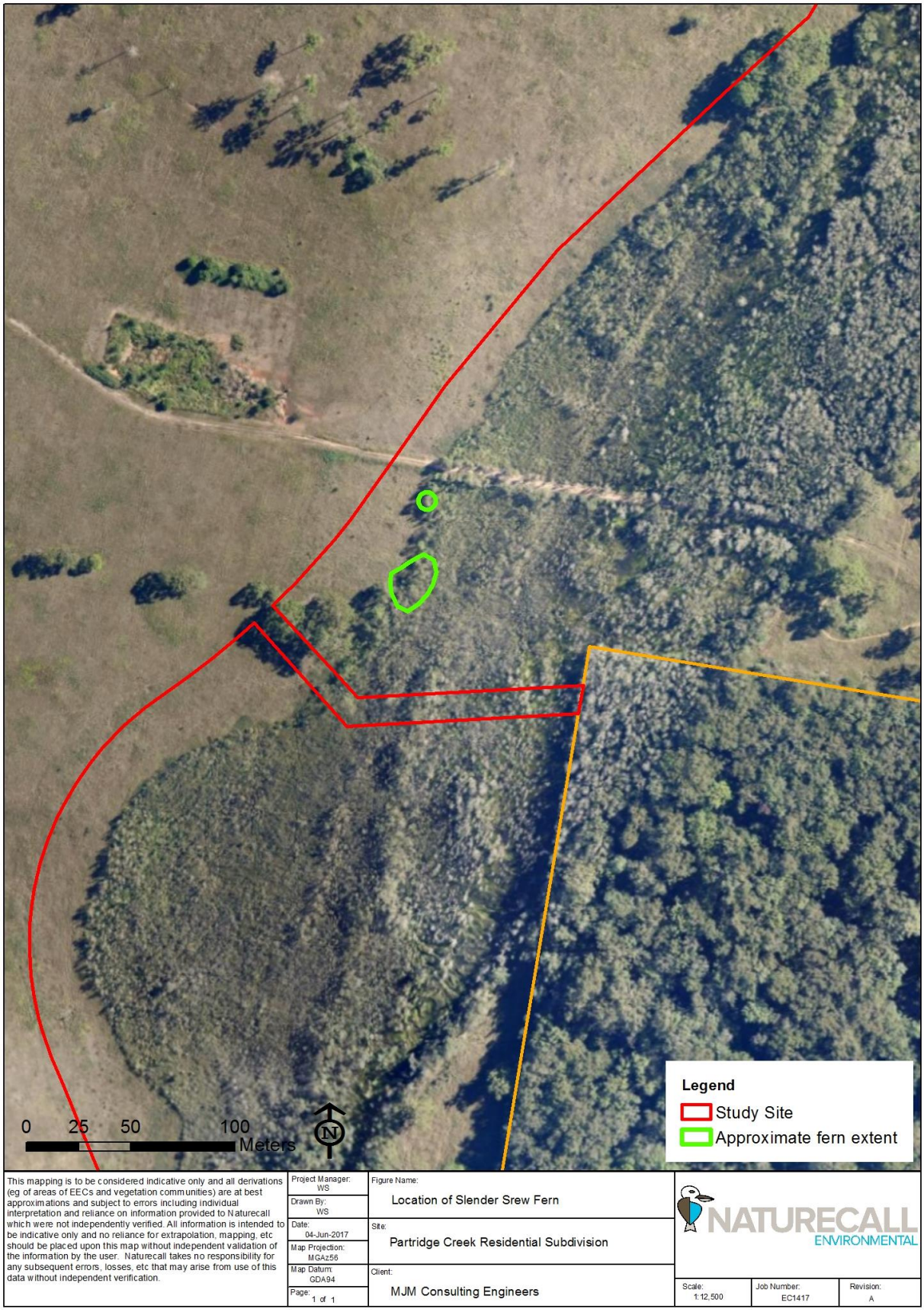


Figure 6: Location of Slender Screw Fern



4.2.3. Endangered Ecological Communities

As detailed in the following analysis, the site contains Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC listed under the TSC Act 1995.

4.2.3.1. Swamp Sclerophyll Forest on Coastal Floodplains

Final Determination Criteria

"*Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*" is a characteristic ecological community listed as Endangered under the TSC Act 1995. This EEC is associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Swamp Sclerophyll Forest on Coastal Floodplains (SSFCF) generally occurs below 20 m (though sometimes up to 50 m) elevation, often on small floodplains or where the larger floodplains adjoin lithic substrates or coastal sand plains. The structure of the community is typically open forest (but may be reduced to scattered trees via disturbance), and in some areas the tree stratum is low and dense ie a scrub. The community also includes some areas of fernland and tall reedland or sedgeland where trees are very sparse or absent. The most widespread and abundant dominant trees include *Eucalyptus robusta* and *Melaleuca quinquenervia*.

Site Evaluation

As shown in Figure 3, the southern connector road is located on an alluvial soil formation described as "Valley Fill". These soils have been formed by fluvial process such as aggradation by overbank and in-channel fluvial discharge and runoff processes (Troedson and Hashimoto 2008). This area is considered to meet the geomorphological requirements of the Final Determination for the EEC - *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (NSWSC 2004) due to the presence of waterlogged alluvial soils and topographic location.

Most of the Swamp Forest community in the study area, including that located within the services easement footprint, is underlain by a coastal barrier formation comprised of marine sand. This formation is not formed by alluvial processes and does not match the definition of a floodplain according to the Final Determination criteria for coastal floodplain EECs.

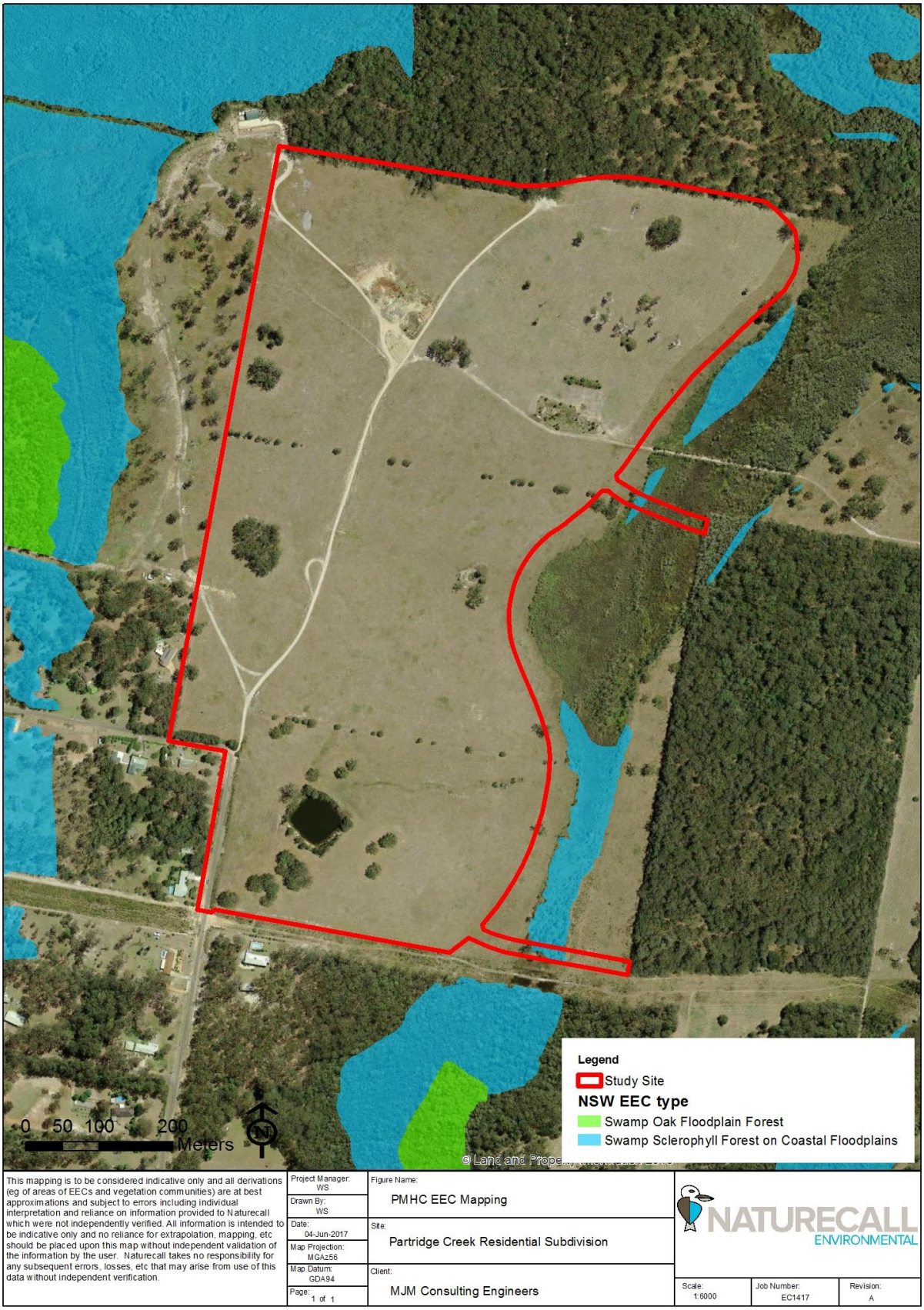
In floristic terms, the swamp forest vegetation community located within the connector road and in the study area to the east of the residential area footprint meets the floristic criteria for this EEC, with recorded native species matching the species listed under the Scientific Committees' Final Determination. Characteristic canopy and understorey species for this EEC recorded on site include Broad-leaf Paperbark, Swamp Mahogany, Willow Bottlebrush, Sieber's Paperbark and Flax-leaved Paperbark. The ground layer was also characterised by species associated with this EEC i.e. predominantly fern and sedge species.

The swamp forest vegetation occurring on alluvial soils on site and within the study area therefore qualifies as part of the '*Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*' EEC as it matches the key floristic descriptors, soil

type, habitat and ecological process indicators described by the NSW Scientific Committee's Final Determination (NSWSC 2004).

The approximate extent of this EEC on the site is shown in Figure 7 below.

Figure 7: Location of EECs in the study area



4.2.4. Other TECs and Endangered Populations

No Endangered Populations were found within the site or in the study area.

A summary of TECs and Endangered Populations listed under the TSCA 1995 or EPBCA 1999 which occur in the North Coast Bioregion (OEH 2017b, DotE 2017b) and their potential for occurrence in the study area is provided in the following table:

Table 8: Review of Endangered Ecological Communities

Act	Literature Review	Occurrence Assessment
TSC Act	***"Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion"*** is a characteristic ecological community listed as Endangered. This Endangered Ecological Community (EEC) is associated with clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Subtropical Coastal Floodplain Forest (SCFF) generally occurs below 50m, but may occur on localised river flats up to 250 m elevation in the NSW North Coast bioregion. While the composition of the SCFF tree stratum varies considerably, the most widespread and abundant dominant canopy trees include *Eucalyptus tereticornis*, *E. siderophloia*, *Corymbia intermedia*, and *Lophostemon suaveolens* (latter only north of the Macleay floodplain).	An alluvial formation occurs to the east of the site which meets the definition of a coastal floodplain. The floristic characteristics of this community however do not conform to the definition of this EEC.
TSC Act	**"*River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*"** is an EEC associated with silts, clay-loams and sandy loams on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. River-Flat Eucalypt Forest on Coastal Floodplains (RFEF) generally occurs below 50m elevations, but may occur on localised river flats up to 250m above sea level. In the North Coast, the most widespread and abundant dominant trees include *Eucalyptus tereticornis, E. amplifolia, Angophora floribunda, A. subvelutina*, *E. saligna* and *E. grandis.*	Vegetation on the site does not meet the floristic criteria of this EEC.
TSC Act	**"*Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions*"** is an EEC associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. Swamp Oak Floodplain Forest (SOFF) generally occurs below 20 m (rarely above 10 m) elevation. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees. SOFF has a dense to sparse tree	An alluvial formation occurs to the east of the site which meets the definition of a coastal floodplain. The floristic characteristics of this community however do not conform to the definition

Act	Literature Review	Occurrence Assessment
	layer in which Swamp Oak (*Casuarina glauca*) is the dominant species. Other trees including *Acmena smithii*, *Glochidion* spp. and *Melaleuca* spp. may be present as subordinate species. The understorey is characterised by frequent occurrences of vines *ie Parsonsia straminea, Geitonoplesium cymosum* and *Stephania japonica* var. *discolor*, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.	of this EEC.
TSC Act	"***Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregion***" has been listed as an Endangered Ecological Community since December 2006 on Schedule 1 – Part 3 of the TSCA 1995. Lowland Rainforest, in a relatively undisturbed state, has a closed canopy, characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes. Typically, the trees form three major strata: emergents, canopy and sub-canopy which, combined with variations in crown shapes and sizes, give the canopy an irregular appearance (Floyd 1990). The trees are taxonomically diverse at the genus and family levels, and some may have buttressed roots. A range of plant growth forms are present in Lowland Rainforest, including palms, vines and vascular epiphytes. Scattered eucalypt emergents may occasionally be present. In disturbed stands the canopy continuity may be broken, or the canopy may be smothered by exotic vines.	Vegetation on the site does not meet the floristic criteria of this EEC.
TSC Act	**"*Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions*"** is typically a closed forest, the structure and composition of which is strongly influenced by its proximity to the ocean. The plant species of this community are predominantly rainforest species while emergent *Eucalypts* or *Lophostemons* are present in some stands. This community grows only in coastal areas within maritime influence on sand dunes and soil derived from underlying rocks.	Vegetation meeting the floristic and geomorphological criteria of this EEC does not occur on site or in the study area.
EPBC Act	**"*Littoral Rainforest and Coastal Vine Thickets of Eastern Australia*"** is a Critically Endangered Ecological Community listed under the EPBC Act 1999, which is generally identical to the TSC Act listing.	Vegetation meeting the floristic and geomorphological criteria of this EEC does not occur on site or in the study

Act	Literature Review	Occurrence Assessment
		area.
TSC Act	A localised population of a distinctive variation of *Glycine clandestina*, identified as Glycine sp. "Scotts Head", has been listed as an Endangered Population. This population is restricted to part of the headland complex at Scotts Head.	The site is beyond the range of this population which only occurs at Scotts Head.
TSC Act	**"*Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregion*"** has been listed as an Endangered Ecological Community under the TSC Act 1995. Coastal Saltmarsh is the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons along the NSW coast. Characteristic species include: *Baumea juncea, Juncus kraussii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis, Zoysia macrantha.*	The site does not meet the floristic or geomorphological requirements of this EEC, hence it does not occur.
TSC Act	**"*White Box Yellow Box Blakely's Red Gum Woodland*"** is an EEC predicted to occur in Macksville, Dorrigo, Grafton, Kempsey, Korogoro Part, Nambucca, Coffs Harbour and Bare Part Atlas of Wildlife databases. This community is generally restricted to the tablelands and western slopes.	Vegetation on the site does not meet the floristic and geomorphological criteria of this EEC.
TSC Act	**"*Hunter Lowland Red Gum Forest in the Sydney Basin and North Coast Bioregions*"** is an EEC found on gentle slopes arising from depressions and drainage flats on Permian sediments of the Hunter Valley floor in the Sydney Basin and NSW North Coast Bioregions.	Vegetation on the site does not meet the floristic and geomorphological criteria of this EEC.
TSC Act	The "Population of *Eucalyptus seeana* in the Greater Taree Local Government Area" has been listed as an Endangered Population.	*Eucalyptus seeana* does not occur on the site, and is beyond the specified distribution of this Endangered Population.

Act	Literature Review	Occurrence Assessment
TSC Act	"***White Gum Moist Forest in the NSW North Coast Bioregion***" is an ECC characteristically dominated by White Gum (*Eucalyptus dunnii*) either in pure stands or with *E. saligna, E. microcorys* and/or *Lophostemon confertus* (NSWSC 2008a).White Gum Moist Forest typically occurs on the escarpment slopes and foothills of the north-east NSW, most commonly between 400 and 650 m elevation, where mean annual rainfall exceeds approximately 1000 mm and has a summer maximum (DECC 2007) on fertile soils. It is currently known from the local government areas of Clarence Valley, Coffs Harbour, Kyogle and Tenterfield.	White Gum does not occur on the site, thus the EEC does not occur.
TSC Act	"***Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions***" is a Critically Endangered Ecological Community (CEEC). This CEEC occurs on Carboniferous sediments (often on limestone) mainly on rocky slopes. The community typically forms a low closed forest dominated by low trees, shrubs and vines. The canopy is dominated by both varieties of *Elaeodendron australe* (Red Olive Plum), *Geijera parviflora* (Wilga), *Notelaea microcarpa* var. *microcarpa* (Native olive), and *Alectryon oleifolius subsp. elongatus* (Western Rosewood). Emergent eucalypts are common and include *Eucalyptus albens* (White Box), *E. dawsonii* (Slaty Box), and *E. crebra* (Narrow-leaved Ironbark). Hunter Valley Vine Thicket has been recorded from the local government areas of Muswellbrook, Singleton, and Upper Hunter (NSWSC 2007b).	This community does not occur on the site which is located outside the prescribed range, thus the EEC does not occur.
TSC Act	"***Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions***" is an EEC which occurs on Carboniferous sediments of the Barrington footslopes along the northern rim of the Hunter Valley Floor, where it occupies gullies and steep hill slopes with south facing aspects. The community usually forms a closed forest 15-20m high with emergent trees 20-30m high. Vines are abundant and there is a dense shrub and ground layer (NSWSC 2007c).	This community does not occur on the site which is located outside the prescribed range, thus the EEC does not occur.
TSC Act	***"Themeda* grassland on seacliffs and coastal headlands in the NSW North Coast, etc"** is an that belongs to the Maritime Grasslands vegetation class of Keith (2004) and its structure is typically closed tussock grassland, but may be open shrubland or open heath with a grassy matrix between the shrubs.	The site does not meet the floristic or geomorphological requirements of this EEC, hence it does not occur.

Act	Literature Review	Occurrence Assessment
TSC Act	***"Carex Sedgelands of the New England Tableland, Nandewar, Brigalow Belt South and NSW North Coast Bioregions***" is a preliminarily listed EEC **in marshy regions d**ominated by sedges, grasses and semi-aquatic herbs. The species dominants are *Carex appressa, Stellaria angustifolia, Scirpus polystachyus, Carex gaudichaudiana, Carex sp. Bendemeer, Carex tereticaulis and Isachne globosa,* either as single species or in combinations. Other common species include *Geranium solanderi var. solanderi, Haloragis heterophylla, Lythrum salicaria, Epilobium billardierianum subsp. hydrophilum and Persicaria hydropiper* (Hunter and Bell 2009).	The site does not meet the floristic requirements of this EEC, hence it does not occur.
TSC Act	'***Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions'*** is an EEC that generally occurs on floodplains and on floodplains and associated floodplain rises along the Hunter River and tributaries.	This community does not occur on the site which is located outside the prescribed range, thus the EEC does not occur.
TSC Act	**'*Coastal Cypress Pine Forest in the NSW North Coast Bioregion*'** is a distinctive vegetation community dominated by Coastal Cypress Pine (*Callitris columellaris*) and is typically found on coastal sand plains, north from the Angourie area on the far north coast of NSW.	The site is far beyond the known range of this EEC and the Coastal Pine does not occur, thus the EEC does not occur.

4.3. Fauna Survey Results

4.3.1. Habitat Evaluation, Corridors and Linkages

The following table summarises the habitat evaluation results and comments on regional/local corridors and habitat linkages.

Table 9: Summary of site habitat values

Habitat/ Attribute Type	Site/Study Area	Potential Values to Threatened Species Occurrence
Groundcover	Largely comprises a low grassland that is regularly slashed. Open groundcover of native grasses and herbs occurs in forest patches. The swamp forest vegetation features a dense and sometimes diverse ground layer of sedges, rushes, herbs and ferns (Photo 13).	Slashed areas have minimal value for threatened fauna species, however provide good grazing areas for macropods. Forested areas containing groundcover may provide cover for common species such as native and exotic rodents, frogs and reptiles. Groundcover in the swamp forest vegetation may provide habitat for threatened amphibians such as the Wallum Froglet which has been previously recorded in this community. Areas with a diverse groundcover in the swamp forest may also provide shelter for the Eastern Chestnut Mouse which has been previously recorded in this community.
Leaf litter	Sparse in derived grassland. Forest patches contain some leaf litter, especially around canopy trees. The swamp forest community does not have any well developed areas of leaf litter.	No significance for any threatened species.
Logs and debris	A few fallen logs and stumps occur in Blackbutt Grassy Forest (BGF) patches but are not hollow. Some old log piles are present.	Only likely to provide habitat for common rodents and reptiles. The log piles have potential to harbour feral species such as cats and foxes.

Habitat/ Attribute Type	Site/Study Area	Potential Values to Threatened Species Occurrence
Hollows	A total of 6 hollow-bearing trees were detected on site. These contained limb and trunk hollows ranging from small to large in size. Some of these hollows showed signs of fauna activity (e.g. scratches, worn or chewed edges). The Captain Cook tree (H1) was inspected by an arborist to determine the dimensions of the large hollows and evidence of fauna nesting/denning. It was found that this tree contained 17 hollows ranging from small branch hollows <5cm diameter to large trunk cavities of >50cm in diameter and at least 1.5m in depth (Photos 10-12).	Presence but overall low abundance of nesting/denning opportunities for hollow-obligate species such as Microchiropteran bats, Squirrel Glider, Brown Tree Creeper, Brush-tailed Phascogale and Little Lorikeet. Two hollow-bearing Trees (H1 and H3) contain large hollows which are potentially suitable for forest owls and the Glossy Black-Cockatoo. The only evidence of fauna usage of the Captain Cook Tree was a nesting Scaly-breasted Lorikeet in a small limb hollow.
Nectar Sources	Mainly summer flowering Eucalypt species present on site. Tallowwood flowers in mid-winter to early summer. Bloodwoods flower late summer to early autumn. Blackbutt flower in summer. The swamp forest contains a high abundance of flowering shrub and tree species including Leptospermums, Banksias, Melaleucas and Callistemons.	Eucalypts in study area highly likely to be used when flowering by Grey-headed Flying Fox. Other species with potential to utilise the resource include Squirrel Glider and Little Lorikeet. Some suitable species for winter migrants e.g. Swift Parrot. Flowering shrubs would also attract insects which are a prey source for Microchiropteran bats.
Sap and gum sources	Occasional Pink Bloodwood in BGF patches. This is a preferred sap source for the Squirrel Glider. Other eucalypt species are less preferred.	Site contains a potential sap resource for the threatened Squirrel Glider. Old sap incisions were noted on several Bloodwoods on the site indicating glider foraging activity in the past.
Primary preferred Koala browse trees	The site contained a total of 130 trees that are considered to be preferred by the Koala comprising 129 Tallowwood, and 1 Swamp Mahogany.	Site contains foraging habitat and preferred browse trees. No Koalas were observed on site, however scats were found under a single Tallowwood tree in the southwest of the site.
Allocasuarinas	Site contains Forest Oaks and Black Oaks (common in BGF patches, scattered in grassland), which are preferred foraging species for the Glossy Black Cockatoo, however 75% of these were immature.	Site contains some foraging resources for Glossy Black-cockatoo. No evidence of feeding (chewed cones) was observed during the survey.

Habitat/ Attribute Type	Site/Study Area	Potential Values to Threatened Species Occurrence
Aquatic/wetland habitats	Two constructed farm dams occur on the site (Photos 14 and15). These are fringed by aquatic plants. Mosquito Fish (*Gambusia sp.*) were present on both these dams. The swamp forest community on site and in the study area contains some areas of standing water, however the groundcover is dense throughout and there are no open water bodies. No defined watercourses are present in the study area.	Farm dams have limited potential for threatened amphibians due to the presence of Mosquito Fish. Their small size is unlikely to attract any threatened water birds. The swamp forest has potential to provide habitat for the Wallum Froglet, however it was not recorded during the survey. No suitable large wetland areas for threatened water birds such as the Black-necked Stork, Brolga, Blue-billed Duck, Australasian Bittern or Magpie Goose are present in the study area. Suitable habitat for these species does however occur on adjoining land to the north and east. No water bodies on site are large enough to support foraging by the Eastern Osprey or White-bellied Sea Eagle, however suitable foraging habitat for these species occurs in extensive wetland areas to the north and east. The Eastern Osprey was observed during the survey in swamp forest near the northern connector road.
Fruiting species	Very few fruiting species occur on the site.	Lack of potential foraging resources for threatened frugivores such as Wompoo Fruit-dove, Rose-crowned Fruit-dove, Barred Cuckoo Shrike and the Grey Headed Flying Fox.

Habitat/ Attribute Type	Site/Study Area	Potential Values to Threatened Species Occurrence
Forest bird habitat	Average to poor quality. Areas of diverse forest structure are limited to small stands with high exposure, edge effects and limited connectivity. The understory and shrub layer are largely removed across much of the site.	Blackbutt Grassy Forest habitat on site not large enough in area to support threatened forest/woodland birds such as the Flame Robin, Scarlet Robin, Black-chinned Honeyeater, Varied Sittella or Brown Treecreeper. The adjoining forest to the north is extensive and may potentially provide habitat for these species. The swamp forest habitat links to larger areas of forest to the east and has the potential to support the Varied Sittella.
Caves, cliffs, overhangs, culverts, bridges	Absent.	Absence of roosts for obligate Microchiropteran bats.
Small terrestrial prey	Likely to below prey abundance over most of the site due to lack of cover. Arboreal prey species such as possums and gliders are also likely to be in low abundance due to the lack of hollow-bearing trees.	Despite limitations on prey habitat, the site may form part of the foraging range of threatened forest owls (Powerful Owl, Barking Owl and Masked Owl) and raptors such as the Eastern Osprey, Square-tailed Kite, Little Eagle and Spotted Harrier. The low prey abundance means these species could only use the study site/study area as a very small part of their foraging range.
Corridors	Figure 7 shows that the northern part of the site falls within a Subregional Corridor.	This regional corridor provides connectivity from Laurieton in the south to Lake Innes Nature Reserve in the south and Cowarra State Forest in the west. May be suitable for threatened fauna species such as the Eastern Chestnut Mouse, Koala, Brush-tailed Phascogale and Rufous Bettong.

Habitat/ Attribute Type	Site/Study Area	Potential Values to Threatened Species Occurrence
Habitat Linkages	Much of the site is cleared or modified and linkages to forested areas offsite are poor. Tree stands on site are isolated. The swamp forest does however have strong habitat linkages to retained habitat to the east and north.	Highly mobile species only would likely utilise the cleared parts of the site (e.g. macropods, birds, forest owls and bats). The Squirrel Glider is unlikely to utilise any of the isolated tree stands, however is likely to use forest edges along the northern and western site boundaries. Small terrestrial species dependant on continuous cover (eg. Wallum Froglet, Eastern Chestnut Mouse) and gap shy birds such as the Varied Sittella may utilise the intact areas of swamp forest in the study area.
Key Habitat	North-west area of the site is mapped as key habitat, however this area comprises cleared land.	The site alone would not comprise key areas of habitat for any threatened fauna species.

Photo 10: Captain Cook Tree

Photo 11: Arborist climbing Captain Cook Tree

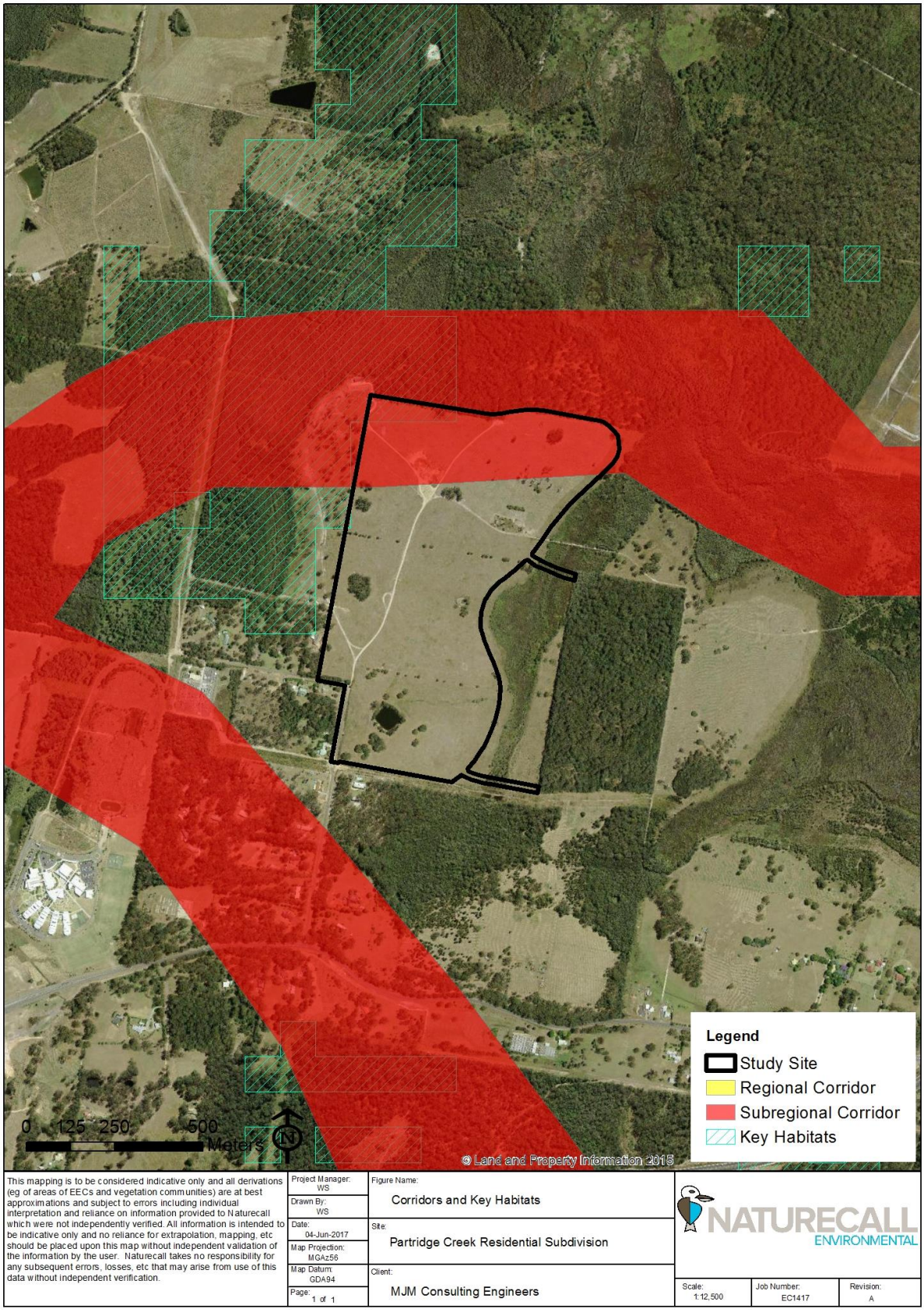
Photo 12: Largest hollow in Captain Cook Tree

Photo 13: Dense groundcover and shrub layer in swamp forest

Photo 14: Large farm dam located in south west of the study site

Photo 15: Smaller farm dam located in central east of the study site

Figure 8: OEH corridors and key habitats



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Project Manager: WS	Figure Name: Corridors and Key Habitats
Drawn By: WS	
Date: 04-Jun-2017	Site: Partridge Creek Residential Subdivision
Map Projection: MGAz56	
Map Datum: GDA94	Client: MJM Consulting Engineers
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4.3.2. Observed/Detected Fauna

The surveys detected a range of fauna species over the site. Birds were the most common species detected (37), followed by mammals (8) and then amphibians (3). No reptiles were detected on site.

A total of five threatened fauna species were detected during the survey (Figure 9) comprising the Eastern Osprey (Vulnerable TSC Act), Grey-headed Flying-fox (Vulnerable TSC Act and EPBC Act), Koala (Vulnerable TSC Act and EPBC Act), Little Lorikeet (Vulnerable TSC Act) and Powerful Owl (Vulnerable TSC Act).

The Koala was recorded via scats under two Tallowwoods in the southwest of the site (Figure 9; Photo 16). No other evidence of this species was found on site despite undertaking two dedicated SAT searches, diurnal searches, call playback and spotlighting.

Very few mammal species were recorded on site. Macropods consisting of the Eastern Grey Kangaroo and Red-necked Wallaby were common and several feral Deer were also observed. No arboreal mammal species (aside from the Koala) were detected.

A number of common woodland birds including the Australian Magpie, Kookaburra, Rainbow Lorikeet and Noisy Miner were detected in the sclerophyll forest patches and adjoining forest edges. The swamp forest habitats appeared to be the best bird habitat on site, and the high diversity of flowering shrub and tree species would provide a year-round nectar source for nectivorous species. Only a few bird species were recorded in the open grassland areas including the Australasian Pipit, Masked Lapwing, Brown Falcon and Jacky Winter.

Reptiles and amphibians were poorly represented on the site, and this is largely attributed to the lack of suitable habitats for these species and the agricultural management regime of the site. Table 10 provides the total fauna list for the site and the method of detection.

Table 10: Fauna species recorded on the site

Group	Common Name	Species	Detection Method
Mammals	Black Flying-fox	*Pteropus alecto*	Obs
	Dog*	*Canis lupus familiaris**	Scats
	Eastern Grey Kangaroo	*Macropus giganteus*	Scats
	Grey-headed Flying-fox#	***Pteropus poliocephalus#***	**Obs**
	Koala#	***Phascolarctos cinereus#***	**Scats**
	Long-nosed Bandicoot	*Perameles nasuta*	Diggings
	Red-necked Wallaby	*Macropus rufogriseus*	Obs
	Rusa Deer*	*Rusa timorensis**	Obs
Birds	Australian King-Parrot	*Alisterus scapularis*	Obs
	Australian Magpie	*Cracticus tibicen*	Obs, HC
	Australasian Pipit	*Anthus richardi*	Obs

Group	Common Name	Species	Detection Method
	Bar-shouldered Dove	*Geopelia humeralis*	Obs
	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Obs
	Brown Falcon	*Falco berigora*	Obs
	Eastern Osprey	***Pandion cristatus***	**Obs**
	Eastern Rosella	*Platycercus eximus*	Obs
	Eastern Spinebill	*Acanthorhynchus tenuirostris*	Obs
	Eastern Whipbird	*Psophodes olivaceus*	HC
	Eastern Yellow-robin	*Eopsaltria australis*	Obs
	Grey Fantail	*Rhipidura albiscapa*	Obs, HC
	Grey Goshawk	*Accipiter novaehollandiae*	Obs
	Grey Shrike-thrush	*Collurincla harmonica*	Obs, HC
	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	Obs
	Jacky Winter	*Microeca fascinans*	Obs
	Laughing Kookaburra	*Dacelo novaeguineae*	Obs
	Leaden Flycatcher	*Myiagra rubecula*	Obs
	Lewin's Honeyeater	*Meliphaga lewinii*	HC
	Little Corella	*Cacatua sanguinea*	Obs, HC
	Little Lorikeet	***Glossopsitta pusilla***	**Obs, HC**
	Little Wattlebird	*Anthochaera chrysoptera*	Obs, HC
	Noisy Friarbird	*Philemon corniculatus*	Obs, HC
	Noisy Miner	*Manorina melanocephala*	Obs, HC
	Pied Butcherbird	*Cracticus nigrogularis*	Obs, HC
	Powerful Owl	***Ninox strenua***	**Obs, HC**
	Rainbow Lorikeet	*Trichoglossus haematodus*	Obs, HC
	Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	Obs, HC
	Superb Fairywren	*Malurus cyaneus*	Obs, HC
	Torresian Crow	*Corvus orru*	Obs, HC
	Welcome Swallow	*Hirundo neoxena*	Obs, HC

Group	Common Name	Species	Detection Method
	Willy Wagtail	*Rhipidura leucophrys*	Obs, HC
	White-headed Pigeon	*Columba leucomela*	Obs
	White-throated Treecreeper	*Cormobates leucophaea*	Obs
	White-cheeked Honeyeater	*Phylidonyris niger*	OBS
	Yellow-faced Honeyeater	*Caligavis chrysops*	HC
	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	Obs, HC
	Yellow Thornbill	*Acanthiza nana*	Obs, HC
Amphibians	Common Eastern Froglet	*Crinia signifera*	HC
	Eastern Sign-bearing Froglet	*Crinia parinsignifera*	HC
	-	*Pseudophryne sp.*	HC

Bold: Vulnerable under TSC Act
- Vulnerable under EPBC Act
Observation Key: Obs – observation; HC – heard calling
*Denotes introduced species

4.3.3. Recorded Threatened Fauna Species

4.3.3.1. Koala

A total of 1438 Koala records are listed within the BioNet results within a 10km radius of the site (OEH 2017a). The Koala has also been previously recorded in the study area (but not on site) and on adjoining land during previous surveys in the area (ELA 2014, Peter Parker 2014, Biolink 2012, GHD 2007).

During this survey the Koala was recorded via scats found under two Tallowwoods in the south of the site. The SAT surveys undertaken over the site scored 6.6% (SAT 1) and 0% (SAT 2) activity. The development layout allows for retention of the Tallowwoods in the south of the site where the Koala was recorded, hence this foraging resource will remain post development.

The results of this survey show that the Koala still has an association with the site despite the overall lack of foraging habitat .The presence of wilds dogs on site (detected via scat) and the extensive cleared areas may also be a deterrent for the Koala. The retained habitat in the south of the site would therefore be likely to comprise only the disturbed fringe of a home range for a single Koala. Retained habitats on adjoining land (especially to the north and south) would form key foraging habitats and important linkages for the local population.

Photo 16: Koala scats located under Tallowwood in the southwest of study site

4.3.3.2. Grey-headed Flying Fox

A total of 117 Grey-headed Flying Fox records are listed within the BioNet results within a 10km radius of the site (OEH 2017a). The nearest Flying Fox camp is located approximately 6.5km to the east in Kooloonbung Creek Nature Park.

During this survey, several individuals were directly observed flying over the site. It is expected that the Grey-headed Flying Fox would use habitat throughout the site coinciding with seasonal variation in tree species flowering times. The site would make up a marginal fraction of the overall foraging potential throughout the locality. No known roost habitat is located on site.

4.3.3.3. Powerful Owl

Powerful Owl records in the locality are common, with 12 observations being recorded within 10km of the site (OEH 2017a). Of these records, the closest to the site is found 500m to the north. It has not been recorded on adjacent land by previous ecological surveys reported in ELA (2016).

During the survey, the Powerful Owl was recorded on the first night of call playback/spotlighting surveys (Photo 17). It was first heard calling some distance to the south of the site and gradually moved closer to the point of the call playback.

The site does not provide any significant area of foraging habitat for this species, and prey species are likely to be in very low abundance. The Captain Cook tree in the south of the site contains numerous large hollows

that may provide a suitable nesting site for this species. On closer inspection of this tree by an arborist, only one hollow at the top of the tree was found to be a suitable nesting site (Photo 9), however no evidence of current or prior nesting activity was found.

The Powerful Owl could potentially use this tree as a nest site, however this is considered to be unlikely given that it is relatively exposed and surrounded by cleared areas. Common species such as Brushtail Possums, Wood Ducks and Kookaburras would also compete with the Powerful Owl for the low number of hollows in the area.

Photo 17: Powerful Owl observed within the study site after Call Playback

4.3.3.4. Little Lorikeet

The Little Lorikeet has been previously recorded in the locality in the Bionet Wildlife Atlas (OEH 2017a), to the west of the site on Thrumster Street (Naturecall 2016) and on adjacent land to the northeast by Biolink (2012).

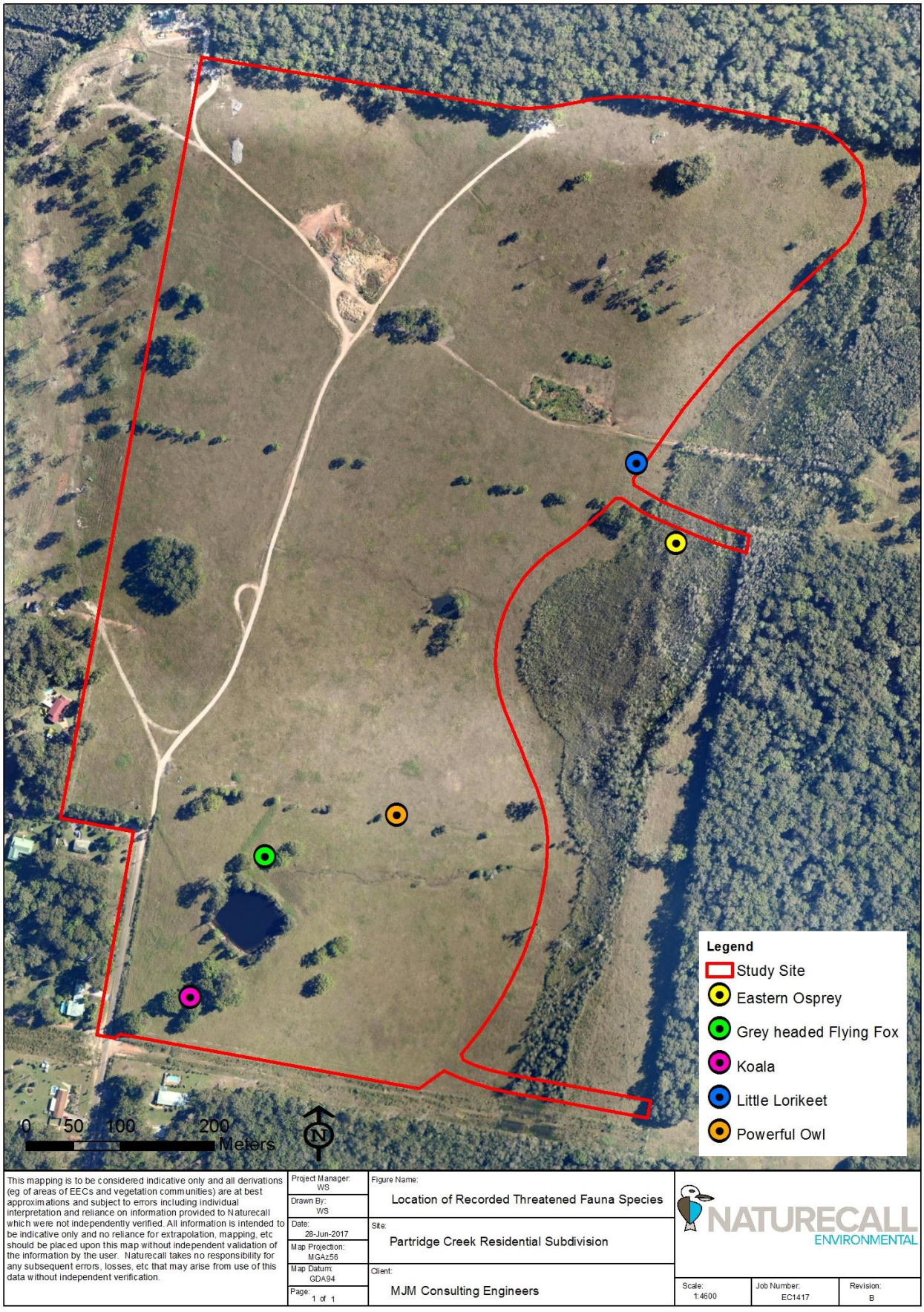
During the survey, a small flock was observed flying overhead near the proposed services easement in the northeast of the study area. The site overall lacks foraging habitat for this bird and it is most likely to forage over extensive areas of forest to the north, east and west of the site. Nesting opportunities in hollow-bearing trees are also limited on site. The few hollow-bearing trees that do occur are likely to be used by common birds such as the Rainbow Lorikeet, Scaly-breasted Lorikeet and Eastern Rosella.

4.3.3.5. Eastern Osprey

The Eastern Osprey has been recorded in the locality in the OEH Bionet (OEH 2017a), as well as on adjacent land to the north (ELA 2014, GHD 2007).

During the survey it was recorded perching in a tree in the swamp forest near the proposed services easement. While this species is likely to fly over the site on occasion, there is no suitable foraging habitat (i.e. large water bodies containing fish) in the study area. Given this lack of foraging habitat, the Osprey would also be unlikely to nest in the study area. The extensive wetlands to the north and east of the site, as well as the Hastings River located 3.5km to the north would provide foraging and nesting opportunities for the Osprey.

Figure 9: Location of recorded threatened fauna species



4.4. Potential Occurrence Assessment

Each of the species listed below in Table 11 have been evaluated for their potential to occur on the study site/area, as well as for the likely significance of the proposal and thus their eligibility for Seven Part Test and MNES assessment, in Appendix 1. From this assessment, the following species are considered to potentially use the site.

Table 11: Threatened species potentially occurring in the study area

Species	Occurrence Type	Occurrence Likelihood
Squirrel Glider	Potential foraging habitat and denning hollows present.	Low to fair chance of occurrence using adjacent forest habitats in the study area. Unlikely to use isolated forest patches on the site.
Eastern Chestnut Mouse	Foraging habitat in less disturbed areas of swamp forest with a dense groundcover.	Moderate chance of occurrence in swamp forest in study area given previous records.
Eastern Bent-wing Bat Little Bent-wing Bat Eastern Freetail Bat Greater Broad-nosed Bat Yellow-bellied Sheathtail Bat	Foraging over site as small part of range. Potential nesting hollows present.	Fair to moderate chance of using study area as part of local foraging movements.
Square-tailed Kite Little Eagle Spotted Harrier	Minute portion of large foraging territory. Generic potential nest trees.	Low to moderate chance as fly-over. Unlikely to nest on site given high exposure.
Masked Owl Barking Owl	Minute portion of large foraging territory. Unlikely to nest on site although there are hollows large enough present.	Low to fair chance of occurrence using site and study area as small part of foraging range.
Glossy Black Cockatoo	Generic potential foraging habitat.	Low to fair chance of occurrence foraging on site and in adjoining forested areas. Unlikely to nest on site.
Dusky Woodswallow	Generic potential foraging habitat	Low chance of occurrence as infrequent flyover.
Varied Sittella	Potential foraging and nesting habitat in swamp forest habitats in the east of the study area and forest edges along northern boundary.	Fair chance of occurrence

Species	Occurrence Type	Occurrence Likelihood
Brown Treecreeper	Potential foraging habitat in adjoining open forest to the north and west of the site.	Fair chance of occurrence given previous record to east of site.
Wallum Froglet	Generic potential foraging habitat.	Highly likely to occur in swamp forest habitat in the study area given previous records.

5.0 Impact Assessment

5.1. Direct Impacts

The proposed development includes establishment of a residential subdivision over the 55ha study site. This comprises 503 residential lots, one business lot and two open space areas. The subdivision is to be released over ten stages.

This would require the removal of the majority of the site vegetation apart from a 1.6 ha area in the south west which will become retained open space. The vegetation to be removed largely comprises slashed grassland with some areas of scattered trees, however an estimated 0.7ha of dry sclerophyll forest and 0.3ha of swamp forest will require removal. The two farm dams on site would also require draining and filling.

Three hollow-bearing trees which are located within the development footprint will require removal. A total of 97 primary Koala browse trees comprising 96 Tallowwoods and one Swamp Mahogany will require removal.

No other significant habitat features will be affected.

5.2. Indirect Impacts

The following potential indirect impacts may be associated with the proposal:

a) ***Fragmentation and landscape change*:** The proposal will contribute to local habitat loss and fragmentation, however the majority of habitat to be removed comprises isolated forest patches, scattered trees and pasture grassland.

   The greater impact will result from establishing the proposed connector road and services easement as these will sever currently intact swamp forest habitat. This combined with the loss of vegetation from the approved development of the adjoining L'Estrange land may result in the isolation of a large area of swamp forest and create a barrier for less mobile terrestrial species including the Wallum Froglet and Eastern Chestnut Mouse which have been recorded here.

   Establishing the connector road and services easement is unlikely to affect local movement of the Koala as they will not create major barriers. Fauna underpasses and floppy top fencing will allow for safe passage under the connector road and reduce the risk of road strike.

b) ***Injury/mortality during clearing:*** Three hollow-bearing trees will require removal, and there will be an injury/mortality risk to fauna that may be denning/nesting in these trees during clearing. Presence of an ecologist during all clearing activities will mitigate risks of injury to fauna. In addition, two farm dams will also require draining. These dams will likely contain a number of fish species as well as turtles. It is recommended that dewatering activities be undertaken in accordance with an approved Dewatering Management Plan.

   Koalas are also at risk of injury if they are present on site at the time of clearing. An ecologist /fauna spotter must be present prior to and during clearing activities to search for Koalas and ensure they

do not enter the site.

The swamp forest vegetation also contains dense groundcover which may provide shelter for a number of small mammals and amphibians, and clearing here would likely result in high mortality. Pre-clearing surveys and relocation of fauna by an ecologist in this area will serve to mitigate this impact.

c) ***Edge effects:*** Most of the vegetation on site and in the study area is currently exposed to edge effects due to current land use practices and historic clearing. The open/dry sclerophyll forest vegetation communities adjoining the site are not likely to be impacted by edge effects beyond levels which are currently experienced.

The Swamp Forest is highly likely to be impacted by edge effects as a result of the development, particularly given that the services easement will be constructed through an intact area of forest and new edges will be created. Potential effects may include weed invasion, wind damage, microclimate changes and feral species (eg deer) incursion.

These edge effects are unlikely to have any major adverse impacts on the Slender Screw Fern population given the extent of buffering vegetation around the ferns.

Vegetated buffers along the eastern edge of the swamp forest community are also currently being established. These will reduce potential edge effects.

d) ***Increased human presence:*** The site is currently vacant and has very little human presence. Residential human presence will significantly increase over time both on site and in the area as the total development is completed. Approved developments to the west, east and southeast will also contribute to this impact.

This has the potential to impact some fauna species that are not accustomed to human presence and other associated effects such as noise and lighting. Given that there is very little habitat to be retained on the site, this has the greatest potential to impact sensitive fauna (e.g. via avoidance, behavioural changes) in adjoining forested areas to the north, west and east.

Other environmental impacts of increased population on the site such as fertiliser use, runoff, waste disposal etc have also been considered as separate indirect impacts below.

e) ***Weed invasion:*** Lawns and gardens will be established around new dwellings, and it is possible that some plants introduced as garden ornamentals may escape and become weeds eg via dumping greenwastes over back fences. Sedimentation and flow of nutrients could also potentially increase the occurrence of exotic weed species eg adjacent to roads. Ongoing weed control will be required in areas of retained habitat on the site and in adjacent bushland.

Conversely, any planted fruit trees or flowering trees/shrubs may attract flying foxes or provide more structures for Microchiropteran bats to forage around, and passerine birds (potential prey species) to forage on.

f) Erosion and sedimentation: The greatest potential for erosion and sedimentation impacts will be within the swamp forest where the connector roads are proposed. Specific control measures will be required during construction and post-development to minimise impacts on surrounding aquatic habitats and threatened species, in particular the Slender Screw Fern population.

g) Eutrophication and pollution: Runoff and stormwater from roads and residential areas containing pollutants, herbicides and elevated nutrients have the potential to adversely impact the Swamp Forest community and Slender Screw Fern population to the east. Such impacts may include reduced water quality, floristic changes and impacts on aquatic and wetland fauna.

Stormwater should be managed to ensure contaminated runoff is directed away from sensitive aquatic habitat, and treated sufficiently before draining off-site. Detention basins and stormwater drainage are currently proposed along the eastern edges of the residential area adjoining the swamp forest. These structures will need to be carefully designed and maintained to ensure there are no adverse impacts on the adjoining sensitive swamp forest and wetland habitat.

h) Hydrological regime changes: Alterations to topography, vegetative cover, etc., can increase water shedding rates, concentrate runoff, and affect flood peaks. Soil compaction and construction of hard surfaces can also influence these factors, plus reduce infiltration, which can adversely affect plant growth, aquifer recharge, groundwater base flow and wetland regimes. *Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands* is listed as Key Threatening Process under the NSW TSC Act.

Given the topography of the site, there is a high risk that runoff from the development would affect the swamp forest community and the population of Slender Screw Fern through raising the water levels and impacting hydrology, floristics, fauna habitats etc.

Stormwater detention and drainage features proposed along the eastern boundary of the site must be adequately designed to cope with stormwater and runoff to ameliorate against such impacts.

i) Noise and vibration: Fauna occurring in the study area are likely to be accustomed to existing noise levels given that the airport is located <1km to the northeast, regular slashing of the site and major roads nearby. Thus the construction phase is unlikely to significantly increase this threat beyond that which already occurs in the study area. Beyond the construction phase, noise levels will be typical of a residential area.

j) Road kill: Roads in the new residential areas are unlikely to increase the incidence of road kill they will not bisect habitat and will be low speed. The proposed connector road in the southeast will pass through swamp forest habitat and may result in a high incidence of road kill unless specific mitigation measures are employed to reduce this risk. This may include construction of dedicated fauna underpasses, fencing, warning signage and speed reduction measures.

k) Introduction of feral species: Pets which have the potential to prey on native species (ie cats and dogs) are likely to be introduced to the site. If allowed to roam, these pets have the potential to prey on native fauna species in adjoining bushland, particularly to the north and east. Many of threatened species that have been recorded or could potentially occur here would be vulnerable to predation (eg. Koala, Squirrel Glider, Eastern Chestnut Mouse, Brown Treecreeper, microbats). Specific

measures will be required to reduce this risk.

6.0 UIA 13 KPoM Compliance Assessment

6.1. Introduction

Areas of Core Koala Habitat containing both "medium use" and "high use" are mapped within the northeast and southwest of the site (Figure 9). The proposal will require the removal of two Koala food trees (KFT) within areas of medium – high use as defined within the UIA 13 KPoM. Approximately 14 KFTs which fall with medium use areas will be removed.

The majority of the forested areas on site are mapped as Potential Koala Habitat. The Area 13 KPoM states that **development in Potential Koala Habitat** must meet either of the following provisions I. or II. as well as meeting provisions III. and IV:

I. Retention of preferred Koala food trees at a density averaging no less than 10 trees/ha, or

II. That a minimum of 20% of native vegetation that contains preferred Koala food trees and is within the area proposed for development has been retained in the form of one or more habitat linkages, or otherwise added to existing habitat areas.

III. Road design standards and /or approved vehicle calming devices must be incorporated into any subdivision design such that motor vehicles are restricted to a maximum speed of 60 km/hr.

IV. Part 6 (b-d) of the plan shall apply to any residential allotments that adjoin a Medium use area.

The relevant provisions of Part 6 (**Development in Core Koala Habitat Areas**) comprise the following:

a) Road Design Standards

   i. Road design standards and/or approved vehicle calming devices must be incorporated into all subdivision designs such that motor vehicles are restricted to a maximum speed of 40km/hour along minor residential streets and 50km/hr on collector roads.

b) Keeping of domestic dogs

   i. As a minimum, the keeping of domestic dogs in areas of Core Koala Habitat must be prohibited by an effective restriction as to user on the title of the land or other suitable planning measure. Council will also undertake enforcement measures.

c) Protection of Koala Food trees

   i. Preferred Koala food trees that occur within residential allotments must be protected by an effective restriction as to user on the title of the land.

   ii.

d) Fencing

   i. Notwithstanding provisions of the Swimming Pools Act 1992, fencing of residential allotments must not inhibit the movement of Koalas by virtue of providing an average minimum ground clearance of 250mm.

e) Development in "High Use" areas

   i. For the purposes of the plan, Development Precinct 4 must be regarded as a "High Use'" area

ii. The development of land within vegetated High Use areas of Core Koala Habitat for the purposes of providing a high-density residential subdivision is not supported unless compliant with section (iii) below.

iii. The Consent Authority may consider alternative development options on merit, subject to the following:

- The proposal must demonstrate by way of stadia survey that retention of all preferred koala food trees >150mm dbhob has been achieved and that such trees will not be negatively impacted by any subsequent development activities including roadworks, the construction of buildings, associated infrastructure and/or the provision of public utilities, and
- That the retention of native vegetation has been maximised

f) Development in "Medium (normal) Use" areas

i. Where subdivision and/or development of land for residential purposes is proposed within areas of Medium (normal) Use, subdivision design must demonstrate by way of stadia survey that retention of all preferred koala food trees >250mm dbhob has been achieved and that such trees will not be negatively impacted by subsequent development works including the construction of houses, associated infrastructure and/or provision of public utilities.

g) Landscaping

i. The use of preferred koala food trees must be demonstrated in the landscaping of all residential subdivisions within areas affected by Part 6 of the plan.

6.2. Compliance Assessment

6.2.1. Tree Removal

Establishing the development will require the removal of up to 97 primary browse species comprising Tallowwoods and Swamp Mahogany. These Koala food trees (KFT) are located in the following locations defined by the UAI Area 13 KPoM:

- 37 KFTs lie within land mapped as Potential Koala Habitat,
- 14 KFTs lie within land mapped as Core Koala habitat -medium use
- 2 KFTs lie in the north east of the study site within area mapped Core Koala Habitat - high use.
- 44 KFTS to be removed are located outside Core Koala Habitat or Potential Koala Habitat

With consideration of the information above and within Section 6.1, the proposed development cannot achieve compliance with Part 7, Part 6 (e) and Part 6 (f) of the Area 13 KPoM.

Given that only low numbers of scattered trees are located in Core Koala Habitat areas, their retention (outside the parkland area in the southwest) is not considered to be practical as trees in residential allotments are commonly removed at a later date by residents and it would encourage Koalas to enter the residential areas and be placed at risk of road strike and domestic dog attack. It is considered that the best option is to improve the condition of suitable koala habitat around the fringe of the proposed development area and to

exclude the koalas from the residential area. A variation to the KPoM to allow the trees to be removed is suggested as the best approach in this instance.

Koala activity survey as per Phillips and Callaghan 2011 Spot Assessment Technique was undertaken at two locations across the study site, as shown in Figure 5. One of these surveys was undertaken in the central west of the study site in Potential Koala Habitat (PKH), and another was conducted in the far south west within the area of 'medium use'.

The SAT undertaken within the PKH area recorded zero scats whilst the survey in the southern 'medium use' area returned two trees with scats, or 6.6% activity, which only constitutes a low activity score for east coast med-high environments. This data would suggest that the usage of the study site has decreased since the 2003 surveys which provided data for the development of the 2008 Area 13 KPoM. When considering current activity scores, it is considered unlikely that the study site would contain an area of Core Koala Habitat as defined by SEPP 44.

In order to achieve PMHC DCP compliance the proposed development must offset the removal of all KFTs at a ratio of 2:1, resulting in a total of 194 KFTs to be planted. These will be planted at 10m x 10m spacing's to maximise crown development and hence potential carrying capacity.

It is recommended that as a condition of approval, a comprehensive Vegetation Management Plan is developed to govern the location, planting specification, monitoring requirements and responsible entities etc. of the offset KFTs.

Whilst the current development proposal cannot meet all the provisions of the Area 13 KPoM, namely Part 7, Part 6 (e) and Part 6 (f), a net increase in the value of the study area and property for the local Koala population is considered likely once the fruition of the recommended offset Koala food tree plantings is achieved.

6.2.2. Keeping of Domestic Dogs

The study site is partially mapped as Potential Koala Habitat with Core Koala Habitat occurring within the northeast and southwest of the proposed development footprint. As per the KPoM, the keeping of domestic dogs in areas of Core Koala Habitat must be prohibited by an effective restriction as to user on the title of the land or other suitable planning measure. Given that very few Koala food trees will be retained in these areas of Core Koala habitat and that fences proposed around the E2/E3 zones should prevent Koalas entering residential areas and exclude dogs from entering the E2/E3 zones, the enforcement of this measure is not considered to be required.

6.2.3. Protection of Preferred Koala Food trees

Under the current proposal, only preferred KFTs within the open space area in the south will be retained. As previously stated, the preferred option for improving Koala numbers is to exclude them from the residential area and concentrate efforts to improve the quality/condition of habitat areas around the perimeter of the residential area.

It is likely that the older trees within the open space area will need to be pruned to meet Australian safety standards for communal open spaces. Apart from this necessary safety work, trees located here will be

protected through statutory mechanisms.

6.2.4. Fencing

The KPoM states that any future fencing within Core Koala Habitat areas are be Koala permeable. Given that very little Koala habitat currently occurs or is proposed to be retained within the Core Koala Habitat areas on site, this measure should not be required. Allowing Koalas to enter the residential areas will also place them at higher risk of road strike and dog attack.

Koala proof 'floppy top' fencing will be constructed along the eastern and northern edges of the site reduce the incidence of Koalas entering residential areas and dogs entering the E2 and E3 zones on the property.

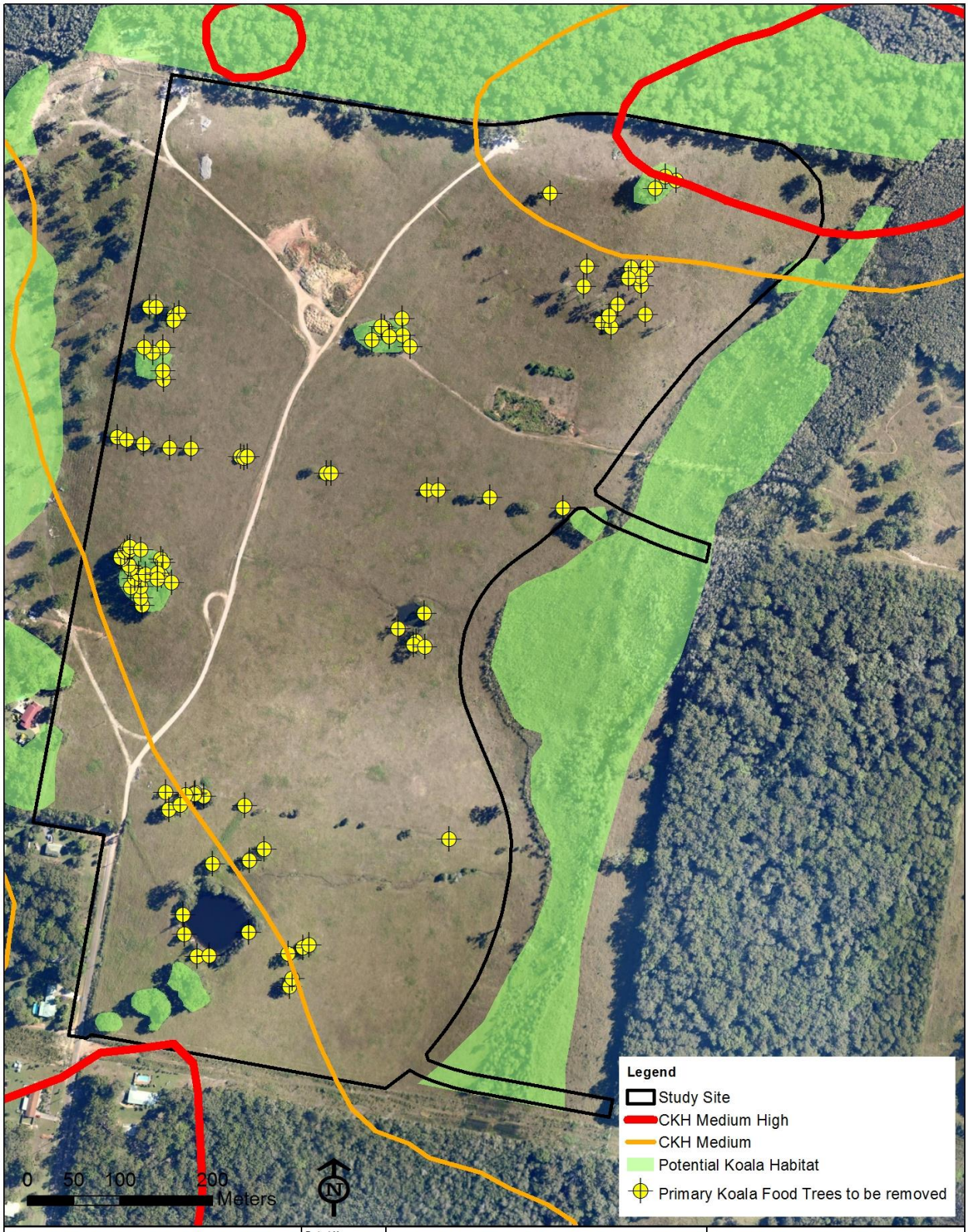
6.3. Conclusion

Under the current layout, the proposed development cannot meet a number of the specific provisions within the Area 13 KPoM, specifically Part 7, Part 6 (e) and Part 6 (f). This said, the current survey has identified that the local Koala population is not utilising the study site to the same extent as that which was recorded in Biolink's 2003 surveys, which could be attributed to a number of influences including surround developments, an overall decline in the Port Macquarie Koala population and the presence of key threatening processes such as dogs. Only one SAT out of the two undertaken recorded scats resulting in low activity.

Retaining Koala food trees in residential areas is also not recommend as previously discussed.

The proponent is obligated to offset the proposed removal of the 97 KFTs at a ratio of 2:1 under the PMHC DCP 2013. It has also been recommended that these offset plantings be undertaken in accordance with an approved Vegetation Management Plan. Provided this recommendation is adopted, it is considered likely that once the offset plantings have grown, the Koala population will have a net positive increase in the usability of the property as a movement corridor and an increase the amount of available foraging resource.

Figure 10: Area 13 KPoM mapping



This mapping is to be considered indicative only and all derivations (eg of areas of EECs and vegetation communities) are at best approximations and subject to errors including individual interpretation and reliance on information provided to Naturecall which were not independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping, etc should be placed upon this map without independent validation of the information by the user. Naturecall takes no responsibility for any subsequent errors, losses, etc that may arise from use of this data without independent verification.

Project Manager: WS	Figure Name: Area 13 KPoM Mapping
Drawn By: WS	
Date: 28-Jun-2017	Site: Partridge Creek Residential Subdivision
Map Projection: MGAz56	
Map Datum: GDA94	Client: MJM Consulting Engineers
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7.0 PMHC DCP Compliance Assessment

Under the Port Macquarie-Hastings Council Local Environmental Plan (PMHC LEP) 2011, Council has prepared and implemented the PMHC Development Control Plan (DCP) 2013. The DCP has a specific section titled Environmental Management. This section has relevant provisions for hollow-bearing trees, Koala food trees, Endangered Ecological Communities and riparian zones.

7.1. Hollow-bearing Tree Provisions

7.1.1. Tree Ratings

The DCP 2013 requires each hollow-bearing tree (HBT) to be assessed by an ecologist using the PMHC HBT assessment protocol. Based on the scores, the following provisions apply:

- Score <8: Tree may be considered for removal subject to compensatory measures.
- Score 8-12: Tree may be considered for removal if management measures are 'impractical to allow retention' (determined by an arborist) subject to compensatory measures.
- Score >12: Tree must be retained within an exclusion zone/buffer (minimum 1.25 X the tree height, measured horizontally), or located with an area protected as environmental land.

7.1.2. Hollow-bearing Tree Assessment

The following table summarises the results of the hollow-bearing tree assessment conducted during the survey (see Appendix 4 for full assessments). The approximate location (subject to GPS inaccuracies) of hollow-bearing trees on site is shown in Figure 12 and photographs are provided as Photos 18-23.

Table 12: Hollow-bearing tree assessment

Tree Species	Tree Number	Alive/Dead		Trunk DBH (cm)		No. Hollows		Hollow Size (mm)		Habitat Proximity		Longevity		Total Score
Blackbutt	1	Alive	3	80-100+	3	>5	3	>100	3	*In situ*	3	High	3	18
White Stringybark	2	Alive	3	<60	0	0-1	0	<50	1	>30	0	High	3	7
Blackbutt	3	Alive	3	80-100+	3	>5	3	>100	3	*In situ*	3	Medium	1.5	16.5
White Stringybark	4	Alive	3	80-100+	3	0-1	0	>50	2	>30m	0	High	3	11

Swamp Mahogany	5	Alive	3	80-100+	3	2-4	1.5	>50	2	<30m	2	High	3	14.5
Tallowwood	6	Alive	3	80-100+	3	>5	3	>100	3	<30m	2	High	3	17

Of the 6 hollow-bearing trees recorded on and adjacent to the site, three are proposed to be retained and protected in the residual habitat. These trees must be afforded a buffer comprising 1.25m X the tree height. Roads or other development must not occur in the buffer.

Three hollow-bearing trees (H2, H4, H5) fall within the proposed clearing footprint and cannot be practically retained. These are recommended to be removed subject to compensation measures comprising nest boxes.

7.1.3. Compensation Measures

The removal of the hollow-bearing trees shall be compensated with replacement nest boxes at a ratio of one box for every hollow removed. This will require the following number of nest boxes per category:

- 1 possum nest box
- 2 small glider/phascogale nest boxes
- 2 bat roost boxes

It is recommended that boxes are mounted in retained habitat to the north of the study site and within the open space area in the south of the site. This should be completed prior to clearing. Nest boxes are to be mounted on mature trees that do not contain hollows.

Boxes are to be constructed of ACQ treated timber and mounted by an ecologist at the appropriate height and aspect. A report detailing the details of nest boxes is to be provided to PMHC within 14 days of mounting.

Removal of hollow-bearing trees requires designation of recruit hollow-bearing trees. The E2 zones on the property contain numerous mature eucalypts that can be designated as recruit trees.

Figure 11: Location of Hollow Bearing Trees

Note: Locations approximate only and subject to GPS limitations

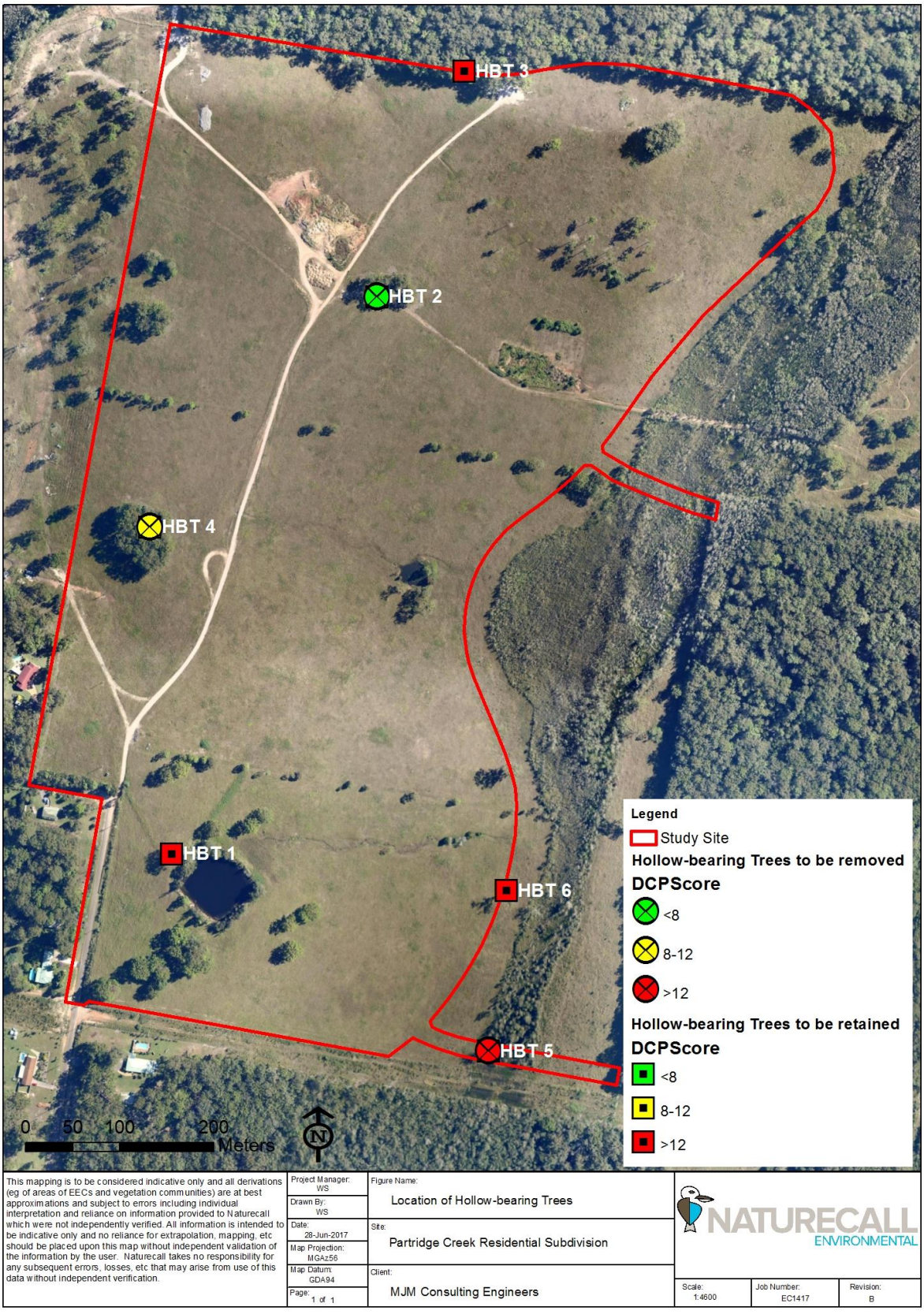


Photo 18: HBT 1 (Captain Cook Tree)

Photo 19: HBT 2

Photo 20: HBT 3

Photo 21: HBT 4

Photo 22: HBT 5

Photo 23: HBT 6 (just outside eastern study site boundary)

7.2. Koala Food Trees

The Port Macquarie Hastings Council Development Control Plan 2013 states that the removal of Koala browse tree species is to be replaced at a ratio of 2:1 on site or at a secure location offsite agreed to by Council.

There are 130 Primary Koala food trees (KFTs) all comprising Tallowwood, and Swamp Mahogany within the study site. The details of these are provided in Appendix 3. Of these trees, it is estimated that 97 fall within the proposed clearing footprint and will require removal (see Figure 13 below).

Under the DCP, the removal of these trees would require 194 Koala food trees to be replanted at 10m spacings. There is sufficient space on the remaining areas of the property to plant these trees (e.g either side of the E2/E3 zones to the east of the site).

These plantings will be managed under a Vegetation Management Plan.

7.3. Endangered Ecological Communities

The Port Macquarie Hastings Council Development Control Plan 2013 states that a minimum fully vegetated buffer of 35m must be provided for coastal floodplain EECs and a 50m buffer for all other EECs. The buffer cannot contain roads, infrastructure or an APZ. Buffers must also be provided for watercourses, with width depending on the size of the watercourse. Where different buffers apply to an area, the greater of the buffer widths apply.

The EEC *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* occurs on the site and in the study area and hence will require a 35m buffer. This buffer can be accommodated to most of the swamp forest community, including the areas which qualify as the EEC. The proposed connector road and services easement passing through the swamp forest are the only areas where the buffer cannot be achieved. The buffer to the swamp forest largely consists of previously cleared land, however it is currently being established via cessation of slashing which is allowing natural regeneration to occur. This buffer will assist in reducing indirect impacts to the EEC as discussed in Section 5.2 and 8.2.2.

7.4. Riparian Zones

There are no defined watercourses on the study site, hence the provisions for riparian zone buffers do not apply to the proposed development.

Figure 12: Location of Koala Food Trees

Note: Locations approximate only and subject to GPS limitations

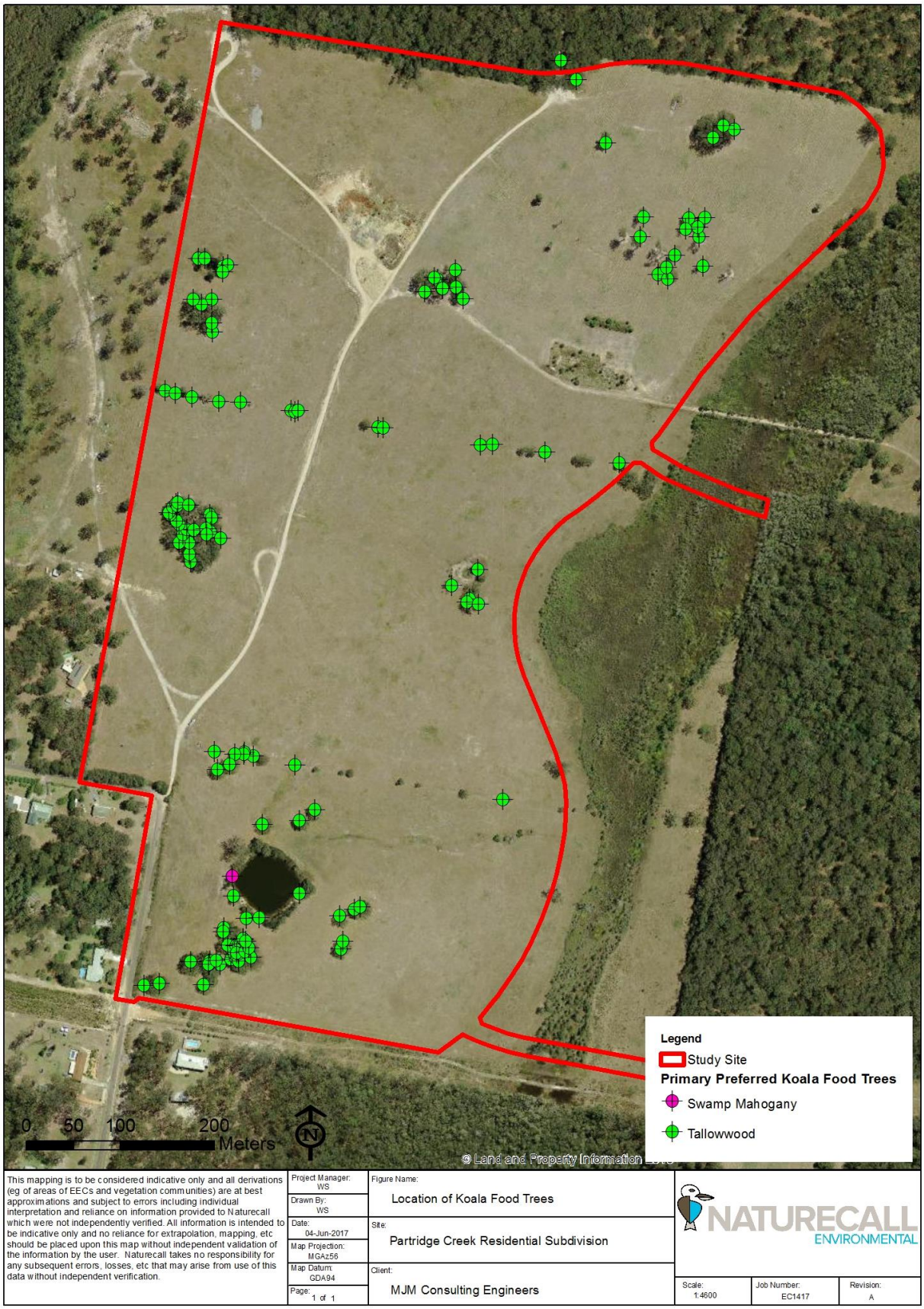
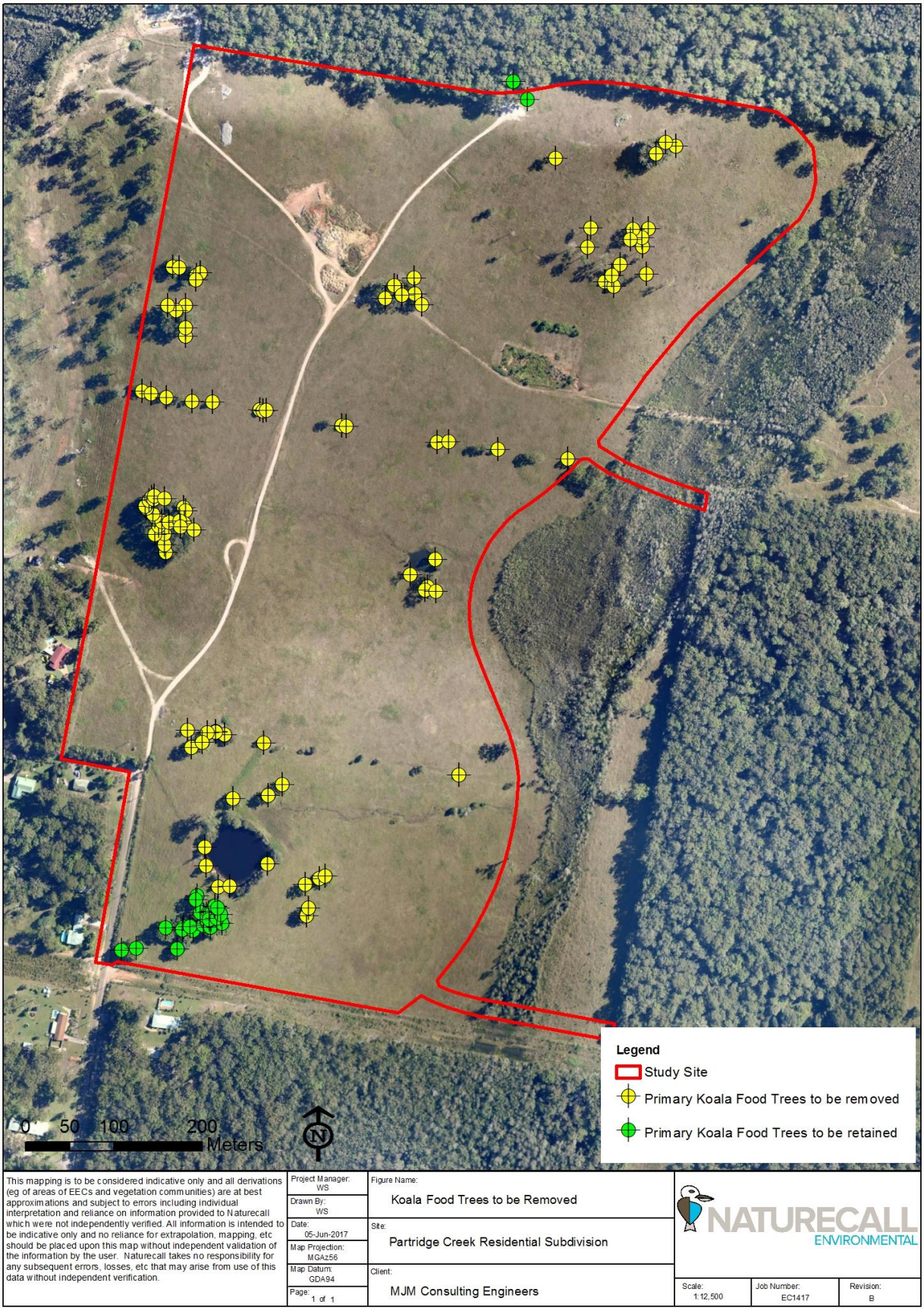


Figure 13: Koala food tree removal



8.0 Seven Part Tests Assessment

8.1. Entities to be Assessed

The 7 Part Tests are used to determine whether a proposed development is likely to have a significant negative effect on species, Endangered Ecological Communities, Endangered Populations and Critical Habitat (and their habitat) listed under schedules of the *Threatened Species Conservation Act 1995* (DECC 2007).

The 7-Parts of Consideration are described by Section 5A of the *Environmental Planning and Assessment Act 1979*, as amended by the *Threatened Species Act 1995* which in turn has been amended by the *Threatened Species Conservation Amendments Act 2002,* are listed in the following 7 Part Tests.

One EEC occurs on the site. This is automatically subject to the Seven Part Test.

The following threatened species were recorded in the study area during the survey:

- Slender Screw Fern
- Koala
- Grey-headed Flying Fox
- Powerful Owl
- Eastern Osprey
- Little Lorikeet

These species are automatically subject to the Seven Part Test.

As detailed in Section 4.4, the following species are subject to the 7 Part Tests as they are considered to have at least a low potential to use habitat in the study area at some time:

- **Mammals**: Squirrel Glider, Eastern Chestnut Mouse, Greater Broad-nosed Bat, Eastern Bent-wing Bat, Little Bent-wing Bat, Eastern Freetail Bat, Yellow-bellied Sheathtail Bat.
- **Birds**: Square-tailed Kite, Little Eagle, Spotted Harrier, Masked Owl, Barking Owl, Brown Treecreeper, Varied Sittella, Glossy Black Cockatoo, Dusky Woodswallow.
- **Amphibians**: Wallum Froglet

The guidelines associated with the revised factors have provided definitions for key terms with the most significant being that of the “local population” and “local occurrence” follows (DEC 2007a):

> “Local population: the population that occurs in the study area. The assessment of the local population may be extended to include individuals beyond the study area if it can be clearly demonstrated that contiguous or interconnecting parts of the population continue beyond the study area, according to the following definitions.
>
> - The local population of a threatened plant species comprises those individuals occurring in the study area or the cluster of individuals that extend into habitat adjoining and contiguous with the

study area that could reasonably be expected to be cross-pollinating with those in the study area.

- The local population of resident fauna species comprises those individuals known or likely to occur in the study area, as well as any individuals occurring in adjoining areas (contiguous or otherwise) that are known or likely to utilise habitats in the study area.
- The local population of migratory or nomadic fauna species comprises those individuals that are likely to occur in the study area from time to time."

8.2. Seven Part Tests Assessment

8.2.1. Seven Part Test Structure

To minimise repetition and superfluous information, the responses to the 7 Part Tests are structured as follows:

- In Part (a), species are grouped together based on broadly common ecology (i.e. mobile bird species such as the owls or species with similar habitats such as the Microochiropteran bats) or similar impacts, and subject to a common 7 Part Test response to part (a).
- Part (b) deals with Endangered Populations of which none are relevant to the proposed development. In Part (d) and (f) all of the subject species are collectively assessed. Part (c) applies specifically to EECs, and the site recorded EEC is assessed here. Part (e) deals with Critical Habitat, which is not relevant to the proposed development.

8.2.2. Seven Part Test Responses

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The proposal will result in the loss/modification of around 0.7ha of dry sclerophyll forest on the site and 0.3ha of swamp forest, along with pasture grassland and scattered trees. The impact of the proposal will vary in significance and context per species/species groups as follows:

Large range/highly mobile species

For potentially occurring species that are highly mobile and have extensive ranges in terms of hundreds if not thousands of hectares (i.e. Square-tailed Kite, Little Eagle, Spotted Harrier, Eastern Osprey, Grey-Headed Flying Fox, Glossy Black Cockatoo, Little Lorikeet, Dusky Woodswallow, forest owls, Microchiropteran bats), the development will result in the removal of potential foraging habitat over the site which may be used for foraging as a small part of their territory. This is recognised as negative (incremental and accumulative) effect on the current carrying capacity of the study area and a contribution to the main threatening processes affecting these species.

However, while the overall effect will be generally negative; due to the ecology of these species and presence of extensive areas of forest adjacent and within range of the site (e.g. Lake Innes Nature Reserve, State Forests), more than sufficient habitat will remain for the local populations of these species to forage as part

of their wider range, hence the proposal will essentially constitute a relatively minor contraction on the fringe of their wider range.

Three hollow-bearing trees are proposed to be removed on site. These contain potential nesting habitat for the smaller hollow obligate species ie. Little Lorikeet and Microchiropteran bats. This is recognised as a negative effect given the rarity of these features in the local landscape. Nest boxes will however replace the loss of these hollows which, along with the three retained hollow-bearing trees, breeding and nesting functions of these potentially occurring species can continue.

As such, while the proposal will remove some potential habitat for these species, the loss would not be expected to result in the decline of a local population due to the extent of alternative available habitat and proposed compensatory measures.

Squirrel Glider

For the Squirrel Glider, the site contains small areas of suitable foraging habitat and some of the hollow-bearing trees on site may offer potential denning hollows. A few trees on the site showed evidence of past Glider feeding activity (old sap incisions), but no fresh/weeping sap incisions. This species is only considered to have a low potential to occur as it was not detected during surveys, there is very limited potential habitat on site, there are no recent nearby records and there was no evidence of recent feeding activity on site.

The proposal will impact a potential local population of the Squirrel Glider via removal of an estimated 0.7ha of dry sclerophyll forest comprising isolated patches of forest surrounded by derived grassland. This will remove a small extent of foraging resources for this species such as nectar/gum sources and prey habitat.

The best potential habitat for this species in the study area occurs to the north of the site, and this will not be directly impacted by the development.

Three hollow-bearing trees are likely to be removed for the proposal, and these could potentially offer denning habitat to a local population, although this is unlikely given that they are isolated from surrounding intact habitats. The installation of nest boxes on the property to offset this loss will ensure that the retained habitats over the study area and property continue to provide a denning resource for this species.

Establishment of a residential subdivision on site will also increase anthropogenic impacts such as noise and artificial lighting. Future residents are also likely to keep pet cats which can prey on Squirrel Gliders. Given that there will very little habitat retained in the residential areas, and provided there is an effective separation of residential areas and retained bushland on the property and adjacent land, this is unlikely to impact the Squirrel Glider.

Despite the minor negative impacts associated with the proposal, it is expected that a potential local colony of this species would continue to use the remaining habitat in the study area and adjoining interconnected habitats. This species currently occurs in developed parts of Port Macquarie, hence increased human presence is not considered an effective deterrent.

While the proposal will have a net negative impact on these species, incrementally and cumulatively contributing to the loss of habitat resources, given that the availably of potential denning hollows will not be reduced and the extent of habitat remaining on adjacent land, the proposal is unlikely to result in the loss of

viability of a local population.

Koala

During the survey the Koala was only detected through scats found under two Tallowwoods in the south of the site. There are numerous records of the Koala on surrounding land to the north, east and south of the site. Approximately 15 records occur on the L'Estrange land to the east and southeast of the site and there are several nearby records to the north (ELA 2016).

The site falls within the boundary of the Area 13 KPoM (Biolink 2008) and contains areas of Core Koala Habitat (medium and high usage) in the southwest and northeast (Figure 7). All of the Blackbutt Grassy Forest patches on site and the swamp forest to the east are mapped as Potential Koala Habitat.

Given the survey results, it is likely that the retained trees in the south of the study site would form the disturbed fringe of a Koala's home range which is likely to be centred on habitat to the south. This also suggests that the usage of the study site has decreased since the 2003 surveys which provided data for the development of the 2008 Area 13 KPoM. When considering current activity scores, it is considered unlikely that the study site would contain an area of Core Koala Habitat as defined by SEPP 44.

The proposal will result in the removal of approximately 0.7ha of Potential Koala Habitat and 97 preferred Koala food trees which are either isolated paddock trees or are located in the several forest patches on site. The patch of Tallowwoods in the south where scats were found will be retained.

The removal of these trees will be offset via Koala food tree plantings on the property and retention/regeneration of areas of existing Koala habitat to the north and east. These compensation measures will see the lost habitat on the site replaced over time. The Koala food trees on site will also be removed gradually through the various stages of the development which will allow time for the offset plantings to establish before all of the current trees on site are removed.

In the short term, the loss of this vegetation on site will reduce the amount of potential available habitat to the local Koala population. Given that most of the site habitat currently shows no usage by Koalas, and the habitat in the south that did recorded Koala usage will be retained, the loss would not be expected to result in nutritional stress or reduced fecundity of the local population.

Retention of Koala habitat and preferred food trees within the proposed residential areas on site is also not recommended as this may attract Koalas to enter these areas and be placed at risk of road strike and dog attack. Further, individual trees retained within residential allotments have a high likelihood of being removed by future residents.

It is acknowledged that the proposal has the potential to impact the local Koala population through an increased risk vehicle strike both along the proposed connector road in the east and on Thrumster Street which will see a large increase in traffic volumes. A number of mitigation measures are proposed to reduce this risk including providing Koala proof fencing.

While the proposal will have the negative effect of removing a large number of Koala food trees, given the extent of habitat that will remain on the property and in the local area, the mitigation measures proposed, and that the local population would range well beyond the site, the proposal would be unlikely to place the

local population at risk of extinction.

Varied Sittella and Brown Treecreeper

The small areas of vegetation on the study site are generally considered poor potential habitat for these species given their isolation and high exposure. Adjacent forest to the east and north does however offer generic potential foraging and breeding habitat for these species, and the Brown Treecreeper has been recorded on adjacent land to the east by Biolink.

The proposal will result in the loss of an estimated 0.7ha of open forest and 0.3ha of swamp forest for these species and up to 5 potential nesting hollows for the Brown Treecreeper, although a number of these are likely to be unsuitable due to insufficient size and competition with common birds. The best hollow-bearing trees in the study area will be retained and nest boxes will be erected on the property to replace the hollows proposed for removal.

The minor loss of generally low quality habitat associated with the proposal is unlikely to adversely impact these species, given that potential local population would be reliant on retained habitats on adjacent and nearby land.

A number of indirect impacts associated with the proposal such as cat predation, edge effects and higher human presence have the potential to negatively affect these birds, especially along the edges of the retained forested habitat to the north and east of the site. This may lead so some behavioural changes and avoidance of areas close to human occupation, however there is likely to be sufficient habitat on surrounding lands to allow these birds to adjust their territory if necessary.

Overall, while the proposal will have a negative impact on the current habitat potential of the site and contribute to the threatening processes responsible for the decline of these species, it is unlikely to place a local population at risk of extinction.

Wallum Froglet

The Wallum Froglet was not detected by this survey, however it has been recorded by a number of previous surveys on the property and adjacent land to the north (ELA 2014, ERM 2008, GHD 2007, Biolink 2006).

The only habitat within the study site for this species is the swamp forest which will be impacted by the proposed road and services easement connecting to the L'Estrange land to the east. The Wallum Froglet has been previously recorded in this swamp forest community, and while it was not recorded during the current survey it is still considered to be a potential occurrence. This habitat extends to extensive swamp habitat in the north and northeast, and a local population of the Wallum Froglet would not be confined to habitats in the study area or property.

The proposal will remove an estimated 0.3ha of habitat for this species on site to establish the connector road and services easement. Given the large extent of remaining habitat on the property and adjacent land, this loss is unlikely to result in a decline of the local population. The swamp forest habitats are also zoned E2 and E3, and as such will be afforded long term protection.

The proposed 4m wide services easement will bisect the swamp forest community, fragmenting the current north-south linkage through the property. This would be able to be crossed by the Wallum Froglet, however

would increase the risk of predation.

The proposed connector road in the south will also pass through potential (although lower quality) Wallum Froglet habitat. A wildlife underpass will be constructed here which will allow passage under the road.

Associated with the proposal is a number of secondary impacts which may affect the Wallum Froglet such as reduced water quality, sedimentation and increased anthropogenic disturbance such as noise generated from traffic. Potential water quality impacts may be mitigated through standard control measures, adequate design of drainage and stormwater systems and regeneration/plantings along the swamp forest edges which will create a buffer to the residential areas.

Overall, while the proposal will have the negative impact of removing habitat and reducing connectivity, given the extent of habitat remaining on the property and adjoining lands, that no permanent barriers will be created and the mitigation measures proposed, the order of magnitude of impacts associated with the proposal is not considered likely to be sufficient to place a local population of the Wallum Froglet at risk of extinction.

Eastern Chestnut Mouse

Due to its ecological preference for dense vegetative cover, the Eastern Chestnut Mouse is likely to be highly sensitive to any process that reduces vegetative cover e.g. grazing, fire, logging and clearing. In the context of the site, the previous history of clearing, cattle grazing and regular slashing have modified the most of the study site to the point that it would be unlikely to support this species. The swamp forest in the east of the study area is considered to represent the only potential habitat for this species due to the dense groundcover layer present, and it has been recorded in this area during previous surveys (ELA 2016). No trapping surveys were undertaken as part of this study, however this species is still considered to have a moderate chance of persisting in the study area. Numerous records also occur on adjoining and nearby land to the north and east (OEH 2017a, ELA 2016).

The proposal will remove up to 0.3ha of swamp forest habitat for this species for the proposed connector road and services easement. The potential impact on breeding, foraging success and persistence of the local population is expected to be minimal given the presence of large areas of similar and higher quality habitat available adjacent.

The construction of the proposed connector road and services easement through the swamp forest will reduce connectivity through the site and may pose a barrier to this species. Fauna underpasses will be established under the road, however this would still require the Eastern Chestnut Mouse to cross open ground and be placed at risk of predation. Regeneration of groundcover along the services easement is likely to allow the Eastern Chestnut Mouse to cross this clearing safely.

Overall, while the proposal will reduce the amount of potential habitat available to the local population and increase secondary impacts, it is considered that neither breeding nor foraging success of the Eastern Chestnut Mouse is likely to be significantly affected. Therefore the proposal is unlikely to affect its lifecycle such that a viable population is placed at risk of extinction.

Slender Screw Fern

The Slender Screw Fern was recorded in the study area during the survey. This species was only found in a small section of the swamp forest community to the east of the site as detailed in Section 4.2.2. It was found growing on the edges of the swamp forest with associated species including *Melaleuca quinquenervia*, *Eucalyptus robusta*, *Melaleuca linariifolia*, and a dense groundcover of sedges, herbs and ferns such as *Gleichenia dicarpa, Blechnum indicum, Dampiera stricta, Baumea rubiginosa, Chorizandra cymbaria* and *Casutis recurvata*.

The site occurrence is a very important record of the species given that is has only been previously recorded from a few locations between Grafton and Coffs Harbour (OEH 2017a, Plantnet 2017). It also occurs in Queensland where it is more common.

The population appears to be contained within the E2 zone on the property, however may slightly extend into the E3 zone. The population covers an area of approximately 450m^2 and may number several hundred individuals. No other populations are known to occur in the area at this stage, hence this small patch currently represents the local population of the fern. The small size and limited distribution of this fern makes it vulnerable to extinction via direct and indirect impacts as a result of development and stochastic events.

The full extent of the population on site was not determined during the survey, however it has potential to extend further north and south of the known location and also beyond the study area given the presence of suitable habitat over the property and adjoining land.

The fern is growing in the footprint of a former proposed road which is now no longer required. A services easement is however required in this area and will consist of a cleared easement between the development footprint and the L'Estrange development to accommodate sewerage and other essential services. The location of the easement has been moved to the south to avoid the Slender Screw Fern population and allow a 40m vegetation buffer (see Figure 6).

The proposal will not result in the loss of any Slender Screw Ferns. The population would therefore be highly likely to continue to be viable in the study area post development provided indirect impacts and other threats are managed. The proposal will however remove a small area of potential habitat that this species could expand into as a result of clearing for the services easement.

There are a number of indirect threats to the Slender Screw Fern which may arise from construction activities and subsequent development nearby including weed invasion, alterations to hydrology, pollution and increased nutrients from runoff.

Erosion, sedimentation and weed hygiene will need to be managed during construction of the residential development area and services easement to ensure offsite impacts are mitigated. Similarly, runoff and stormwater from the development must be effectively effectively managed to ensure hydrology of the Swamp Forest is not altered and that water is sufficiently treated before being discharged.

Edge effects potentially arising from the services easement clearing are unlikely to affect the Slender Screw Fern given the amount of buffering vegetation that will remain. Increased human presence in the area may lead to people entering or walking along the edge of the Swamp Forest which could potentially trample the Slender Screw Fern or spread weeds and pathogens. Fencing that is proposed to be constructed along the perimeter of the E2/E3 zone would prevent public access to this area, hence this is not considered a

significant risk.

Given that the fern is only known to grown in a very restricted area on the property, there will need to be careful management and monitoring in place to ensure its survival is not threatened by development of the site along with other approved developments nearby. A monitoring program is recommend to commence during construction to monitor the population and determine if any changes or further recommendations are needed to maintain viability.

Providing that the recommendations of this report are implemented and successful in reducing impacts, and an adaptive approach to management is taken, the proposal would be unlikely to place the long term survival of the local population at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

No Endangered Population occurs on site or in the study area, hence none are affected by the proposal.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

The EEC *Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner Bioregions* occurs on the site and in the study area. As described in Section 4.2.3, it comprises the swamp forest community located on alluvial soils to the east of the site and partially within the footprint of the connector road and services easement. The land on which this community occurs is zoned as E2 or E3 under the PMHC LEP 2011.

An estimated 0.3ha of swamp forest EEC will require removal for construction of the road and services easement connecting to adjacent land east of the site. The remaining EEC in the study area will be retained and protected. This EEC is well represented in the area and extends well beyond the study site. In this context, the EEC that falls within the development footprint represents a fraction of the local extent, and its removal would not place the local occurrence at risk of extinction. In addition, regeneration of formerly cleared areas of swamp forest EEC is proposed, along with planting of Swamp Mahogany in low lying parts of the property.

Given that a large residential development is proposed to be established within close proximity to this EEC, indirect impacts have the potential to arise and adversely impact the EEC. These include edge effects (eg weed invasion, microclimate changes), impacts on water quality from polluted runoff and changes in hydrology.

At present, this EEC is bordered by cleared land to the east and is already subject to high edge effects. Slashing has been ceased along the western edge of this community to allow regeneration of a buffer to the development footprint. This will assist in reducing edge effects and potential impacts from runoff.

Stormwater and runoff from the residential areas will be directed to swale drains leading to 5 retention basins located around the edges of the site. These will prevent runoff directly entering the swamp forest community in the east which could alter the hydrology. It will also ensure any runoff containing pollutants or elevated nutrients will not flow directly into the EEC.

There is a risk that new residents will enter the swamp forest and other forested areas adjoining the site. This could potentially damage these sensitive environments via track creation and spreading of weeds. To reduce this risk and provide separation of landuses, fencing will be established along the entire swamp forest boundary.

In consideration of the minor potential for direct and indirect impacts on the EEC and the ameliorative measures recommended, the proposal is unlikely to place the local occurrence of the EEC at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed,

The proposal will see around 0.7ha of open forest and 0.3ha of swamp forest removed which includes three hollow-bearing trees. Two farm dams on site will also be removed. A total of 97 preferred Koala food trees fall within the development footprint and will require removal.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action,

The study site contains very limited forest habitats and connectivity over the site is poor due to the large areas of slashed grassland devoid of trees and understorey vegetation. The dry sclerophyll forest vegetation on site proposed to be removed currently does not form a key local linkage as it only comprises patches of forest isolated from nearby forested areas by slashed grassland.

The swamp forest in the east of the study area provides a north-south linkage through the property and to extensive habitats on adjacent land to the north. The dense vegetation in this community offers habitat for small terrestrial mammals and amphibians such as the threatened Eastern Chestnut Mouse and Wallum Froglet.

The new connector road proposed in the south east of the site is located adjacent to a cleared and slashed powerline easement which currently creates a large gap and a potential barrier for small terrestrial species. The new road will extend this cleared area northward by approximately 20m, however will not create a new barrier to fauna or isolate any habitat. The road design has allowed for fauna underpasses to be constructed under these roads. Fencing will also be established along the edge of the road to prevent access to the road corridor by Koalas and other fauna species. This should allow the continued movement of fauna through this habitat and also reduce the risk of road strike.

The proposed services easement clearing in the north will however pass through currently intact habitat and create a new gap in vegetative cover of up to 15m during construction of the easement and services. This is unlikely to affect mobile species such as birds, bats or macropods. For small terrestrial species dependant on continuous cover, this clearing has the potential to create a barrier to movement, especially during

clearing and construction activities. After the easement has been established, it is likely that some vegetation may be allowed to regrow and a 4m wide easement would be maintained as a low grass cover for maintenance. Small terrestrial species such as the Wallum Froglet and Eastern Chestnut Mouse would be able to cross this gap, however may be placed at a higher risk of predation.

Given that no permanent barrier will be created for the subject species, no habitat is likely to become isolated as a result of the proposal.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

As noted in part (a), the site offers known and potential foraging, refuge (denning, roosting, etc.) and possibly breeding habitat for a number of threatened species. However, the range of all the species is considered likely to extend well off the site due to the limited extent of the site habitat and hence finite resources.

The exception is the Slender Screw Fern which appears to consist of a small and localised population on the property. This fern does not occur in the development footprint and the small about of potential habitat to be removed for the services easement is unlikely to affect the long-term survival of this species given the large areas of suitable habitat remaining on the property and adjoining lands.

For the other subject species and EEC, the remaining habitat on site is not of sufficient extent to be of any key importance to their long term survival in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

The site is not critical habitat declared, under Part 3 of the TSC Act.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

Draft/final recovery plans have only been prepared for the Forest Owls, Grey-headed Flying-fox and Koala (DEC 2006, DECCW 2009, DECC 2008).

For these and all other all species, the proposal will remove vegetation from the site which by strict interpretation could be considered as adding to the main threatening process affecting these species (habitat loss) , and hence is inconsistent with the recovery of these species.

The subject species are now also addressed under a Species Action Statement (SAS). The following table shows the management streams for the new Saving our Species threatened species conservation funding program and the subject species that fall into each category. As shown, the recovery actions identified have limited relevance to the proposal and generally relate to the actions of government authorities.

Table 13: Management streams and recovery actions for the subject species

Management Stream	Species	Actions
Site managed species	East-coast Freetail Bat Slender screw Fern	No conservation projects have been developed for the Eastern Freetail Bat. The Slender Screw Fern has a current conservation project which is being undertaken at two sites (Fortis Creek National Park, Bongil Bongil National Park). This involves monitoring of species abundance, extent and condition, threat analsyis and weed control.
Iconic species	Koala	In areas where a koala population is present, undertake planting to restore and increase the area of koala habitat. Restoration and augmentation planting and/or direct seeding should use appropriate feed and shelter tree species in areas of degraded and/or potentially suitable habitat. Revegetation should focus on expanding existing smaller areas of known occupied habitat, including private land, and connecting areas of suitable habitat to create corridors for movement. Resources for long-term monitoring and management of revegetated areas should be included.
Landscape managed species	Squirrel Glider, Grey-headed Flying Fox, Bent-wing bats, Greater Broad-nosed Bat, Powerful Owl, Masked Owl, Square-tailed Kite, Little Eagle, Little Lorikeet	These species are managed by: • Broadscale vegetation and habitat management programs, e.g. replanting or weeding • Land clearing controls regulated through the *Native Vegetation Act 2003* and the *Environmental Planning and Assessment Act 1979* • Water sharing plans for riparian and floodplain ecosystems and species that depend on them • Programs to manage coasts, estuaries and coastal wetlands • The management of national parks and reserves under the *National Parks and Wildlife Act 1974.*

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The TSC Act 1995 defines a "*threatening process*" as "a *process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities*". Loss and fragmentation of habitat due to urban, residential and rural development is a recognised threat to these species (Smith *et al* 1995, Lindenmayer and Fisher 2006, Johnson *et al* 2007, Smith *et al* 1995, Gibbons and Lindenmayer 2002, OEH 2017b, NPWS 1999b, Watson *et al* 2003, Gilmore and Parnaby 1994, NPWS 2003b, etc.). The proposal thus generically qualifies as a class of activity that is considered a threatening process.

For all of the subject species, the proposal will or may contribute (to varying extents) to the following Key Threatening Processes:

Table 14: Key threatening processes

KTP	Extent/Manner Which Proposal Affects KTP	Mitigable?
Clearing of native vegetation (NSWSC 2001c).	Removal of an estimated 1ha of native vegetation.	Vegetation removal required to establish future development. Offset plantings and natural regeneration will occur over E2 and E3 zones on the property.
Human caused climate change (NSWSC 2000d).	As above and generation of greenhouse gasses by machinery during construction.	As above.
Loss of Hollow-bearing trees (NSWSC 2007).	Three hollow-bearing trees will be removed.	Yes - losses will be mitigated via instillation of nest boxes.
Invasion, establishment and spread of *Lantana camara* (NSWSC 2006)	Disturbed natural area will create opportunities for invasion.	The site will be actively managed which should prevent any new infestations.
Invasion and establishment of exotic vines and scramblers (NSWSC 2006).	Disturbed natural area will create opportunities for invasion	As above.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (NSWSC 2002)	Development area has potential to alter the hydrological regime of the adjoining wetlands and swamp forest to the east.	Drainage and stormwater detention structures will capture runoff from the development area which will assist in mitigating potential impacts.

9.0 EPBCA 1999 - MNES Significance Assessment

9.1. General Assessment Overview

The provisions of the EPBCA require determination of whether the proposal has, will or is likely to have a significant impact on a "matter of national environmental significance". These matters are listed and addressed in summary as follows:

1) **World Heritage Properties**: The site is not listed as a World Heritage area nor does the proposal affect any such area.
2) **National Heritage Places**: The site is not listed as a National Heritage Place nor does the proposal affect any such area.
3) **Ramsar Wetlands of International Significance**: A Ramsar wetland does not occur on the site, nor does the proposal affect a Ramsar Wetland.
4) **EPBCA listed Threatened Species and Communities**: The Koala (Vulnerable) and the Grey-Headed Flying Fox (Vulnerable) were recorded on site. As detailed in section 9.3, these species are not considered at risk of a significant impact.
5) **Migratory Species Protected under International Agreements**: No Migratory species is likely to be significantly affected by the proposal as assessed below.
6) **The Commonwealth Marine Environment (CME)**: The site is not within the CME nor does it affect such
7) **The Great Barrier Reef Marine Park:** The proposal does not affect the Great Barrier Reef Marine Park.
8) **Nuclear Actions**: The proposal is not a nuclear action.
9) **A water resource, in relation to coal seam gas development and large coal mining development:** The proposal is not a mining development.

The proposal thus is not considered to require referral to Department of Environment and Energy (DEE) for approval under the EPBCA 1999.

9.2. Koala Referral Assessment

The habitat on site has been assessed using the Koala habitat assessment tool from the EPBC Act Referral Guidelines (DotE 2014). To qualify as critical habitat, it must score 5 or more. This is shown in the following table:

Table 15: Koala habitat assessment

Attribute	Score	Reason	
Koala occurrence	2	Desktop	A number of records occur within 2km of the site on Bionet Atlas, some of which are from the last 5 years.
		On-ground	Koala recorded on site via scats.
Vegetation structure and composition	2	Desktop	PMHC vegetation mapping of site shows potential Koala habitat comprising Blackbutt Grassy Forest.
		On-ground	Vegetation on site contains >2 known Koala food tree species.
Habitat connectivity	2	Vegetation on site is connected to other habitats which are >500ha in area.	
Key existing threats	1	Desktop	OEH Bionet has records of Koala road kill in locality.
		On-ground	The access roads on the property would pose a low risk of road strike. Domestic and wild dogs in surrounding areas would be a high threat to local Koalas.
Recovery value	1	The following factors indicate that it is uncertain if the habitat to be removed is important for achieving the interim recovery objectives for the Koala: • Low Koala activity in the study area • Site contains preferred foraging resources • Risk of dog attack and car strike in study area • Removal of site vegetation will not affect movement throughout the regional corridor	
Total	8	Site qualifies as critical habitat	

As per the Koala habitat assessment tool, the site qualifies as critical habitat. An assessment has been undertaken to determine if the proposal will adversely affect this habitat and/or interfere substantially with the recovery of the Koala and require referral to the Minister.

The following table derived from the Koala Referral Guidelines (DotE 2014) assesses whether the proposal

is likely to adversely affect habitat critical to the survival of the Koala.

Table 16: Critical habitat assessment

Factor	Y/N	Reason
Does impact area contain habitat critical to the survival of the Koala	Y	Site scores 8 as per the Koala habitat assessment tool.
Do the areas proposed to be cleared contain known Koala food trees	Y	Habitat to be removed contains Tallowwood and Swamp Mahogany which are known local Koala food tree species.
Are you proposing to clear ≤2ha of habitat containing known Koala food trees in an area with a habitat score of ≤5	N	Proposal will remove/modify ≤2ha of potential habitat containing Koala food trees in an area that scores 8.
Are you proposing to clear >20ha of habitat containing known Koala food trees in an area with a habitat score of ≥8	N	Proposal will remove/modify ≤2ha of potential habitat containing Koala food trees in an area that scores 8.
Outcome	Impact uncertain. Further assessment required – See Section 9.3.	

9.3. Protected Species Assessments

9.3.1. Grey-headed Flying Fox and Koala

9.3.1.1. Factors to Be Considered for a Vulnerable Species

The guidelines to assessment of significance to this Matter, define an action is as likely to have a significant impact on a Vulnerable and/or Endangered species, if it will:

a) Lead to a long-term decrease in the size of an important population of a species, or:

b) Reduce the area of occupancy of an important population, or:

c) Fragment an existing important population into two or more populations, or:

d) Adversely affect habitat critical to the survival of a species, or:

e) Disrupt the breeding cycle of an important population, or:

f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or:

g) Result in invasive species, that are harmful (by competition, modification of habitat, or predation) to a Vulnerable species, becoming established in the Vulnerable species' habitat, or:

h) Introduce a disease that may cause a species to decline, or:

i) Interferes substantially with the recovery of the species.

An *important population* is one that is necessary for a species' long-term recovery. This includes such

populations as:

- Key populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity, and or:
- Populations that are near the limit of the species range:

9.3.1.2. Assessment of Significance

This section addresses each of the previous points listed.

a) Lead to a long-term decrease in the size of an important population (Vulnerable) or population (Endangered) of a species, or:

Grey-headed Flying Fox

In the context of the species ecology, the site provides an extremely minute area of foraging habitat. It is not known nor considered suitable as roosting habitat for the species, thus no such areas are affected by the proposal.

The proposal will require the removal of an estimated 1ha of forest habitat which provides a very small area of potential nectar resource for the important population. While in very strict terms a negative effect, this loss will have a negligible impact on the local Grey-headed Flying Fox population as the site and study area in total would only form a minute fraction of this species wider opportunistic/seasonally variable foraging range, and losses will be replaced by offset plantings. Thus the proposal will thus not lead to a long-term decrease in the size of an important population.

Koala

The site contains previously mapped core and potential Koala habitat under the Area 13 KPoM. During the site survey however, Koala scats were only found under two trees in the south of the site suggesting low activity. Given the large areas of potential habitat in the area, the site is only likely to at best form the marginal fringe of a Koalas territory or be used by transient Koalas.

The removal of 0.7ha of isolated forest patches and a number of primary and secondary browse species will reduce the current habitat potential of the study area for this species and contribute to some secondary impacts. However the habitat affected appears unlikely to be of primary importance to the Koala at this time and the trees in the south which showed Koala activity will be retained in a parkland area. Further; no impassable barriers will result from the development and sufficient connectivity will remain around the site. In consideration of these factors, the proposal would not be capable of leading to a long term decrease of an important population.

b) Reduce the area of occupancy of an important population (Vulnerable) or population (Endangered), or:

For the Grey-headed Flying Fox, the proposal will not result in the loss of any roosting habitat, as the site is not known or suitable to be a roost site. Foraging habitat of this species is measured in terms of hundreds of thousands of hectares, hence the loss of habitat on site is insignificant relative to the area of occupancy.

For the Koala, an estimated 0.7ha of habitat will require removal for the proposal and up to 97 preferred food trees. With the presence of large areas of habitat adjacent, the site is only likely to form the disturbed outer fringe of a Koalas home range and does not offer any significant connectivity values. The Koalas was recorded on site during the survey, however the habitat that was found to be occupied in the south of the site will be retained within a parkland. Given this, and that the trees to be removed will be replaced with offset plantings which will see an increase in the extent of Koala habitat over time, the proposal is not likely to reduce the area of occupancy of an important population.

c) Fragment an existing important population (Vulnerable) or population (Endangered) into two or more populations, or:

The Grey-headed Flying Fox is highly mobile and known to be capable of crossing human-modified habitat (personal observations, Eby 2002, Parry-Jones 2006, Smith 2002). The proposal will thus offer no barrier to movement and hence will not fragment an existing important population.

The Koala is also relatively mobile and able to cross clearings and roads, though is highly susceptible to other threats such as dog attack and vehicle strike. The future residential areas over the site will pose a barrier to Koalas, however there will be very little habitat retained within this area, and connectivity around the site and through property will be retained. The new connector road proposed to the east of the site is unlikely to pose a barrier given that fauna underpasses will be established.

d) Adversely affect habitat critical to the survival of a species, or:

According to the MNES guidelines, "*critical habitat*" refers to areas critical to the survival of a species or ecological community and may include areas that are necessary for/to:

- Activities such as foraging, breeding, roosting or dispersal.
- Succession.
- Maintain genetic diversity and long term evolutionary development, or
- Reintroduction of populations or recovery of the species/community.

As mentioned previously, the study site/area is not known roosting habitat for the Grey-headed Flying Fox, nor is any significant extent of potential or known foraging habitat affected by the proposal.

As demonstrated in Section 9.2, the site qualifies as critical habitat for the Koala. To determine if the proposal is likely to adversely affect this habitat (and thus require a referral) the proposed development has been assessed against the following factors (DotE 2014):

- *The score calculated for the impact area:* The site scored 8 out of a possible 10 due to the presence of preferred Koala food trees on site and that Koalas were recorded during the survey. The site is unlikely to be important for the recovery of the Koala given that it is largely cleared and showed very low usage.
- *Amount of Koala habitat being cleared:* The proposal will remove up to 0.7 of open forest and scattered trees which includes primary and secondary Koala browse species. To offset this loss, Koala food trees will be replanted over the property at a 2:1 ratio to those being removed.

- *Method of clearing:* The proposal will require removal of most of the vegetation within the development footprint. This will reduce the likelihood of Koalas entering the residential areas and risking road strike or dog attack. A patch of trees on the south of the site will be retained and Kola food trees located in the site's APZs can also be selectively retained. It is recommended that a fauna spotter is present on site during any clearing operations to ensure no Koalas are present in the works footprint.
- *The density or abundance of Koalas:* There is a high number of Koala records in the Thrumster area, however most of these are >5 years old (OEH 2017a). The Koala was only recorded via scats in the south of the site, indicating most of the site is currently not used for foraging. Known Koala habitat to the south and east is likely to support a higher density of Koalas.
- *Level of fragmentation caused by the clearing:* The proposal will increase fragmentation in the area however will not create any impassable barriers for the Koala.

Given the above, the proposal is not considered to significantly affect habitat critical to the survival of the Koala.

e) Disrupt the breeding cycle of an important population, or:

The proposal is unlikely to disrupt the breeding cycle of an important population/population given that:

- The site does not represent potential breeding habitat for the Grey-headed Flying Fox and only marginally suitable breeding habitat for the Koala, with other higher quality habitat in the area more likely to support breeding;
- The subject species have very large ranges that far exceed the site,
- The potential for these species to occur within the study area and property will be retained post-development; and
- The extent of alternative potential habitat in the locality is sufficient to support the local populations and offset plantings will see the habitat lost replaced over time.

f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or:

As detailed previously, the degree of vegetation loss imposed by the proposed development is not significant enough to affect the local population of the subject species to the point that it could cause a decline of the species.

g) Result in invasive species that are harmful (by competition, modification of habitat, or predation) to an Endangered species, becoming established in the Vulnerable and/or Endangered species' habitat, or:

No new species that affects the any of the subject species is likely to be introduced as a direct result of the proposed works.

h) Introduce disease that may cause a species to decline, or:

No disease that poses a potential risk to these species is likely to be introduced to the site.

i) Interferes substantially with the recovery of the species.

As detailed previously, the proposal will result in the removal/modification of a relatively minute area of foraging habitat for the Grey-headed Flying Fox that is not significant enough to interfere with its recovery.

Similarly for the Koala, the proposal is unlikely to substantially interfere with its recovery due to the following:

- The risk of vehicle strike and dog attack is unlikely to change as a result of the proposal as there will be physical separation between the retained Koala habitats surrounding the site and the residential areas
- The bushfire regime is not likely to change adversely due to the proposal.
- The proposal is unlikely to introduce any new disease or increase the incidence of Chlamydia.
- No new barriers for the local Koala population will be created as a result of the proposal.

9.3.1.3. Conclusion

The proposal is not considered likely to have a significant impact on the Koala or Grey-headed Flying Fox.

9.3.2. Migratory species

No migratory bird species were recorded during the field survey.

The habitats present across the site provide potential habitat for a few listed migratory species such as the Cattle Egret, Oriental Cuckoo, White-throated Needle-tail Swift and Fork-tailed Swift.

These species are collectively assessed below.

9.3.2.1. Factors To Be Considered

The guidelines to assessment of significance to this Matter, define an action as likely to have a significant impact on a migratory species, if it will:

a) Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or;

b) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species, or;

c) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An *important area of habitat* is:

1) Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or:

2) Habitat utilised by a migratory species which is at the limit of the species range, or;

3) Habitat within an area where the species is declining.

9.3.2.2. Assessment of Significance

This section addresses each of the previous points listed.

a) Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or;

The site was not considered to be *important habitat* for the migratory species likely to occur there. Overall, the development will displace a minor area of vegetation (dry sclerophyll forest and swamp forest), resulting in a reduction in the local area of potential habitat. However, the small areas to be altered are unlikely to represent *substantial* modification of such habitat which is abundant elsewhere in the locality.

b) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species, or;

An invasive species is one that may become established in the habitat and harm the migratory species by direct competition, modification of habitat, or predation. No such invasive species is to be introduced by the proposal.

c) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species

The site is unlikely to be important habitat for migratory species and their lifecycles are unlikely to be disrupted by the proposed development. Species which fly over the site (Swifts and Needletails) are unlikely to be affected as they would rarely land there and are also regularly observed flying over urban centres (pers. obs.).

In view of the above, no migratory bird is considered likely to be significantly affected by the proposal.

10.0 Recommendations

The following are recommended to be included as conditions of consent if the proposal is approved. The conclusions of this assessment assume the measures are implemented and effective in mitigating impacts.

10.1.General Clearing Measures

The area to be cleared/modified should be clearly marked (e.g. with stakes and bunting before clearing in order to prevent inadvertent clearance beyond what is required and has been assessed.

Site induction is to specify that no clearing is to occur beyond the marked area, and vehicles/machinery are only to be parked in designated areas. Similarly, any materials are to be stored outside the retained vegetation. Clearing and earthworks is to avoid damage to root zones of the retained trees.

No further clearing is to be undertaken outside of that required to establish the development. Each stage of the development should be cleared separately when required so the remaining site vegetation is gradually removed over time.

10.2.Management of Retained Hollow-bearing Trees

The hollow-bearing trees over the study area that are proposed to be retained (H1, H3, H6) should be afforded a buffer zone of 1.25x the height of the tree as per the PMHC DCP requirements. This is to be established around the trees prior to clearing using stakes and bunting tape and must remain for the duration of clearing and earth works.

These trees contain large overhanging limbs that could potentially fail and pose a risk to future residents or infrastructure. It is therefore recommended that these hollow-bearing trees are inspected by an arborist who will provide recommendations for their management.

10.3.Pre-clearing Survey and Clearing Supervision

The following ameliorative measures should be carried out during clearing works on site.

1. The clearing extent is to be inspected for Koalas and other fauna by a qualified ecologist immediately prior to commencement of any vegetation removal involving machinery and/or tree-felling. This is to occur each morning if clearing spans over multiple days/weeks.
2. If a Koala is present in an area subject to vegetation removal/modification, works must be suspended until the Koala moves along of its own volition. If the Koala is located in a position that a 50m buffer may be established, works may proceed outside this buffer.
3. The ecologist is to remain on site to supervise clearing and dewatering of dams to retrieve any fauna detected during works, and undertake appropriate action (e.g. euthanize severely injured animals) and ensure Koalas do not enter the site during clearing works.
4. If any exotic aquatic species are captured during the dam dewatering (e.g. carp) they are to be euthanised on site by the ecologist. Any native aquatic species captured during the dam dewatering are to be released in suitable aquatic habitat nearby (e.g. Partridge Creek).

10.4.Dewatering of Dams

Two farms dams occur within the development footprint and are proposed to be drained and filled. The dams will likely contain a number of fish species as well as turtles. It is recommended that dewatering activities be undertaken in accordance with a Dewatering Management Plan.

10.5.Hollow-bearing Tree Removal Protocol

Apart from legal obligations, PMHC DCP 2013 requires hollow-bearing trees to be felled in a manner that will minimise the risk of injury/mortality of denning/roosting fauna within the limitation of Work Health and Safety (WHS) Guidelines. This is suggested to be achieved by the following general procedure (where practical):

- Where physically practical (i.e. smaller trees) and with due consideration of statutory O&HS requirements, the hollow-bearing tree should be removed via a method that does not require traditional felling to minimise risk of injury/death i.e. use of a suitable machine with a harvester attachment that can hold and cut the tree in sections, or a crane that can hold the trunk while the tree's base is sawn. The fallen tree is then to be gently laid on the ground, and the hollows inspected for fauna (see next point). If hollows are not able to be confidently certified as absent of fauna, the tree is to be carefully sectioned until the hollows are deemed clear, or preferably (to reduce stress) laid aside for 48hrs to allow fauna to escape. The tree may then be disposed of.

  If the above methods are not feasible, an arborist should be engaged to lop hollow limbs and lower them to the ground gently for inspection, followed by dropping of the remaining tree.

  If (for safety reasons or physical impracticality of the above methods) the tree is required to be hard-felled (i.e. cut and drop with a chainsaw, or pushed over), the hollow-bearing sections of the tree are to be sectioned after felling to retrieve any fauna which are highly likely to be injured during this process (hence why it is not recommended).

- A qualified ecologist is to be present during felling and sectioning of hollow-bearing trees. Hollows are to be inspected once the tree is deposited and appropriate measures undertaken (e.g. veterinary treatment or assessment/rehabilitation by FAWNA at the proponent's cost). All rehabilitated animals are to be released in the retained habitat on the property.

- If the hollow is determined to be occupied and fauna do not require assistance (e.g. roosting bats), the entrance is to be blocked and the log placed in a shaded and protected area on the edge of the site. The obstacle is to be removed just prior to dusk to allow passive escape of the fauna within. The log may then be removed if required.

Upon completion of this exercise, a brief written report (with photos) detailing the above is to be submitted to Council within 14 days of the removal of the hollow-bearing trees.

10.6.Threatened Plant Management Plan

A management plan for the Slender Screw Fern population on the property is recommended to be prepared.

This would contain a summary of available literature on the species along with specific on-site measures to manage the population during construction and post development and ensure risks and threats are minimised. The following actions are recommended to be included in the plan and/or listed as specific consent conditions for the development.

10.6.1.Surveys

Targeted surveys for the Slender Screw Fern are recommended to be undertaken by a qualified ecologist in suitable habitat over the entire property prior to construction commencing. The aim of the surveys would be to obtain accurate information of the full extent and population of the fern over the property and provide baseline data for future monitoring studies. These surveys could be undertaken at any time of year given that the fern would be detectable year round.

The known population in the study area is to be surveyed by a registered survey and shown on relevant plans for the development.

10.6.2.Clearing Supervision

A qualified ecologist must be present during any works involving clearing or construction in the vicinity (eg 100m radius) of the Slender Screw Fern population. The ecologist would be present to monitor the works and ensure the fern is not impacted directly or indirectly.

10.6.3.Monitoring

A monitoring programme is recommended to be developed for the Slender Screw Fern. This would involve monitoring surveys conducted by a qualified ecologist at regular intervals. A recommended survey programme is every 6 months for the first 5 years following commencement of Stage 1 of the development construction followed by annual surveys thereafter for a further 10 years.

The surveys would involve checking the extent and health status of the population as well as identifying any threats. The results of the survey would be contained in a monitoring report to be submitted to Council which would also contain recommendations for management of the population.

10.7.Donation of Foliage

The Koala Hospital and/or Billabong Wildlife Park are also to be contacted for interest in collecting the foliage and limbs of the felled Tallowwoods. The Koala Hospital is particularly interested in limbs that meet the following criteria:

- 2 metre lengths of straight timber runners that are approx. 120 mm in diameter.
- 3 metre lengths with forks at one end that are roughly 90 mms in diameter.
- 4 metre lengths of approx. 70 mm diameter.
- 2 metre lengths of fork at one end and 70 mm in diameter.

Due to chemical changes in the leaves, foliage must be collected as soon as possible after felling (Cheyne Flanagan, pers. comm.), hence collectors must be contacted and arranged prior to felling.

10.8.Replacement Nest Boxes

Nest boxes are to be mounted in retained trees in the residual habitat on the property to offset the loss of the three hollow-bearing trees in the development footprint. The following nest boxes will be required:

- 1 possum nest boxes
- 2 small glider/phascogale nest boxes
- 2 bat roost boxes

These are to be constructed of ACQ treated timber and mounted by an ecologist prior to clearing of the site's hollow-bearing trees. A brief report detailing the following is to be provided to Council within 14 days of mounting:

- GPS coordinates of the nest boxes (with nest boxes numbered consecutively).
- Host tree species, trunk DBH, and height.
- Mounting height and aspect of each nest box.

10.9.Restriction of Access

Future residents of the site should be discouraged from walking through the retained habitats surrounding the site (especially to the north and east) to reduce anthropogenic impacts such as trampling, track creation, weed invasion, feral and domestic predator access etc. Educational signage noting access restrictions should be placed around the edge of the residential areas where appropriate to discourage unauthorised entry.

Fencing/screening and edge plantings may also be used to discourage access. This will also help reduce edge effects acting on the adjacent vegetation.

10.10. Vegetation Management Plan

As per the PMHC Development Control Plan 2013, a Vegetation Management Plan (VMP) is to be prepared to manage the offset plantings of Koala food trees and regeneration areas on the property. This will detail the works required, location of planting areas, timeframes, and parties responsible for implementing the works and cost estimates to carry out the works.

10.11. Sedimentation and Erosion Control

Standard soil and sedimentation control measures will be required throughout the earthworks phase to ensure that habitats on the site and in the study area, as well as subsequent aquatic habitats nearby are not substantially affected.

Proposed drainage systems need to be adequately designed and effectively established to prevent the risk

of any substantial impacts (eg erosion and sedimentation, changed hydrology from stormwater runoff) as per statutory obligations. This is of particular concern to the swamp forest and wetland habitats to the east of the site. Any stormwater runoff which enters this area must be of suitable quality and not introduce an excessive sediment or nutrient load and cause eutrophication.

10.12. Street Lighting

Future dwellings and new roads in the proposed subdivision will have artificial lighting.

In general, lighting design and location must ensure lighting is directed to the ground within the site and not onto retained or adjacent vegetation to minimise impacts on fauna potentially using this habitat.

11.0 Conclusion

This report has assessed the impact of establishing a staged residential subdivision on Lot 1 DP 1087368 and Lot 2 DP 1172154. This will require the removal of about 0.7ha of open forest habitat and 0.3 ha of swamp forest within the development footprint.

One Endangered Ecological Community was detected on site comprising *Swamp Sclerophyll Forest on Coastal Floodplains*. Flora surveys also detected the Slender Screw Fern which is listed as Endangered under the TSC Act and is a significant new record of the species on the mid north coast. Although this species will not be directly impacted by the proposed development, it will be susceptible to indirect impacts including edge effects, changed hydrology and sedimentation.

Five threatened fauna species were detected on site during the survey consisting of the Koala, Eastern Osprey, Powerful Owl, Little Lorikeet and Grey-headed Flying-fox. A further 17 threatened fauna species have been identified as having potential to use the site as a small part of a larger range which would encompass adjoining and nearby habitat.

The proposed development will see loss of about 0.7ha of dry sclerophyll forest and 0.3ha of swamp forest along with scattered paddock trees to establish the development. Two farm dams will also require draining and filling. Three hollow-bearing trees and 97 preferred Koala food trees fall in the development envelopes and are proposed to be removed.

Indirect threats as a result of the proposal are unlikely to pose a significant risk to the known and potentially occurring subject species or the EEC.

A key mitigation measure for the proposal is the retention and enhancement of residual habitat on the property. This will see planting of Koala food trees, installation of nest boxes and cessation of slashing in E3 zones to help offset the loss of habitat in the development footprint and meet offset obligations of DCP 2013.

The significance assessment carried out for the proposed development determined that the proposal is not expected to significantly impact upon the EEC or any of the known or potentially occurring threatened species on site or in the study area.

Consequently, the proposal is not considered to require a Species Impact Statement, or referral to the DotE for approval under the EPBC Act 1999.

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Appendix 1: Potential Occurrence Assessment and Impact Assessment Eligibility

A1.1 Flora

Searches of relevant literature and databases (OEH 2017a) found records of 20 threatened for a species within a 10km of the study site and a number may occur according to the protected matters search tool (DEE 2017). These species are collectively assessed for their potential to occur in the following table:

Table 17: Eligibility for Seven Part Test Assessment – Flora

Species	TSC Act	EPBC Act	No. of records	Link to Profile	Likelihood of Occurrence	Significance Assessment Required?
Acronychia littoralis	E	E	7	http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10030	Site does not contain suitable habitat for this species. Unlikely to occur.	No
Allocasuarina defungens	E	E	5	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=21924	Areas of swamp forest in the study area may have potential to support this species. Targeted surveys during this and previous surveys did however fail to detect this species. Unlikely to occur.	No
Asperula asthenes	V	V	1	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=14004	Swamp Forest habitats in the study area considered to be unsuitable for this species. Unlikely to occur.	No
Chamaesyce psammogeton	E	-	3	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10160	Site does not contain suitable habitat for this species. Unlikely to occur.	No
Cryptostylis hunteriana	V	V	0	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=19533	Site does not contain suitable habitat for this species. Unlikely to occur.	No

Species	TSC Act	EPBC Act	No. of records	Link to Profile	Likelihood of Occurrence	Significance Assessment Required?
Cynanchum elegans	E	E	2	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=12533	Recorded on land to the south during previous surveys (Peter Parker 2014). Study site only has marginal potential habitat for this species and it was not found during the survey. Unlikely to occur.	No
Dendrobium melaleucaphilum	E	-	2	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10213	Habitats in the study area are generally disturbed and not considered to be suitable for this species. Unlikely to occur.	No
Eucalyptus nicholii	V	V	3	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=20992	Unlikely potential to occur as outside natural range. Local records include only planted specimens.	No
Euphrasia arguta	CE	CE	0	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=4325	Site does not contain suitable habitat for this species. Unlikely to occur.	No
Macadamia integrifolia	V	V	0	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=7326	Unlikely potential to occur. Local records include only planted specimens.	No
Maundia triglochinoides	V	-	9	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10511	Farm dams may provide potential habitat however this species was not found during this or previous surveys. Unlikely to occur.	No
Melaleuca biconvexa	V	V	33	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=5583	Site may qualify as potential habitat in broad terms but not found during this or previous surveys and no proximate records. Unlikely to occur.	No

Species	TSC Act	EPBC Act	No. of records	Link to Profile	Likelihood of Occurrence	Significance Assessment Required?
Melaleuca groveana	V	-	2	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10516	Site does not contain suitable habitat or geology type for this species. Unlikely to occur.	No
Oberonia titania	V	-	1	http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10571	Site does not contain suitable habitat for this species. Unlikely to occur.	No
Parsonsia dorrigoensis	E	E	0	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64684	Site does not contain suitable habitat for this species and there are no local records. Unlikely to occur.	No
Peristeranthus hillii	V	-	1	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10868	Site does not contain suitable habitat for this species. Single local record is outdated. Unlikely to occur.	No
Phaius australis	E	E	1	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=5872	Site does not contain suitable habitat for this species. Unlikely to occur.	No
Senna acclinis	E	-	1	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10753	Site does not contain suitable habitat for this species. Unlikely to occur.	No
Sophora tomentosa	E	-	7	http://www.environment.nsw.gov.au/determinations/SophoraTomentosaEndSpListing.htm	Site does not contain suitable habitat for this species. Unlikely to occur.	No
Thesium australe	V	V	0	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=15202	The site may have some potential habitat for this species, however it is highly disturbed. Not found during this or previous surveys and no local records. Unlikely to occur.	No

A1.2 Fauna

As noted above, a significant number of threatened and migratory fauna have been recorded in the locality, and a number of others are considered potential occurrences by the consultant. In the table below, these species are evaluated for their potential to occur on the site; significance of the proposal to this potential occurrence; and thus their eligibility/requirement for Seven Part Test/MNES assessment.

Table 18: Eligibility for the Seven Part Test and MNES

	Species	Local records	TSC Act	EPBC Act	Link to Profile	Likelihood of Occurrence	Significance Assessment Required?
BIRDS	Australiasian Bittern (*Botaurus poiciloptilus*)	4	E	E	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1001	The study or study area does not contain any suitable habitat for this species such as large wetlands with water bodies. Unlikely to occur.	No
	Black Bittern (*Botaurus poiciloptilus*)	1	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10441	Site does not contain suitable habitat comprising wetlands with permanent water. Unlikely to occur.	No
	Black-necked Stork (*Ephippiorhyncus asiaticus*)	62	E	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10275	Swamp forest habitats on site are too dense and do not contain permanent water. Unlikely to occur.	No
	Brolga (*Grus rubicunda*)	1	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10382	As for Black-necked Stork. Unlikely to occur.	No
	Magpie Goose (*Anseranas semipalmata*)	1	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10056	No suitable habitat on site. Unlikely to occur.	No
	Blue-billed Duck (*Oxyura australis*)	2	V	-	http://www.environment.nsw.gov.au/ThreatenedSpeciesApp/profile.aspx?id=10580	Farm dams unlikely to provide potential habitat for this species. Unlikely to occur.	No

	Freckled Duck (*Stictonetta naevosa*)	3	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10771	Farm dams unlikely to provide potential habitat for this species. Unlikely to occur.	No
	Comb-crested Jacana (*Irediparra gallinacean*)	2	V	-	http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10435	No suitable habitat on site. Unlikely to occur.	No
	Glossy Black Cockatoo (*Calyptorhynchus lathami*)	51	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10140	Allocasuarina foraging species occur in low density throughout the site and study area. Low to fair chance of occurrence.	**Yes**
	Swift Parrot (*Lathamus discolour*)	7	E	CE	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=744	Site vegetation has very limited winter flowering eucalypts that are preferred by this species. Higher quality habitat occurs to north and east. Unlikely to occur on site.	No
	Eastern Ground Parrot (*Pezoporus wallicus*)	0	V	-	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67047	Areas of the swamp forest in the study area with a sparse canopy and dense shrub layer may qualify as potential habitat for this bird. It has however not been recorded on the property or airport precinct to date despite intensive surveys. Unlikely to occur.	No
	Red Goshawk (*Erythrotriorchis radiatus*)	0	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=942	Lack of records in the region indicate an unlikely chance of occurrence.	No
	Square-tailed Kite (*Lophoictinia isura*)	34	V	-	http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10495	Recorded in the Thrumster area and suitable foraging resources present in study area. Moderate chance of occurrence.	**Yes**
	Spotted Harrier (*Circus assimilis*)	1	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20134	Recorded locally and suitable foraging resources present in study area. Low chance of occurrence.	**Yes**

	White-bellied Sea Eagle (*Haliaeetus leucogaster*)	46	V	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=943	No suitable habitat on site. Unlikely to occur.	No
	Little Eagle (*Hieraaetus morphnoides*)	2	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20131	Recorded within 10km of site and suitable foraging resources present in study area. Sparse local records. Low chance of occurrence.	**Yes**
	Barking Owl (*Ninox connivens*)	1	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10561	Site contains a very small area of potential foraging habitat. Low potential to occur.	**Yes**
	Eastern Grass Owl (*Tyto longimembris*)	24	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10819	Recorded to the north of the site in wetland and heath associated with Partridge Creek. Swamp forest habitats on the site are considered to be largely unsuitable for this species and too small in extent. Unlikely to occur.	No
	Masked Owl (*Tyto novaehollandiae*)	16	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10820	Site contains a small area of potential foraging habitat. One tree on site may provide potential nesting hollows, but no evidence of nesting was found upon inspection by an arborist. Recorded during surveys on adjacent land to the south and moderate potential to occur on site.	**Yes**
	Sooty Owl (*Tyto tenebrecosa*)	7	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10821	Site does not contain typical habitat for this species and it has not been recorded in the locality. Unlikely potential to occur. Lack of proximate records.	No

	Wompoo Fruit Dove (*Ptilinopus magnificus*)	8	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10707	Unlikely chance of occurrence on site due to lack of preferred foraging resources.	No
	Rose Crowned Fruit Dove (*Ptilinopus regina*)	13	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10708	Unlikely chance of occurrence on site due to lack of preferred foraging resources.	No
	Barred Cuckoo-shrike (*Coracina lineata*)	25	V	-	http://www.environment.nsw.gov.au/resources/threatenedspecies/PASconsultation/CP/CPCoracinalineata.pdf	Unlikely chance of occurrence on site due to lack of preferred foraging resources.	No
	Regent Honeyeater (*Anthochaera Phrygia*)	4	E	CE	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82338	No proximate records and unlikely chance of occurrence on site due to lack of preferred foraging resources.	No
	Varied Sitella (*Daphnoensitta chrysoptera*)	23	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=20135	Most of the site too open and exposed for this species and lacks understorey vegetation. Swamp forest habitats in the east of the study area may however be suitable for this species. Fair chance of occurrence.	**Yes**
	Scarlet Robin (*Petroica boodang*)	2	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20133	Unlikely chance of occurrence on site due to lack of preferred habitat structure and disturbance history. No proximate records.	No
	Flame Robin (*Petroica phoenicea*)	0	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20133	Unlikely chance of occurrence on site due to lack of preferred habitat structure and disturbance history. No proximate records.	No
	Eastern Bristlebird (*Dasyornis brachypterus*)	0	E	E	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=533	No suitable habitat on site and outside known range. Unlikely to occur.	No

	Brown Treecreeper (*Climacteris picumnus*)	3	V	-	http://www.environment.nsw.gov.au/determinations/BrownTreecreeperVulSpListing.htm	Recorded to the east of the site during previous surveys by Biolink (2006). Most of the site is too disturbed and unsuitable for this species, however adjoining forest in the study area to the north and east may qualify as potential habitat. Fair chance of occurrence.	**Yes**
	Dusky Woodswallow (*Artamus cyanopterus*)	6	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20303	Marginal habitat present on site. Low chance of occurrence as infrequent flyover.	**Yes**
	Bush-stone Curlew (*Burhinus grallarius*)	2	V	-	http://www.environment.nsw.gov.au/animals/BushStonecurlew.htm	Site unlikely to qualify as potential habitat, predators likely to be present and no nearby records. Unlikely to occur.	No
	Oriental Cuckoo (*Cuculus optatus*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=86651	Fair chance of occurrence due to presence of generic habitat.	**Yes**
	White-throated needletail (*Hirundapus caudacutus*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=682	Fair chance of occurrence due to presence of generic habitat.	**Yes**
	Fork-tailed Swift (*Apus pacificus*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=678	Fair chance of occurrence due to presence of generic habitat.	**Yes**
	Black-faced Monarch (*Monarcha melanopsis*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=609	Site contains poor potential habitat for this species. Unlikely to occur.	No
	Spectacled Monarch (*Monarcha melanopsis*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=610	Site contains poor potential habitat for this species. Unlikely to occur.	No

	Satin Flycatcher (*Myiagra cyanoleuca*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=591	Fair chance of occurrence due to presence of generic habitat.	No
	Rufous Fantail (*Rhipidura ruffifrons*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=592	Site contains poor potential habitat for this species. Unlikely to occur.	No
	Greater Egret (*Ardea alba*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59541	No suitable habitat on site. Unlikely to occur.	No
	Cattle Egret (*Ardea ibis*)	Y	-	M	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59542	Fair chance of occurrence due to presence of generic habitat.	**Yes**
MAMMALS	Brush-tailed Phascogale (*Phascogale tapoatafa*)	8	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10613	Site habitat considered to be too disturbed to support this species. Not recorded in the area during previous surveys. Very low to unlikely chance of occurrence.	No
	Spotted-tailed Quoll (*Dasyurus maculatus*)	27	V	E	http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10207	Site unlikely to support this species given the limited vegetation present in the study area and the disturbance history.	No
	Squirrel Glider (*Petaurus norfolcensis*)	24	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10604	Site contains a small area of potential foraging habitat and potential den trees. Adjoining forest to the north also likely to comprise high quality potential habitat. Recorded within 3km of site. Low potential to occur.	**Yes**
	Yellow-bellied Glider (*Petaurus australis*)	16	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10601	Site does not contain preferred foraging or structural habitat and no nearby records. Unlikely potential to occur.	No

	Greater Glider (*Petauroides Volans*)	0	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=254	Site likely to be too disturbed and isolated to support this species. No local records and unlikely potential to occur.	No
	Rufous Bettong (*Aepyprymnus rufescens*)	1	V	-	http://www.environment.nsw.gov.au/determinations/RufousBettongVulSpListing.htm	Poor habitat on site for this species and very sparse regional records. Presence of feral predators also likely to reduce potential to occur. Unlikely to occur.	No
	Common Planigale (*Planigale maculata*)	3	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10635	Swamp forest habitats in the study area may provide potential habitat, however this species has not been recorded here during extensive previous surveys. Recorded in the locality but unlikely to occur on site.	No
	New Holland Mouse (*Pseudmys novaehollandiae*)	0	-	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=96	No local records and site does not provide suitable habitat. Unlikely to occur.	No
	Long-nosed Potoroo (*Potorous tridactylus tridactylus*)	0	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66645	Unlikely potential to occur. Site does not contain preferred foraging or structural habitat. No records in the locality.	No
	Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*)	15	V	-	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=254	Recorded in swamp forest to the east of the site during previous surveys Given the presence of suitable and previous records, it is considered a moderate chance of occurrence in the study area.	**Yes**

	Common Blossom Bat (*Syconycteris australis*)	1	V	-	http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10785	Site does not contain preferred foraging resources and higher quality habitat occurs nearby. Unlikely to occur.	No
	Eastern Free-tail Bat (*Mormopterus norfolkensis*)	23	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10544	Site contains potential foraging habitat and hollow-bearing trees which may be used as roosts. Recorded in the locality and fair potential to occur on site.	**Yes**
	Little Bentwing-bat (*Miniopterus australis*)	30	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10533	Site contains potential foraging habitat and hollow-bearing trees which may be used as roosts. Recorded in the locality and moderate potential to occur on site.	**Yes**
	Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	5	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10544	Site only contains marginal habitat for this species. Not recorded during survey and unlikely to occur on site. Very low to unlikely chance of occurrence.	No
	Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)	4	V	-	http://www.environment.nsw.gov.au/resources/threatenedspecies/PASconsultation/CP/CPSaccolaimusflaviventris.pdf	Site only contains marginal habitat for this species. Low chance of occurrence.	**Yes**
	Eastern Bent-wing Bat (*Miniopterus schreibersii*)	15	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10534	Site contains suitable foraging habitat and potential non-breeding roosts in hollow-bearing trees. Moderate chance of occurrence.	**Yes**
	Golden Tipped bat (*Kerivoula papuensis*)	3	V	-	http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10444	Unlikely potential to occur. Site does not contain preferred foraging or structural habitat.	No

	Hoary Wattled Bat (*Chalinolobus nigrogriseus*)	1	V	-	http://www.environment.nsw.gov.au/ThreatenedSpeciesApp/profile.aspx?id=10158	Only single local record in locality and site is beyond known range. Unlikely to occur.	No
	Dwyer's Bat (*Chalinolobus dwyeri*)	0	V	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=183	No local records and unlikely to occur given extent of higher quality habitat in locality.	No
	Southern Myotis (*Myotis macropus*)	8	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10549	Farm dams provide some marginal areas of foraging habitat. Given presence of higher quality habitat nearby, it is considered an unlikely occurrence on site.	No
	Greater Broad-nosed Bat (*Scoteanax rueppellii*)	14	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10748	Site contains potential foraging habitat and hollow-bearing trees which may be used as roosts. Recorded in the locality and fair potential to occur on site.	**Yes**
	Eastern Cave Bat (*Vespadelus troughtoni*)	14	V	-	http://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10829	Site does not contain preferred foraging or structural habitat. Unlikely potential to occur.	No
FROGS	Green-thighed Frog (*Litoria brevipalmata*)	9	E	-	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1942	No suitable habitat present on site – unlikely to use farm dams or swamp forest. Unlikely to occur.	No
	Giant Barred Frog (*Mxophyes iteratus*)	0	E	E	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1944	No suitable habitat present on site. Unlikely to occur.	No
	Stuttering Frog (*Mixophyes balbus*)	0	E	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1942	No suitable habitat present on site. Unlikely to occur.	No
	Green and Golden Bell Frog (*Litoria aurea*)	4	E	V	http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1870	No suitable habitat present on site – unlikely to use farm dams and no	No

						open water bodies are present in the swamp forest. Unlikely to occur.	
	Wallum Froglet *(Crinia tinnula)*	49	V	-	http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10484	Recorded on numerous occasions in habitats to the east and north of the site. Not recorded during this survey but considered a high chance of occurrence using swamp forest habitats in the east of the study area.	**Yes**

Appendix 2: Flora List

Frequency: D Dominant at least in some areas,
C Common,
O Occasional,
U Uncommon,
R Rare on site, few specimens.

Community: BGF Blackbutt Grassy Forest
G Derived Grassland with Scattered Trees
SF Swamp Forest
D Farm dams

*denotes an introduced species
Bold – Endangered under TSC Act

Common name	Scientific name	Community	Frequency
Canopy Trees			
Swamp Oak	*Casuarina glauca*	G, SF	O
Pink Bloodwood	*Corymbia intermedia*	BGF	O
White Mahogany	*Eucalyptus acmenoides*	BGF, G	O
White Stringybark	*Eucalyptus globoidea*	BGF, G	C
Tallowwood	*Eucalyptus microcorys*	BGF, G	D
Blackbutt	*Eucalyptus pilularis*	BGF, G	O
Swamp Mahogany	*Eucalyptus robusta*	SF	O
Broad-leaved Paperbark	*Melaleuca quinquenervia*	G, SF	C
Turpentine	*Syncarpia glomulifera*	G	U
Understory trees and shrubs			
Coast Myall	*Acacia binervia*	G	U
Curracabah	*Acacia concurrens*	G	R
Hickory Wattle	*Acacia falcata*	BGF	U
Fringed Wattle	*Acacia fimbriata*	BGF	U
Coastal Wattle	*Acacia longifolia subsp. longifolia*	BGF, G	O
Maidens Wattle	*Acacia maidenii*	BGF	O
Red-stemmed Wattle	*Acacia myrtifolia*	G	U
Sweet Wattle	*Acacia suaveolens*	BGF, G	U
Black Oak	*Allocasuarina littoralis*	G	D

Common name	Scientific name	Community	Frequency
Forest Oak	*Allocasuarina torulosa*	G	R
Groundsel Bush*	*Baccharis halimifolia**	G, SF	O
Heath-leaved Banksia	*Banksia ericifolia*	SF	O
Hairpin Banksia	*Banksia spinulosa*	SF	U
Coffee Bush	*Breynia oblongifolia*	BGF	O
Wallum Bottlebrush	*Callistemon pachyphyllus*	SF	C
Willow Bottlebrush	*Callistemon salignus*	BGF, SF	U
Camphor Laurel*	*Cinnamomum camphora**	SF, G	U
Gorse Bitter Pea	*Daviesia ulicifolia*	G	O
Cheese Tree	*Glochidion ferdinandi*	BGF	R
Lantana*	*Lantana camara**	G	U
Tantoon	*Leptospermum polygalifolium*	G, SF	D
Prickly Tea Tree	*Leptospermum juniperinum*	G, SF	D
Lance Beard-heath	*Leucopogon lanceolatus*	BGF	U
Prickly-beard Heath	*Leucopogon juniperinus*	BGF, G	C
Crinkle Bush	*Lomatia silaifolia*	G	O
Flax-leaved Paperbark	*Melaleuca linariifolia*	SF	O
Sieber's Paperbark	*Melaleuca sieberi*	SF	O
Prickly-leaved Tea Tree	*Melaleuca styphelioides*	BGF, SF	U
Thyme Honey-myrtle	*Melaleuca thymifolia*	SF	O
Large Mock Olive	*Notelaea longifolia*	BGF, G	U
Sago Flower	*Ozothamnus diosmifolius*	G	O
Geebung	*Persoonia stradbrokensis*	BGF, SF	U
Broad-leaved Geebung	*Persoonia levis*	BGF	R
Elderberry Panax	*Polyscias sambucifolia*	BGF	R
Wooly Pomaderris	*Pomaderris lanigera*	BGF	R
Notched Bush Pea	*Pultenaea retusa*	BGF, G	C

Common name	Scientific name	Community	Frequency
Spiny Bush-pea	*Pultenaea spinosa*	BGF, G	O
Wild Tobacco*	*Solanum mauritianum**	G	U
Grasses			
Whisky Grass*	*Andropogon virginicus**	BGF, G, SF	D
Threeawn Speargrass	*Aristida vagans*	G	O
Carpet Grass*	*Axonopus fissifolius**	G, SF	C
Rhodes Grass*	*Chloris gayana**	G	U
Barbed Wire Grass	*Cymbopogon refractus*	BGF	O
Shorthair Plumegrass	*Dichelachne micrantha*	BGF	R
Crabgrass	*Digitaria sp.*	G	U
Bushy Hedgehog-grass	*Echinopogon caespitosus*	BGF, G	U
Common Couch	*Cynodon dactylon*	G	U
Bordered Panic	*Entolasia marginata*	BGF	U
Wiry Panic	*Entolasia stricta*	BGF, G	O
Brown's Lovegrass	*Eragrostis brownii*	G	C
Paddock Lovegrass	*Eragrostis leptostachya*	G	O
Blady Grass	*Imperata cylindrica*	BGF, G, SF	D
Weeping Grass	*Microlaena stipoides*	BGF, G	U
Australian Basket Grass	*Oplismenus aemulus*	BGF	U
-	*Ottochloa gracillima*	BGF	R
Torpedo Grass	*Panicum repens*	G	R
Two-colour Panic	*Panicum simile*	G	O
Common Paspalum	*Paspalum dilatatum**	G	C
Vasey's Grass	*Paspalum urvillei**	G	U
Grey Tussock-grass	*Poa sieberiana*	BGF	R
Setaria*	*Setaria sphacelata**	G	U
-	*Sporobolus sp.*	G	O

Common name	Scientific name	Community	Frequency
Kangaroo Grass	*Themeda triandra*	G	D
Ferns			
Water Fern	*Blenchum indicum*	SF	C
Gristle Fern	*Blechnum cartilagineum*	G	U
False Bracken	*Calochlaena dubia*	BGF, G	O
Rock Fern	*Cheilanthes sieberi*	G	U
Coral Fern	*Gleichenia dicarpa*	SF	O
Slender Screw Fern	***Lindsaea incisa***	SF	R
Screw Fern	*Lindsaea linearis*	SF, G	U
Lacy Wedge Fern	*Lindsaea microphylla*	BGF	R
Elkhorn Fern	*Platycerum bifurcatum*	BGF	R
Bracken	*Pteridium esculentum*	GBF, G	C
Groundcovers			
Cobbler's Pegs*	*Bidens pilosa**	G	O
White Caladenia	*Caladenia catenata*	BGF	R
Gotu Kola	*Centella asiatica*	SF	O
-	*Dampiera stricta*	BGF	C
-	*Desmodium rhytidophyllum*	G	U
Blue Flax-lily	*Dianella caerulea*	BGF, G	C
Kidney Weed	*Dichondra repens*	G	C
Chocolate Lily	*Dichopogon strictus*	BGF	O
Sundew	*Drosera peltata*	G	O
-	*Gonocarpus teucrioides*	G, SF	C
-	*Gonocarpus micranthus*	SF	U
Daisy-leaved Goodenia	*Goodenia bellidifolia*	G	O
Forest Goodenia	*Goodenia hederacea*	BGF, G	U
Hoary Guinea-flower	*Hibbertia obtusifolia*	G	C

Common name	Scientific name	Community	Frequency
Climbing Guinea Flower	*Hibbertia scandens*	BGF	U
Pennywort	*Hydrocotyle peduncularis*	SF	O
Morning Glory*	*Ipomoea cairica**	G	R
Clubmoss	*Lycopodiella sp.*	SF	O
Silky Purple-flag	*Patersonia sericea*	BGF	R
Rice Flower	*Pimelea linifolia*	G	C
Lamb's Tongues*	*Plantago lanceolata**	G	O
White Root	*Pratia purpurascens*	BGF, G	O
Pastel Flower	*Pseuderanthemum variabile*	BGF	U
Fireweed*	*Senecio madagascariensis**	G	C
Stinking Roger*	*Tagetes minuta**	G	R
White Clover*	*Trifolium repens**	G	C
Purple Top*	*Verbena bonariensis**	G	O
Native Violet	*Viola hederacea*	BGF, G	O
Australian Bluebell	*Wahlenbergia gracilis*	G	U
-	*Xanthorrhoea fulva*	SF	O
Sedges, Rushes and Aquatics			
	Baumea articulata	D	D
-	*Baumea rubiginosa*	SF	D
Tall Sedge	*Carex appressa*	SF	O
-	*Caustis recurvata*	SF	O
-	*Chorizandra cymbaria*	SF	C
Umbrella Sedge	*Cyperus eragrostis*	SF, G	O
Slender Flat-sedge	*Cyperus gracilis*	SF, G	U
-	*Eleocharis equisetina*	D	C
Knobby Club-rush	*Ficinia nodosa*	G	R
Tall Saw-sedge	*Gahnia clarkei*	SF	C

Common name	Scientific name	Community	Frequency
Red-fruited Saw Sedge	*Gahnia siberiana*	SF	U
Variable Sword-sedge	*Lepidosperma laterale*	G	U
Wattle Mat-rush	*Lomandra filiformis*	G	O
Spiny-headed Mat-rush	*Lomandra longifolia*	BGF, G, S	C
Many-flowered Mat-rush	*Lomandra multiflora*	G	U
-	*Myriophyllum sp.*	D	O
Cape Waterlily	*Nymphaea capensis**	D	U
Water Snowflake	*Nymphoides indica*	D	U
Wooly Frogmouth	*Philydrum lanuginosum*	SF, D	O
Pondweed	*Potamogeton sp.*	D	U
-	*Schoenus sp.*	SF	C
Lianas, Scramblers and Twiners			
Dodder Laurel	*Cassitha pubescens*	G	U
Hairy Apple Berry	*Billardiera scandens*	BGF, G	C
Wombat Berry	*Eustrephus latifolius*	BGF	U
Scrambling Lily	*Geitonoplesium cymosum*	BGF	U
Glycine	*Glycine clandestina*	BGF	O
Variable Glycine	*Glycine tabacina*	G	U
Purple Coral Pea	*Hardenbergia violacea*	G	U
Monkey Rope	*Parsonsia straminea*	G, SF	O
Bramble Bush	*Rubus moluccanus*	G	U
False Sarsaparilla	*Smilax glyciphylla*	BGF	O

Appendix 3: Koala Food Tree Data

Table 19: Details of primary/preferred Koala food trees on the site

Yellow highlighting = to be retained

Name	Tag Number	Species	Estimated Height (m)	DBH Measured (cm)	Comments	Latitude	Longitude
KFT 1	764	Tallowwood	23	100		-31.451571	152.839788
KFT 2	776	Tallowwood	20	100		-31.451551	152.839958
KFT 3	775	Tallowwood	20	76		-31.451562	152.840451
KFT 4	773	Tallowwood	25	200		-31.451343	152.840309
KFT 5	717	Tallowwood	20	80		-31.451339	152.840525
KFT 6	718	Tallowwood	17	25		-31.451365	152.840516
KFT 7	729	Tallowwood	17	40		-31.451367	152.840514
KFT 8	758	Tallowwood	17	47		-31.45137	152.840644
KFT 9	802	Tallowwood	18	50		-31.451331	152.840599
KFT 10	777	Tallowwood	20	50		-31.451317	152.840765
KFT 11	739	Tallowwood	20	55		-31.4513	152.840815
KFT 12	712	Tallowwood	20	42		-31.451271	152.840888
KFT 13	779	Tallowwood	20	72		-31.451269	152.840804
KFT 14	799	Tallowwood	20	45		-31.451335	152.840848
KFT 15	716	Tallowwood	23	75		-31.451302	152.840982
KFT 16	769	Tallowwood	17	37		-31.451262	152.840852
KFT 17	754	Tallowwood	18	42		-31.451228	152.840819
KFT 18	734	Tallowwood	20	45		-31.451213	152.840799
KFT 19	751	Tallowwood	20	45		-31.451213	152.840761
KFT 20	753	Tallowwood	20	85		-31.451184	152.840725
KFT 21	752	Tallowwood	12	23		-31.45119	152.840823
KFT 22	22	Tallowwood	4	13	New KFT	-31.45118	152.840848
KFT 23	23	Tallowwood	8	12	New KFT	-31.451172	152.840868
KFT 24	24	Tallowwood	10	13	New KFT	-31.451257	152.84083
KFT 25	25	Tallowwood	13	21	New KFT	-31.451247	152.840922
KFT 26	750	Tallowwood	22	53		-31.451209	152.840966
KFT 27	27	Tallowwood	10	14	New KFT	-31.451128	152.840899
KFT 28	28	Tallowwood	12	25	New KFT	-31.451122	152.840899
KFT 29	29	Tallowwood	10	14	New KFT	-31.451144	152.840928
KFT 30	748	Tallowwood	20	48		-31.451014	152.840684
KFT 31	737	Tallowwood	25	85		-31.451056	152.840675
KFT 32	780	Tallowwood	20	40		-31.450928	152.840937
KFT 33	33	Tallowwood	10	20	New KFT	-31.45092	152.841076
KFT 34	34	Tallowwood	12	45	New KFT	-31.450708	152.840792
KFT 35	35	Swamp Mahogany	10	30	New KFT	-31.450521	152.840777
KFT 36	36	Tallowwood	6	15	New KFT	-31.450689	152.841528
KFT 37	741	Tallowwood	20	70		-31.451224	152.841995

KFT 38	767	Tallowwood	20	75		-31.451146	152.84202
KFT 39	789	Tallowwood	23	100		-31.450899	152.841979
KFT 40	713	Tallowwood	20	95		-31.45084	152.842144
KFT 41	732	Tallowwood	20	70		-31.450817	152.842213
KFT 42	726	Tallowwood	10	35		-31.449784	152.843813
KFT 43	708	Tallowwood	15	45		-31.449451	152.841484
KFT 44	792	Tallowwood	23	90		-31.44988	152.841704
KFT 45	709	Tallowwood	25	65		-31.449988	152.841534
KFT 46	798	Tallowwood	25	100		-31.450024	152.841116
KFT 47	711	Tallowwood	15	48		-31.449364	152.841017
KFT 48	801	Tallowwood	15	35		-31.449331	152.840915
KFT 49	797	Tallowwood	15	35		-31.449344	152.840908
KFT 50	707	Tallowwood	12	25		-31.449349	152.840811
KFT 51	706	Tallowwood	15	45		-31.44932	152.840579
KFT 52	704	Tallowwood	25	80		-31.449495	152.840619
KFT 53	705	Tallowwood	25	85		-31.449446	152.840749
KFT 54	54	Tallowwood	8	18	New KFT	-31.447497	152.84032
KFT 55	757	Tallowwood	17	40		-31.447423	152.840306
KFT 56	56	Tallowwood	8	20	New KFT	-31.447311	152.840304
KFT 57	57	Tallowwood	20	40	New KFT	-31.447316	152.840187
KFT 58	58	Tallowwood	17	30	New KFT	-31.447232	152.840236
KFT 59	59	Tallowwood	17	25	New KFT	-31.447185	152.840277
KFT 60	60	Tallowwood	17	28	New KFT	-31.44719	152.840354
KFT 61	738	Tallowwood	18	35		-31.447136	152.840192
KFT 62	715	Tallowwood	10	18		-31.447104	152.840164
KFT 63	781	Tallowwood	20	45		-31.447045	152.840088
KFT 64	793	Tallowwood	15	30		-31.447027	152.840075
KFT 65	760	Tallowwood	15	23		-31.44697	152.840121
KFT 66	759	Tallowwood	17	60		-31.446937	152.840152
KFT 67	768	Tallowwood	22	60		-31.446955	152.840171
KFT 68	68	Tallowwood	12	18	New KFT	-31.446926	152.840179
KFT 69	69	Tallowwood	12	25	New KFT	-31.446949	152.840301
KFT 70	70	Tallowwood	15	25	New KFT	-31.447045	152.840531
KFT 71	71	Tallowwood	15	20	New KFT	-31.447074	152.840557
KFT 72	72	Tallowwood	17	27	New KFT	-31.447207	152.840541
KFT 73	73	Tallowwood	20	55	New KFT	-31.44718	152.840491
KFT 74	74	Tallowwood	20	42	New KFT	-31.447237	152.840495
KFT 75	763	Tallowwood	23	65		-31.447274	152.840653
KFT 76	749	Tallowwood	13	25		-31.44585	152.840036
KFT 77	778	Tallowwood	12	20		-31.445875	152.840147
KFT 78	783	Tallowwood	17	50		-31.445916	152.840332
KFT 79	785	Tallowwood	17	0		-31.445957	152.840636
KFT 80	790	Tallowwood	15	30		-31.445963	152.84088
KFT 81	723	Tallowwood	10	25		-31.446044	152.841442
KFT 82	794	Tallowwood	12	40		-31.446055	152.841485
KFT 83	784	Tallowwood	6	20		-31.446045	152.841521

KFT 84	733	Tallowwood	10	30		-31.446205	152.842418
KFT 85	731	Tallowwood	10	35		-31.44621	152.842475
KFT 86	782	Tallowwood	15	45		-31.446375	152.843563
KFT 87	795	Tallowwood	10	40		-31.446369	152.843698
KFT 88	725	Tallowwood	12	45		-31.446448	152.844286
KFT 89	766	Tallowwood	15	45		-31.446553	152.845117
KFT 90	787	Tallowwood	12	42		-31.447577	152.843534
KFT 91	740	Tallowwood	25	80		-31.447855	152.843444
KFT 92	735	Tallowwood	25	50		-31.447887	152.843412
KFT 93	765	Tallowwood	23	70		-31.447904	152.843538
KFT 94	770	Tallowwood	20	60		-31.44773	152.843239
KFT 95	744	Tallowwood	15	55		-31.445286	152.840563
KFT 96	755	Tallowwood	12	24		-31.4452	152.840562
KFT 97	761	Tallowwood	17	55		-31.444974	152.840562
KFT 98	98	Tallowwood	15	50	New KFT	-31.445025	152.840443
KFT 99	756	Tallowwood	18	55		-31.444973	152.840348
KFT 100	100	Tallowwood	15	30	New KFT	-31.444578	152.840406
KFT 101	100	Tallowwood	13	25	New KFT	-31.444583	152.840483
KFT 102	102	Tallowwood	8	18	New KFT	-31.444664	152.84069
KFT 103	103	Tallowwood	12	30	New KFT	-31.444642	152.840739
KFT 104	104	Tallowwood	8	15	New KFT	-31.444711	152.840683
KFT 105	105	Tallowwood	15	32	New KFT	-31.444903	152.842941
KFT 106	106	Tallowwood	8	24	New KFT	-31.444789	152.843087
KFT 107	107	Tallowwood	15	35	New KFT	-31.444771	152.843053
KFT 108	108	Tallowwood	6	16	New KFT	-31.444694	152.843289
KFT 109	109	Tallowwood	12	45	New KFT	-31.444859	152.843293
KFT 110	719	Tallowwood	20	58		-31.444971	152.843376
KFT 111	111	Tallowwood	5	16	New KFT	-31.444872	152.84314
KFT 112	112	Tallowwood	5	22	New KFT	-31.44487	152.843142
KFT 113	747	Tallowwood	18	50		-31.444381	152.845359
KFT 114	796	Tallowwood	20	55		-31.444187	152.845395
KFT 115	115	Tallowwood	25	58	New KFT	-31.444558	152.845747
KFT 116	116	Tallowwood	10	30	New KFT	-31.444738	152.845561
KFT 117	117	Tallowwood	6	22	New KFT	-31.444783	152.845667
KFT 118	118	Tallowwood	7	20	New KFT	-31.444672	152.845649
KFT 119	119	Tallowwood	23	64	New KFT	-31.444659	152.846061
KFT 120	736	Tallowwood	23	55		-31.444376	152.846017
KFT 121	791	Tallowwood	25	48		-31.444193	152.84608
KFT 122	727	Tallowwood	23	50		-31.444286	152.846006
KFT 123	746	Tallowwood	23	52		-31.444199	152.845903
KFT 124	743	Tallowwood	23	48		-31.444307	152.845866
KFT 125	259	Tallowwood	17	58		-31.443429	152.846174
KFT 126	721	Tallowwood	20	55		-31.443347	152.846414
KFT 127	127	Tallowwood	12	18	New KFT	-31.443312	152.846291
KFT 128	724	Tallowwood	23	66		-31.443472	152.844974
KFT 129	702	Tallowwood	25	69		-31.442867	152.844645

KFT 130	701	Tallowwood	23	50		-31.442685	152.844471

Appendix 4: Hollow-bearing Tree Assessment Data Sheets

Port Macquarie-Hastings Council

Hollow-bearing tree assessment

LGA/Project: THRUMSTER

Date	Easting	Northing	Datum

Tree species (if known) BLACKBUTT #774 H1

Status
Score: Living Tree = 3 | Dead Tree = 1

Alive	Dead	Score
✓		3

DBH Score (living trees only)
Score: 80 -100+cm = 3 | 60 – 80cm = 1.5 | < 60cm = 0

240

Score
~~240~~ 3

Number of visible hollows
Score: > 5 = 3 | 2 – 4 = 1.5 | 0 – 1 = 0

> 5	2 - 4	0 - 1	Score
✓			3

Visible Hollow(s) Score (Highest value only)
1 or more > 100mm = 3 | 1+ > 50mm = 2 | 1+ < 50mm = 1

> 100mm	> 50mm	< 50mm	Score
✓			3

Habitat or Linkage Proximity Score
HBT in habitat block/linkage to be retained (*in situ*) = 3;
< 30m from habitat block/linkage to be retained = 2
> 30m from habitat block/linkage to be retained = 0

In situ	< 30m	> 30m	Score
✓			3

Longevity Ranking
High = 3 | Medium = 1.5 | Low = 0 - Refer to Notes 2.

High	Medium	Low	Score
✓			3

TOTAL SCORE 18

Evidence of existing use

Recommendation(s) RETAIN IN SITU – TREE PROTECTION MEASURES – BUFFER ZONE

Explanatory Notes:

1. Hollow-bearing trees (HBTs) are an important element in the Australian landscape and a significant factor affecting biodiversity values. This assessment sheet is intended to provide a more quantitative and ecologically meaningful approach to the ranking of HBTs than is otherwise currently applied. As advocated by Gibbons & Lindenmayer (2002), the emphasis for conservation purposes is clearly on large, living trees that are likely to offer the greatest diversity of hollow types and/or size.

Port Macquarie-Hastings Council

Hollow-bearing tree assessment

LGA/Project: THRUMSTER

Date	Easting	Northing	Datum
29-11-16			

Tree species (if known) WHITE STRINGYBARK H2

Status
Score: Living Tree = 3 | Dead Tree = 1

Alive	Dead	Score
3		3

DBH Score (living trees only)
Score: 80 -100^{+}cm = 3 | 60 – 80cm = 1.5 | < 60cm = 0

64

Score	
~~1.5~~	0

Number of visible hollows
Score: > 5 = 3 | 2 – 4 = 1.5 | 0 – 1 = 0

> 5	2 - 4	0 - 1	Score
		1	0

Visible Hollow(s) Score (Highest value only)
1 or more > 100mm = 3 | 1+ > 50mm = 2 | 1+ < 50mm = 1

> 100mm	> 50mm	< 50mm	Score
			1

Habitat or Linkage Proximity Score
HBT in habitat block/linkage to be retained (*in situ*) = 3;
< 30m from habitat block/linkage to be retained = 2
> 30m from habitat block/linkage to be retained = 0

In situ	< 30m	> 30m	Score
			2

Longevity Ranking
High = 3 | Medium = 1.5 | Low = 0 - Refer to Notes 2.

High	Medium	Low	Score
✓			3

TOTAL SCORE 9

Evidence of existing use Excavation around edges

Recommendation(s) retain in situ

Explanatory Notes:

1. Hollow-bearing trees (HBTs) are an important element in the Australian landscape and a significant factor affecting biodiversity values. This assessment sheet is intended to provide a more quantitative and ecologically meaningful approach to the ranking of HBTs than is otherwise currently applied. As advocated by Gibbons & Lindenmayer (2002), the emphasis for conservation purposes is clearly on large, living trees that are likely to offer the greatest diversity of hollow types and/or size.

Port Macquarie-Hastings Council

Hollow-bearing tree assessment

LGA/Project: THRUMSTER

Date	Easting	Northing	Datum
29-11-16			

Tree species (if known) BLACKBUTT H3

Status
Score: Living Tree = 3 | Dead Tree = 1

Alive	Dead	Score
3		3

DBH Score (living trees only)
Score: 80 -100+cm = 3 | 60 – 80cm = 1.5 | < 60cm = 0

220 cm DBH

Score
3

Number of visible hollows
Score: > 5 = 3 | 2 – 4 = 1.5 | 0 – 1 = 0

> 5	2 - 4	0 - 1	Score
✓			3

Visible Hollow(s) Score (Highest value only)
1 or more > 100mm = 3 | 1+ > 50mm = 2 | 1+ < 50mm = 1

> 100mm	> 50mm	< 50mm	Score
✓			3

Habitat or Linkage Proximity Score
HBT in habitat block/linkage to be retained (*in situ*) = 3;
< 30m from habitat block/linkage to be retained = 2
> 30m from habitat block/linkage to be retained = 0

In situ	< 30m	> 30m	Score
✓			3

Longevity Ranking
High = 3 | Medium = 1.5 | Low = 0 - Refer to Notes 2.

High	Medium	Low	Score
	✓		1.5

TOTAL SCORE 16.5

Evidence of existing use SCRATCH MARKS ON TRUNK

Recommendation(s) RETAIN INSITU WITH VEGETATED BUFFER

Explanatory Notes:

1. Hollow-bearing trees (HBTs) are an important element in the Australian landscape and a significant factor affecting biodiversity values. This assessment sheet is intended to provide a more quantitative and ecologically meaningful approach to the ranking of HBTs than is otherwise currently applied. As advocated by Gibbons & Lindenmayer (2002), the emphasis for conservation purposes is clearly on large, living trees that are likely to offer the greatest diversity of hollow types and/or size.

Port Macquarie-Hastings Council

Hollow-bearing tree assessment

LGA/Project: Partridge Creek Residential, Thrumster

Date	Easting	Northing	Datum

Tree species (if known) White Stringybark H4

Status
Score: Living Tree = 3 | Dead Tree = 1

Alive	Dead	Score
✓		3

DBH Score (living trees only)
Score: 80 -100+ cm = 3 | 60 – 80cm = 1.5 | < 60cm = 0

Score
3

Number of visible hollows
Score: > 5 = 3 | 2 – 4 = 1.5 | 0 – 1 = 0

> 5	2 - 4	0 - 1	Score
		✓	0

Visible Hollow(s) Score (Highest value only)
1 or more > 100mm = 3 | 1+ > 50mm = 2 | 1+ < 50mm = 1

> 100mm	> 50mm	< 50mm	Score
	✓		2

Habitat or Linkage Proximity Score
HBT in habitat block/linkage to be retained (*in situ*) = 3;
< 30m from habitat block/linkage to be retained = 2
> 30m from habitat block/linkage to be retained = 0

In situ	< 30m	> 30m	Score
		✓	0

Longevity Ranking
High = 3 | Medium = 1.5 | Low = 0 - Refer to Notes 2.

High	Medium	Low	Score
✓			3

TOTAL SCORE 11

Evidence of existing use Not noted. Low quality HBT

Recommendation(s) Remove subject to compensation measures.

Explanatory Notes:

1. Hollow-bearing trees (HBTs) are an important element in the Australian landscape and a significant factor affecting biodiversity values. This assessment sheet is intended to provide a more quantitative and ecologically meaningful approach to the ranking of HBTs than is otherwise currently applied. As advocated by Gibbons & Lindenmayer (2002), the emphasis for conservation purposes is clearly on large, living trees that are likely to offer the greatest diversity of hollow types and/or size.

Port Macquarie-Hastings Council

Hollow-bearing tree assessment

LGA/Project: Partridge Creek Residential, Thrumster

Date	Easting	Northing	Datum

Tree species (if known) Swamp Mahogany #5

Status
Score: Living Tree = 3 | Dead Tree = 1

Alive	Dead	Score
✓		3

DBH Score (living trees only)
Score: 80 -100+cm = 3 | 60 – 80cm = 1.5 | < 60cm = 0

Score
3

Number of visible hollows
Score: > 5 = 3 | 2 – 4 = 1.5 | 0 – 1 = 0

> 5	2 - 4	0 - 1	Score
	✓		1.5

Visible Hollow(s) Score (Highest value only)
1 or more > 100mm = 3 | 1+ > 50mm = 2 | 1+ < 50mm = 1

> 100mm	> 50mm	< 50mm	Score
	✓		2

Habitat or Linkage Proximity Score
HBT in habitat block/linkage to be retained (*in situ*) = 3;
< 30m from habitat block/linkage to be retained = 2
> 30m from habitat block/linkage to be retained = 0

In situ	< 30m	> 30m	Score
	✓	~~✓~~	~~0~~ 2

Longevity Ranking
High = 3 | Medium = 1.5 | Low = 0 - Refer to Notes 2.

High	Medium	Low	Score
✓			3

TOTAL SCORE 14.5

Evidence of existing use No fauna use noted.

Recommendation(s) Occurs in road footprint. Remove subject to compensation measures.

Explanatory Notes:

1. Hollow-bearing trees (HBTs) are an important element in the Australian landscape and a significant factor affecting biodiversity values. This assessment sheet is intended to provide a more quantitative and ecologically meaningful approach to the ranking of HBTs than is otherwise currently applied. As advocated by Gibbons & Lindenmayer (2002), the emphasis for conservation purposes is clearly on large, living trees that are likely to offer the greatest diversity of hollow types and/or size.

Port Macquarie–Hastings Council

Hollow-bearing tree assessment

LGA/Project: Partridge Creek residential Thrumster

Date	Easting	Northing	Datum

Tree species (if known) Tallowood #6

Status
Score: Living Tree = 3 | Dead Tree = 1

Alive	Dead	Score
✓		3

DBH Score (living trees only)
Score: 80 -100^{+}cm = 3 | 60 – 80cm = 1.5 | < 60cm = 0

Score
3

Number of visible hollows
Score: > 5 = 3 | 2 – 4 = 1.5 | 0 – 1 = 0

> 5	2 - 4	0 - 1	Score
✓			3

Visible Hollow(s) Score (Highest value only)
1 or more > 100mm = 3 | 1+ > 50mm = 2 | 1+ < 50mm = 1

> 100mm	> 50mm	< 50mm	Score
✓			3

Habitat or Linkage Proximity Score
HBT in habitat block/linkage to be retained (*in situ*) = 3;
< 30m from habitat block/linkage to be retained = 2
> 30m from habitat block/linkage to be retained = 0

In situ	< 30m	> 30m	Score
	✓		2

Longevity Ranking
High = 3 | Medium = 1.5 | Low = 0 - Refer to Notes 2.

High	Medium	Low	Score
✓			3

TOTAL SCORE 17

Evidence of existing use Large tree with many hollows. No evidence of fauna usage

Recommendation(s) Retain in E3 zone with buffer

Explanatory Notes:

1. Hollow-bearing trees (HBTs) are an important element in the Australian landscape and a significant factor affecting biodiversity values. This assessment sheet is intended to provide a more quantitative and ecologically meaningful approach to the ranking of HBTs than is otherwise currently applied. As advocated by Gibbons & Lindenmayer (2002), the emphasis for conservation purposes is clearly on large, living trees that are likely to offer the greatest diversity of hollow types and/or size.

Appendix 5: Herbarium Correspondence

The Royal
BOTANIC GARDENS
& Domain Trust

National Herbarium of New South Wales

Mr Will STEGGALL
Naturecall Environmental
Level1, Suite3
64 Clarence Street
Port Macquarie, NSW 2444
AUSTRALIA

Enquiry No: 20170
Botanical.Is@rbgsyd.nsw.gov.au
Fax No: (02) 9251 1952
Ph No: (02) 9231 8111
Date: 21 June 2017

Dear Mr STEGGALL,

Thank you for your enquiry of 21-Jun-17. We are happy to provide the following information:

Lindsaea dimorpha det B.M. Wiecek 21 June 2017, specimen retained for herbarium collection. This locality fills a gap in the distribution of this species which I think is rather undercollected. There is no charge for this enquiry

Thank you for your enquiry.

Yours sincerely

Barbara Wiecek
Identification Botanist
Botanical Information Service

The Royal
BOTANIC GARDENS
& Domain Trust

National Herbarium of New South Wales

Mr Will STEGGALL
Naturecall Environmental
Level1, Suite3
64 Clarence Street
Port Macquarie, NSW 2444
AUSTRALIA

Enquiry No: 20194
Botanical.Is@rbgsyd.nsw.gov.au
Fax No: (02) 9251 1952
Ph No: (02) 9231 8111
Date: 4 August 2017

Dear Mr STEGGALL,

Thank you for your enquiry of 17-Jul-17. We are happy to provide the following information:

Thank you for querying my June *Lindsaea* identification. I have checked your comments out against specimens, PlantNET, S.B. Andrews' Ferns of Queensland and Flora of Australia Volume 48 and darn it you are right! I have determined all your collections as *Lindsaea incisa* as of 4 Aug 2017. We don't have many *Lindsaea* collections so yours will make a welcome addition to our herbarium.
Incidently you should check out the full geographic range of both species of *Lindsaea* in question (in case you hadn't already). *L. dimorpha* is commonly recorded in far north coast NSW and SE Queensland with a big gap down to the Central Coast botanical region. I got pretty excited about a potential "missing link". *L incisa* however is endangered so that is just as good. It would be interesting to know if this genus is undercollected (as is the case with ferns in general).

Thank you for your enquiry.

Yours sincerely

Barbara Wiecek
Identification Botanist
Botanical Information Service

Appendix 6: EPBC MNES Search Results

Australian Government
Department of the Environment and Energy

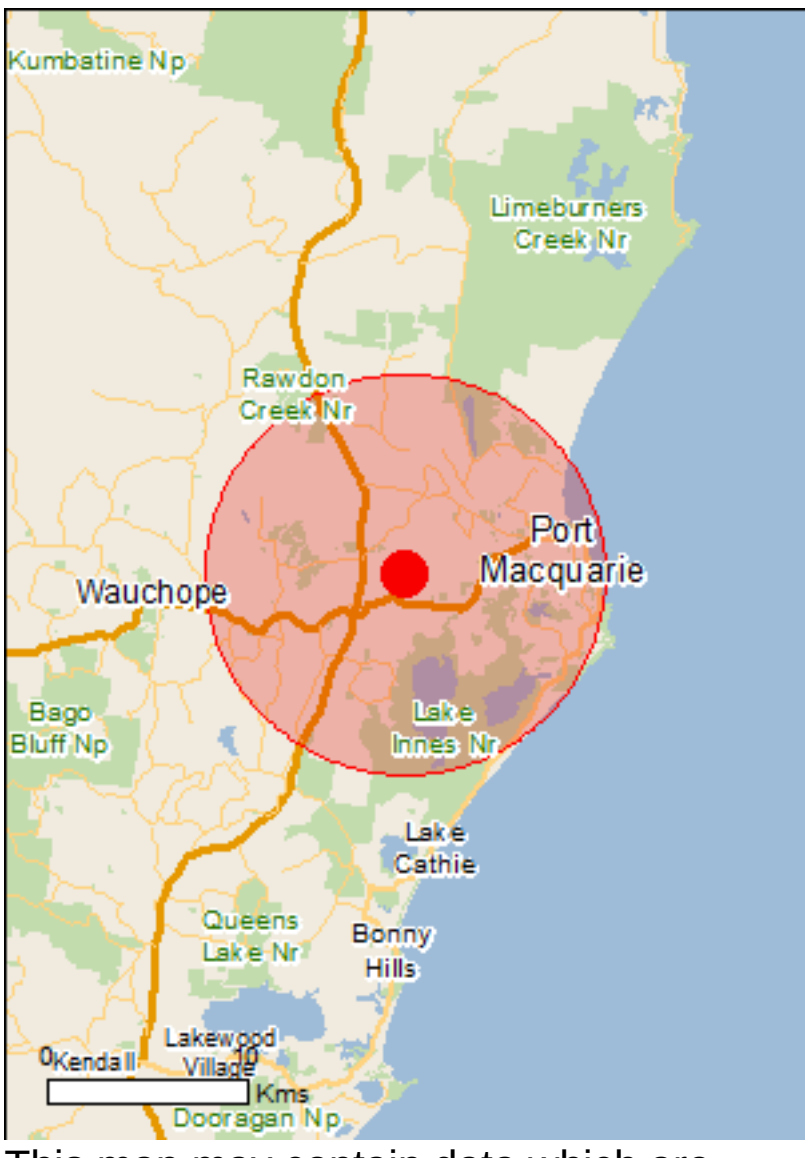
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

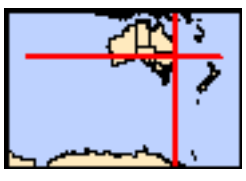
Report created: 09/06/17 16:27:33



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	66
Listed Migratory Species:	60

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	6
Commonwealth Heritage Places:	None
Listed Marine Species:	88
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	10
Regional Forest Agreements:	1
Invasive Species:	39
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	Community likely to occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Status	Type of Presence
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Thalassarche cauta steadi		
White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita		
Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Epinephelus daemelii		
Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Litoria aurea		
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Mixophyes balbus		
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area
Mixophyes iteratus		
Giant Barred Frog, Southern Barred Frog [1944]	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus		
Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat may occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Plants		
Acronychia littoralis Scented Acronychia [8582]	Endangered	Species or species habitat likely to occur within area
Allocasuarina defungens Dwarf Heath Casuarina [21924]	Endangered	Species or species habitat known to occur within area
Arthraxon hispidus Hairy-joint Grass [9338]	Vulnerable	Species or species habitat may occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Euphrasia arguta [4325]	Critically Endangered	Species or species habitat may occur within area
Macadamia integrifolia Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak [7326]	Vulnerable	Species or species habitat may occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species habitat known to occur within area
Parsonsia dorrigoensis Milky Silkpod [64684]	Endangered	Species or species habitat likely to occur within area
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area
Sharks		
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		

Name	Threatened	Type of Presence
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area

Migratory Terrestrial Species

Name	Threatened	Type of Presence
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting may occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Bank of Australia
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Telstra Corporation Limited

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur

Name	Threatened	Type of Presence
		within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting may occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Solegnathus dunckeri Duncker's Pipehorse [66271]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paegnius Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding likely to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area

Name	Status	Type of Presence
[Tursiops aduncus](#)		
Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
[Tursiops truncatus s. str.](#)		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
FMAs in WAUCHOPE	NSW
LNE Special Management Zone No1	NSW
Lake Innes	NSW
Lake Innes	NSW
Limeburners Creek	NSW
Macquarie	NSW
Queens Lake	NSW
Rawdon Creek	NSW
Sea Acres	NSW
Woregore	NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
[North East NSW RFA](#)	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern,		Species or species

Name	Status	Type of Presence
Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425] Asparagus plumosus		habitat likely to occur within area
Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Cabomba caroliniana		
Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171] Chrysanthemoides monilifera		Species or species habitat likely to occur within area
Bitou Bush, Boneseed [18983]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. rotundata		
Bitou Bush [16332]		Species or species habitat likely to occur within area
Eichhornia crassipes		
Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana		
Broom [67538]		Species or species habitat may occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] Opuntia spp.		Species or species habitat likely to occur within area
Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata		
Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus		
Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus		
Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla		
Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis		
Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Limeburners Creek Nature Reserve	NSW

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-31.44738 152.84324

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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CONSULTING ENGINEERS
CIVIL • STRUCTURAL • BUILDING DESIGN • PLANNING

STORMWATER MANAGEMENT PLAN

PARTRIDGE CREEK DEVELOPMENT,
PORT MACQUARIE, NSW 2444

CLIENT: PORT MACQUARIE-HASTINGS COUNCIL

Document Verification Schedule

Project:
Stormwater Management Plan for Partridge Creek Development
At Port Macquarie, NSW 2444

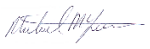
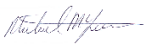
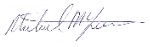
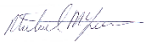
Rev.	Date	Prepared By		Checked By		Approved By	
Rev.01	Oct 16	M McFeeters		J Sutcliffe		M McFeeters	
Rev.02	Aug 17	M McFeeters		J Sutcliffe		M McFeeters	
Rev.03	Aug 18	M McFeeters		J Sutcliffe		M McFeeters	

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TABLE OF CONTENTS

1 INTRODUCTION

The subject of this Stormwater Management Plan includes land within the 'Partridge Creek Residential' precinct, within the Thrumster Urban Release Area.

The land is located approximately 7km to the west of the Port Macquarie city centre.

The subject land includes two parcels which are legally described as Lot 1 DP1087368 and Lot 2 DP1172154. The land is accessible from Thrumster Street only, having no other public road frontages.

This drainage design strategy is intended to maintain the objectives for land subdivisions within the Port Macquarie-Hastings council (PMHC) area as follows:

- provide safety for the public
- minimise and control, nuisance flooding and to provide for the safe passage of less frequent flood.
- protect property
- enhance the urban landscape
- maximise the land area available for dwellings
- minimise the environmental impact of urban runoff
- ensure discharge rates from new developments, do not exceed the capacity of the downstream stormwater systems nor result in additional scour and instability of natural creek and river systems and artificial channels.
- the system is designed to generally conform to natural drainage patterns and discharge to natural drainage paths in the catchment.

2 SITE DESCRIPTION

The development land is irregular in shape and comprises approximately 211.7 hectares. The development area only comprises about 55 hectares of this.

The land is heavily vegetated in parts, mainly contained to the eastern and northern-most parts of the site. The land is free of improvements, excepting a sewer pumping station which is in the north-western corner.

2.1 EXISTING CATCHMENTS

The development area is undulating but is generally defined by a ridgeline that runs north-south. There is an existing water course that runs north-south through the subject land, which is a tributary of Partridge Creek located further to the north. There is also another water course that runs North through the proposed development area and meets with the tributary.

Key statistics of the catchments are provided in Table 1 below:

Catchment Number	Area
C1	14.5ha
C2	11.3ha
C3	9.7ha
C4	13.0ha
C5	10.7ha
C6	2.8ha
C7	0.5ha
C8	4.0ha

Table 1. Partridge Creek subdivision key statistics by catchment

Figure 1. Aerial Image of Development Site and Surrounds

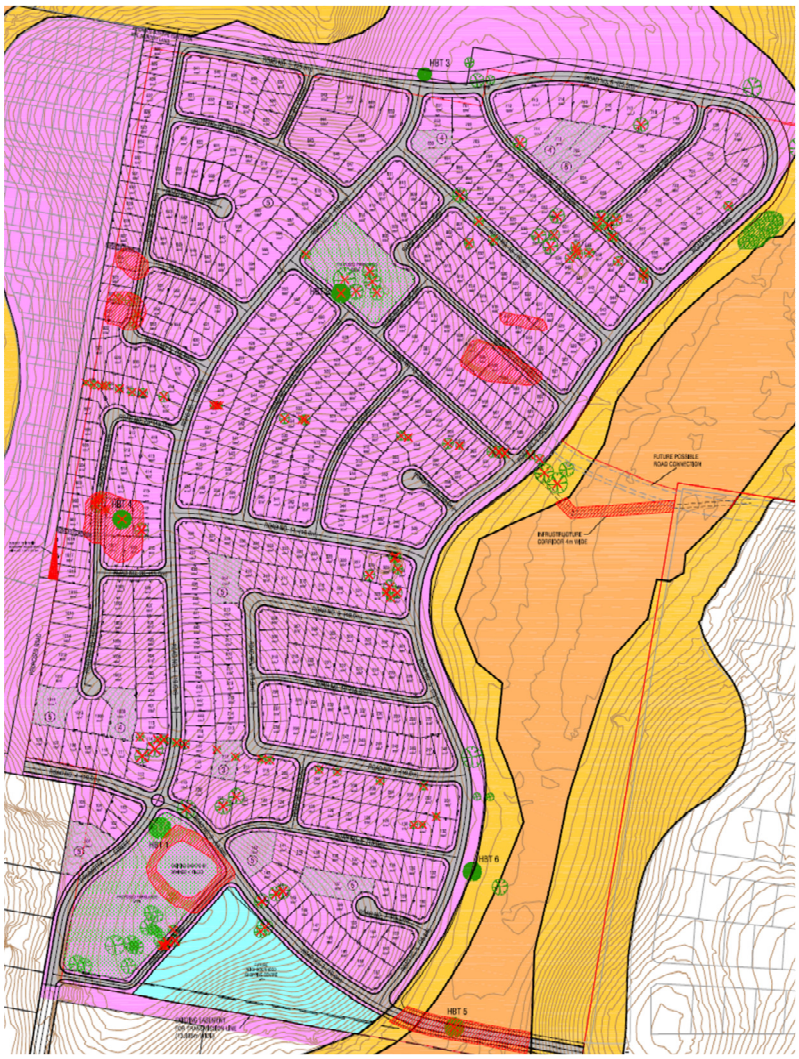


Figure 2. Proposed Subdivision Layout.

3 Catchment Characteristics

3.1 Catchment Definitions

The Partridge Creek development consists of eight individual catchments as defined on the Catchment Plan in Figure 3 below. These eight catchments fall within a wider area catchment as defined in the 'Maunsell|AECOM Thrumster Integrated Water Management Plan Flood Study' as catchment A5.2 and A1-8. Local catchments defined as C4-6 fall within areas A1-8 of the Mansell's Report and a Stormwater Management Plan for this area has been prepared by King & Campbell. Local catchment areas C1-3 and C7-8 fall within the area defined as A5-1. Both catchments fall at the bottom of overall catchments, detention within the lower bounds is not as effective as detention in the upper catchments in reducing the overall peak flow and flood heights. This principle is referenced in King & Campbell Report, "Stormwater detention facilities have been shown to be more effective, the higher their location within the catchment, conversely with a reduction in their effectiveness as we move downstream. In some cases, providing detention within the lower reaches of a catchment may perversely result in increases in the downstream flow rates, due to the peak flow from the downstream sub-catchment being delayed through the use of detention basins to then coincide with the rising peak of the greater catchment at the point of discharge."

Figure 3. Concept Catchment Plan

B1

level	W	L			Batter	
2	35	71			4	1
	H	Area	volume			
	2	2485	0			
	2.25	2701	675.25			
	2.5	2925	1462.5			
	2.75	3157	2367.75			
	3	3397	3397			
	3.25	3645	4556.25			
	3.5	3901	5851.5			
Req Volume From Calc (cum)			3400			
Maximum Height (m)			1.13			

B2

level	W	L			Batter	
3	28	57			4	1
	H	Area	volume			
	3	1596	0			
	3.25	1770	442.5			
	3.5	1952	976			
	3.75	2142	1606.5			
	4	2340	2340			
	4.25	2546	3182.5			
	4.5	2760	4140			
Req Volume From Calc (cum)			2400			
Maximum Height (m)			1.2			

B3

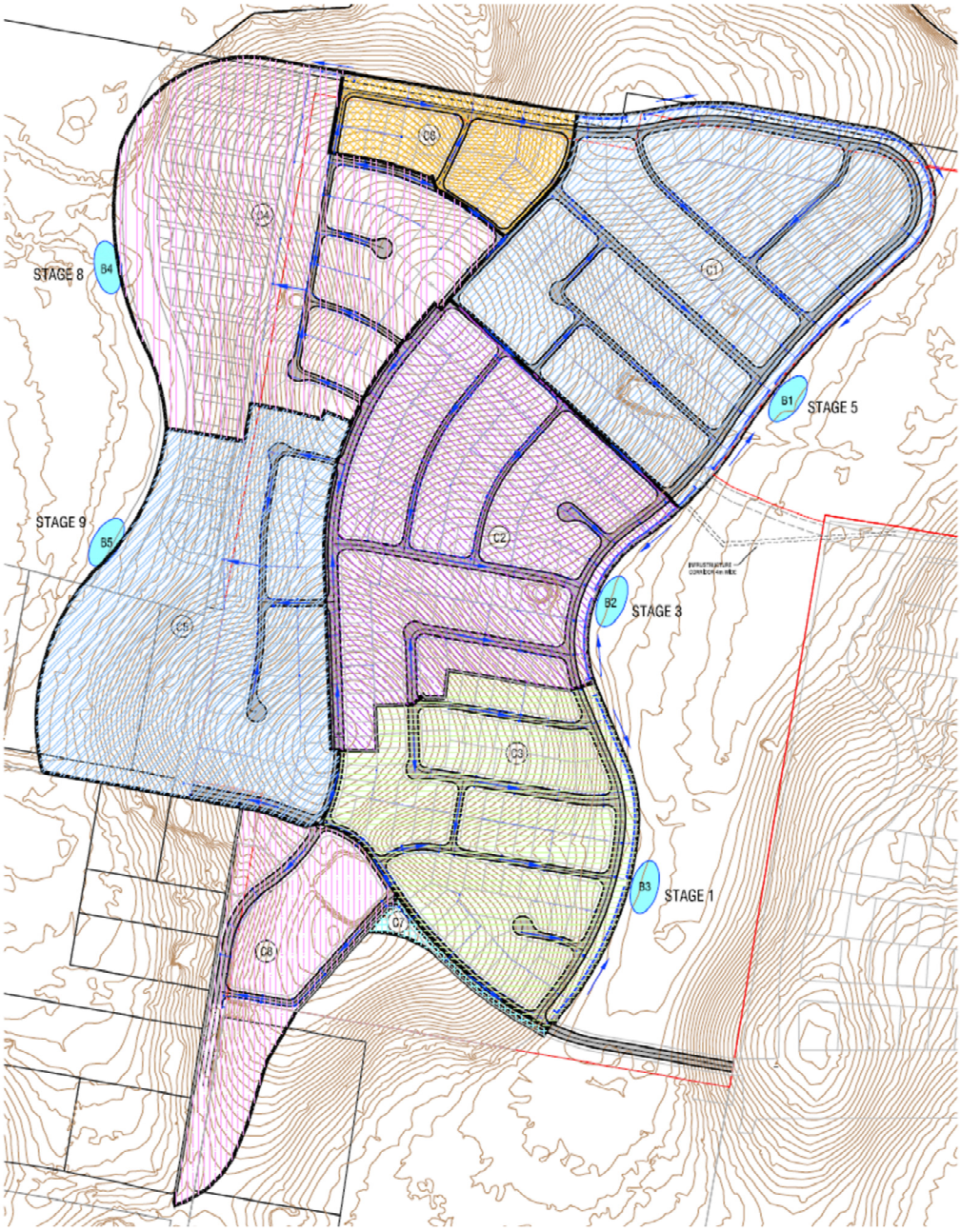
level	W	L			Batter	
3	26	52			4	1
	H	Area	volume			
	3	1352	0			
	3.25	1512	378			
	3.5	1680	840			
	3.75	1856	1392			
	4	2040	2040			
	4.25	2232	2790			
	4.5	2432	3648			
Req Volume From Calc (cum)			2135			
Maximum Height (m)			1.21			

B4

level	W	L			Batter	
2	32	64			4	1
	H	Area	volume			
	2	2048	0			
	2.25	2244	561			
	2.5	2448	1224			
	2.75	2660	1995			
	3	2880	2880			
	3.25	3108	3885			
	3.5	3344	5016			
Req Volume From Calc (cum)			2670			
Maximum Height (m)			1.1			

B5

level	W	L			Batter	
2	28	57			4	1
	H	Area	volume			
	2	1590	0			
	2.25	1770	442.5			
	2.5	1952	976			
	2.75	2142	1606.5			
	3	2340	2340			
	3.25	2546	3182.5			
	3.5	2760	4140			
Req Volume From Calc (cum)			2195			
Maximum Height (m)			1.11			



3.2 HYDROLOGY

To assess the impacts of development on the existing downstream infrastructure the catchment hydrology has been analysed by using the "Drains" with Base model supplied by PMHC. These models have been prepared to determine both the time of concentration and the peak flows for pre and post development.

Storms 1 year, 5 year and 100 year with rainfall events from 5 minutes to 2 hours where analysed to produce peak flows for pre and post development. These models have also incorporated detention to assess the projected volumes to restrict the outflow to pre-developed flows. These times of concentration that have been calculated to help us determine if the time of concentration will correlate to the overall flood times for the Hastings River catchment. Summaries of these are shown in Figure 3 on the previous page. Given that the peak discharge would occur between 40 – 50 minutes for the detention system and between 25 – 30 minutes for the undetained system, the treatment would be redundant. The critical time of concentration for both natural catchments A1-8 and A5-2 is 9 hours. The flows generated by these catchments have been determined for the 1:100 year storm in the Maunsell flood study (2007). It was determined that catchments A1-8 and A5-2 generate 140.9m^3/sec in their current state. Even if the proposed development were to double the impervious area, the total flows would still only represent 0.6% of the total Hastings River flows in the worst case scenario where both peaks were to coincide. Our recommendation in accordance with Council's policy is that all eight catchments be undetained as they have little to no impact on the overall flood heights.

Further to this, it may be shown that the implementation of on site detention could adversely impact the maximum flood height at the confluence of catchments A1-8 and A5-2. The Maunsell flood study (2007) determined that the 100 year time of concentration for the catchments were 9 hours each. By detaining stormwater generated by the development, we would converge the developed and natural flows thus increasing the peak flows from both catchments. This peak amplification could have implications on the capacity of down stream infrastructure.

It has been noted that the development of catchment C8 may result in adverse impacts on the adjacent roadside swale of Thrumster Street. The proportion of additional flows generated by the catchment are anticipated to be low. There currently exists a road through the catchment, and the proposed development will add four residential blocks. In order to mitigate any adverse impacts, lots 101-104 shall be required to restrict their post developed flows to the natural flow rate for that lot by means of on-site detention using water tanks. Flows generated by the proposed road will be offset by the deletion of the existing Thrumster Street connection.

4 Culvert Crossings

The Site includes two major creek crossings on the eastern side adjoining Lot 206 DP 754434 (L'Estrange). (refer to Figure 5). The design flows and flood plain encroachment have been derived from the flood studies as below.

Patterson Britton & Partners Pty Ltd -
"Area 13 'East Expansion, Precinct At Thrumster , Floodplain Encroachment Assessment "
"Figure 3 - Catchment A & B Encroachment Analysis"

Maunsell|AECOM –
"Thrumster Integrated Water Management Plan Flood Study"
"Stage 3,Peak Flood Level Contours, For The 100 Year Ari Event"

The flows were adopted at node A5-2a for culvert 1 the most southern culvert (10.2m3/s) and at A5-2b for the northern most culvert (12.8m3/s). We have conducted a preliminary estimate of size of box culvert however this will need to be detailed designed prior to construction certificate. We have allowed with a max head diff of 0.1m and a submerged outlet.

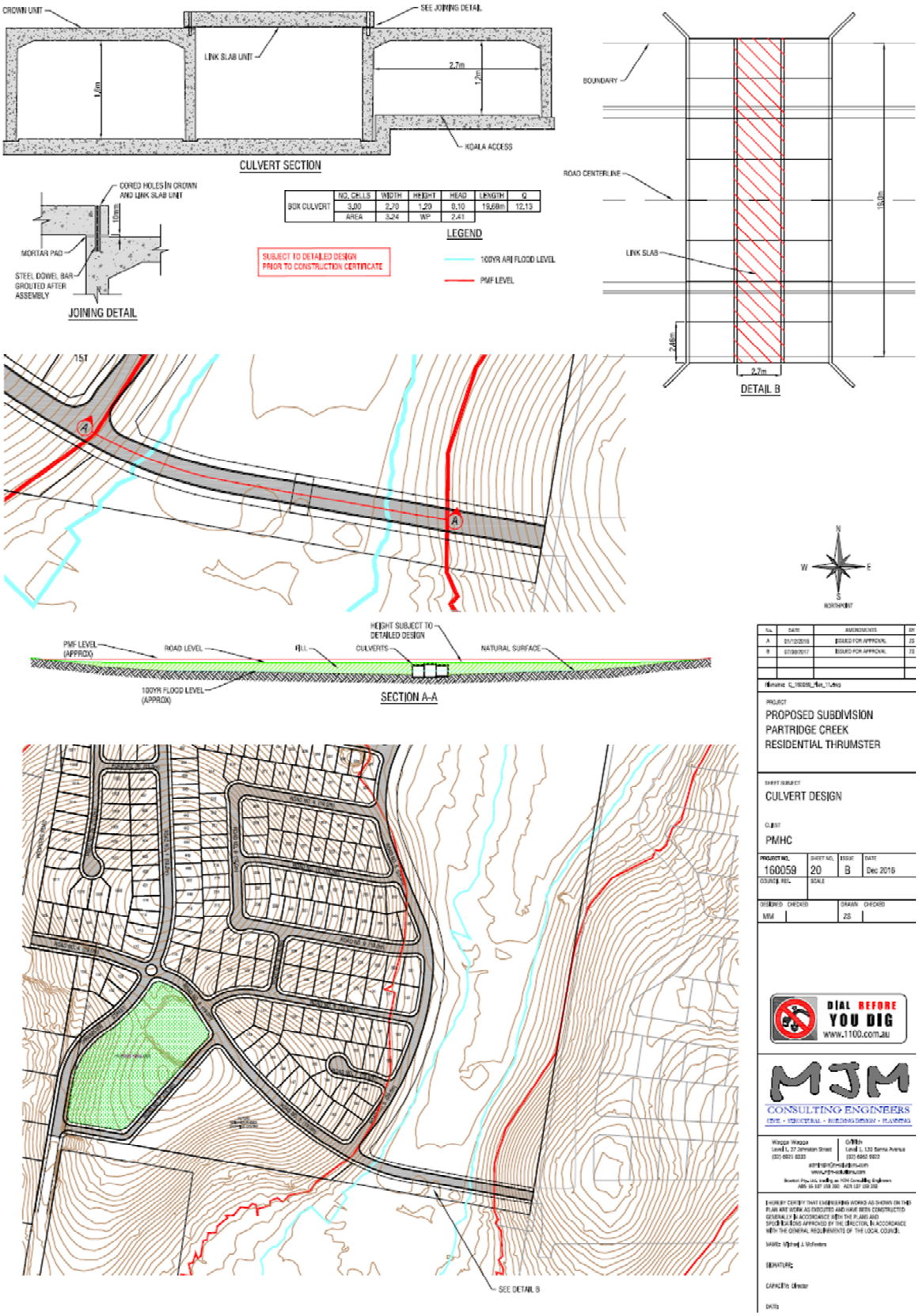
Culvert at Node A5-2a

	NO. CELLS	WIDTH	HEIGHT	HEAD	LENGTH	Q
BOX CULVERT	4.00	2.70	1.20	0.10	20.0m	16.18
	AREA	3.24	WP	2.41		

Culvert at Node A5-2b

	NO. CELLS	WIDTH	HEIGHT	HEAD	LENGTH	Q
BOX CULVERT	3.00	2.70	1.20	0.10	20.0m	12.13
	AREA	3.24	WP	2.41		

Figure 4. Culvert Design



5 STORMWATER QUALITY

5.1 PRE-DEVELOPED SITE CONDITIONS

The site is legally described as Lot 1 DP1087368 and Lot 2 DP1172154, accessible from Thrumster Street only, and the area of the development is approximately 59 hectares which is being developed into approx. 500 residential lots.

5.2 POST-DEVELOPED SITE CONDITION

The site forms part of the 'Partridge Creek Residential' precinct, within the Thrumster Urban Release Area. The development significantly increases the impervious area therefor modelling of the impacts have been carried out below.

The stormwater system is designed such that reduction in pollutants occurs prior to the outlet located in the bio detention basins. The stormwater quality analysis was carried out using the MUSIC modelling program for post-developed conditions with the PMHC template. It is noted that full pollutant reduction will not be achievable in all catchments, namely C6 and C8. Each of these catchments will require Gross Pollutant Traps (GPT) to be installed on their respective drainage outlets. Additional treatment capacity will also be implemented in the bioretention basins to offset the untreated water from these catchments. The result of the additional capacity shall be such that the net water quality generated by the proposed development will be in accordance with relevant standards. Further Music modelling will need to be conducted prior to Construction Certificate to show how the net reduction will be achieved.

The stormwater line from the site is to be directed to the bio detention basin as defined by PMHC and then to the existing Creek line. The site will not include rain water tanks as defined in Auspec D5 and D7.

5.3 COMPARISON OF PRE- AND POST-DEVELOPMENT POLLUTANT LOADS

The computer modelling program MUSIC V6.1 was used to investigate the performance of the treatment systems incorporated in the design. The main pollutants were analysed at the point of discharge.

The proposed stormwater system incorporates the treatment systems of bio detention basin and discharge to the existing creek line as defined in the catchment plan in Figure 3.

5.4 SUMMARY OF RESULTS

In summary, the reductions meet the requirements of the PMHC as defined in Auspec D7. Find summary, pre and post conditions, and a copy of input and output in tables and figures below.

	Sources		Residual Load		% Reduction		Target
	Pre	Post	Pre	Post	Pre	Post	
Flow (ML/y)	218	403	218	390	0	3.23	-
Total Suspended Solids (kg/yr)	28000	65000	28000	2200	0	96.6	85
Total Phosphorus (kg/yr)	85.3	154	85.3	82.4	0	46.5	45
Total Nitrogen (kg/yr)	549	1120	549	342	0	69.5	45
Gross Pollutants (kg/yr)	516	11200	516	0	0	100	100

Music Modelling Results

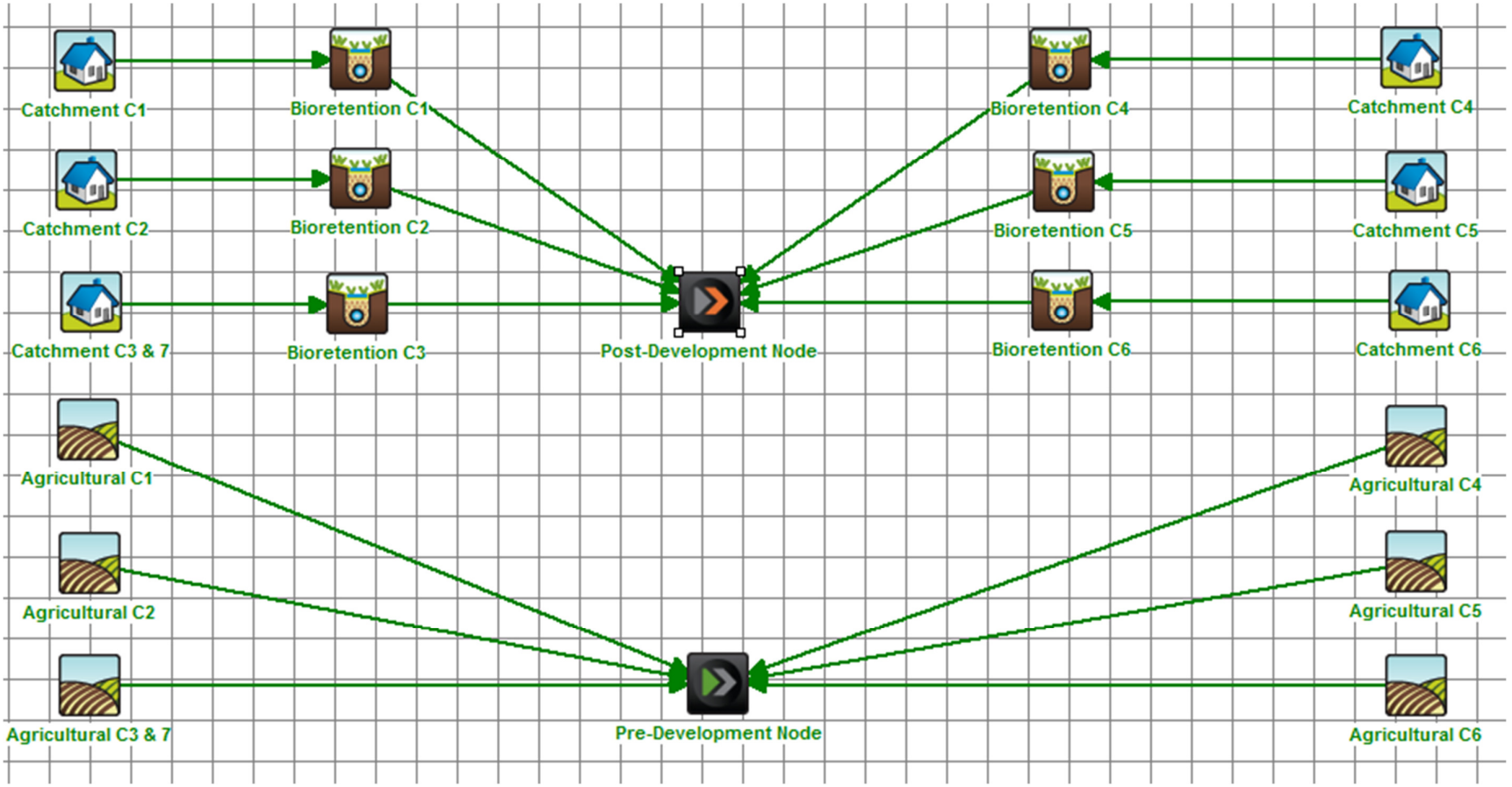


Diagram 1: Network Pre and Post Development Diagram

Figure 5. Site Area Image

VersionNumber	204						{MUSIC Setup File version number}
MeteorologicalTemplate	Z:\Jobs\160059_subdivision Partridge Creek Port Macquarie\Drains\MUSIC\Lower Inland 1997-2000 Daily.mlb						{MLB Filename}
ConstituentAbbreviation	TSS						{Constituent Abbreviation}
ConstituentName	Total Suspended Solids						{Constituent Name}
MUSIC-link Project - Enabled	1						{0 = enabled | 1 = disabled}
Node Type	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	{Node Type}
Node Name	Catchment C1	Catchment C2	Catchment C3 & 7	Catchment C4	Catchment C5	Catchment C6	{Node Name}
Node ID	1	4	7	21	23	26	{Node ID}
Coordinates	70.0096822332752:73.7825443820989	70.226138624407:60.2900657495336	70.7229223235438:46.3921875183308	219.952435268072:74.1304061201782	220.608990517489:60.0144682577101	220.857152369095:46.6151645354191	{Coordinates}{[X:Y]}
General - Location	Catchment C1	Catchment C2	Catchment C3 & 7	Catchment C4	Catchment C5	Catchment C6	
General - Flux unit	mm	mm	mm	mm	mm	mm	
Areas - Total Area (ha)	14.5	11.3	10.7	13	10.7	2.8	{ha}
Areas - Impervious (%)	40	40	40	40	40	40	{%}
Areas - Pervious (%)	60	60	60	60	60	60	{%}
Rainfall-Runoff - Impervious Area - Rainfall Threshold (mm/day)	1	1	1	1	1	1	{mm/day}
Rainfall-Runoff - Pervious Area - Soil Storage Capacity (mm)	120	120	120	120	120	120	{mm}
Rainfall-Runoff - Pervious Area - Initial Storage (% of Capacity)	25	25	25	25	25	25	{% of Capacity}
Rainfall-Runoff - Pervious Area - Field Capacity (mm)	80	80	80	80	80	80	{mm}
Rainfall-Runoff - Pervious Area - Infiltration Capacity Coefficient - a	200	200	200	200	200	200	
Rainfall-Runoff - Pervious Area - Infiltration Capacity Exponent - b	1	1	1	1	1	1	
Rainfall-Runoff - Groundwater Properties - Initial Depth (mm)	10	10	10	10	10	10	{mm}
Rainfall-Runoff - Groundwater Properties - Daily Recharge Rate (%)	25	25	25	25	25	25	{%}
Rainfall-Runoff - Groundwater Properties - Daily Baseflow Rate (%)	5	5	5	5	5	5	{%}
Rainfall-Runoff - Groundwater Properties - Daily Deep Seepage Rate (%)	0	0	0	0	0	0	{%}
Total Suspended Solids - Base Flow Concentration - Mean (log mg/L)	1.1	1.1	1.1	1.1	1.1	1.1	{log mg/L}
Total Suspended Solids - Base Flow Concentration - Std Dev (log mg/L)	0.17	0.17	0.17	0.17	0.17	0.17	{log mg/L}
Total Suspended Solids - Base Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Suspended Solids - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Suspended Solids - Storm Flow Concentration - Mean (log mg/L)	2.2	2.2	2.2	2.2	2.2	2.2	{log mg/L}
Total Suspended Solids - Storm Flow Concentration - Std Dev (log mg/L)	0.32	0.32	0.32	0.32	0.32	0.32	{log mg/L}

Total Suspended Solids - Storm Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Suspended Solids - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Phosphorus - Base Flow Concentration - Mean (log mg/L)	-0.82	-0.82	-0.82	-0.82	-0.82	-0.82	{log mg/L}
Total Phosphorus - Base Flow Concentration - Std Dev (log mg/L)	0.19	0.19	0.19	0.19	0.19	0.19	{log mg/L}
Total Phosphorus - Base Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Phosphorus - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Phosphorus - Storm Flow Concentration - Mean (log mg/L)	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	{log mg/L}
Total Phosphorus - Storm Flow Concentration - Std Dev (log mg/L)	0.25	0.25	0.25	0.25	0.25	0.25	{log mg/L}
Total Phosphorus - Storm Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Phosphorus - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Nitrogen - Base Flow Concentration - Mean (log mg/L)	0.32	0.32	0.32	0.32	0.32	0.32	{log mg/L}
Total Nitrogen - Base Flow Concentration - Std Dev (log mg/L)	0.12	0.12	0.12	0.12	0.12	0.12	{log mg/L}
Total Nitrogen - Base Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Nitrogen - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Nitrogen - Storm Flow Concentration - Mean (log mg/L)	0.42	0.42	0.42	0.42	0.42	0.42	{log mg/L}
Total Nitrogen - Storm Flow Concentration - Std Dev (log mg/L)	0.19	0.19	0.19	0.19	0.19	0.19	{log mg/L}
Total Nitrogen - Storm Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Nitrogen - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Import Flow Properties - Import Flow Enabled	1	1	1	1	1	1	
Import Flow Properties - Import Flow File							
Import Flow Properties - Header lines	0	0	0	0	0	0	
Import Flow Properties - Baseflow Column	0	0	0	0	0	0	

Import Flow Properties - Impervious Stormflow Column	0	0	0	0	0	0	
Import Flow Properties - Pervious Stormflow Column	0	0	0	0	0	0	
Import Flow Properties - Unit	5	5	5	5	5	5	{Index from 0 to 14 for "ML" | "kL" | "L" | "mL" | "ML/s" | "m3/s" | "L/s" | "mL/s" | "ML/day" | "kL/day" | "L/day" | "mL/day" | "km" | "m" | "mm"}
Import Flow Properties - Catchment Area for GP (ha)	1	1	1	1	1	1	{ha}
Node Type	AgriculturalSourceNode	AgriculturalSourceNode	AgriculturalSourceNode	AgriculturalSourceNode	AgriculturalSourceNode	AgriculturalSourceNode	{Node Type}
Node Name	Agricultural C1	Agricultural C2	Agricultural C3 & 7	Agricultural C4	Agricultural C5	Agricultural C6	{Node Name}
Node ID	9	10	11	27	28	29	{Node ID}
Coordinates	70.3705740783174:32.0297629159723	70.5275987460788:16.9553948108759	70.5275987460788:3.13722404787095	220.606213121334:31.2041528858522	220.458076234359:17.0835305649062	220.458076234359:3.11586584912311	{Coordinates}{[X:Y]}
General - Location	Agricultural C1	Agricultural C2	Agricultural C3 & 7	Agricultural C4	Agricultural C5	Agricultural C6	
General - Notes							
General - Flux unit	mm	mm	mm	mm	mm	mm	
Areas - Total Area (ha)	14.5	11.3	10.2	13	10.7	2.8	{ha}
Areas - Impervious (%)	3	3	3	3	3	3	{%}
Areas - Pervious (%)	97	97	97	97	97	97	{%}
Rainfall-Runoff - Impervious Area - Rainfall Threshold (mm/day)	1	1	1	1	1	1	{mm/day}
Rainfall-Runoff - Pervious Area - Soil Storage Capacity (mm)	120	120	120	120	120	120	{mm}
Rainfall-Runoff - Pervious Area - Initial Storage (% of Capacity)	25	25	25	25	25	25	{% of Capacity}
Rainfall-Runoff - Pervious Area - Field Capacity (mm)	80	80	80	80	80	80	{mm}
Rainfall-Runoff - Pervious Area - Infiltration Capacity Coefficient - a	200	200	200	200	200	200	
Rainfall-Runoff - Pervious Area - Infiltration Capacity Exponent - b	1	1	1	1	1	1	
Rainfall-Runoff - Groundwater Properties - Initial Depth (mm)	10	10	10	10	10	10	{mm}
Rainfall-Runoff - Groundwater Properties - Daily Recharge Rate (%)	25	25	25	25	25	25	{%}
Rainfall-Runoff - Groundwater Properties - Daily Baseflow Rate (%)	5	5	5	5	5	5	{%}
Rainfall-Runoff - Groundwater Properties - Daily Deep Seepage Rate (%)	0	0	0	0	0	0	{%}
Total Suspended Solids - Base Flow Concentration - Mean (log mg/L)	1.4	1.4	1.4	1.4	1.4	1.4	{log mg/L}
Total Suspended Solids - Base Flow Concentration - Std Dev (log mg/L)	0.13	0.13	0.13	0.13	0.13	0.13	{log mg/L}
Total Suspended Solids - Base Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Suspended Solids - Base Flow Concentration - Serial Correlation	0	0	0	0	0	0	{R squared}

(R squared)							
Total Suspended Solids - Storm Flow Concentration - Mean (log mg/L)	2.3	2.3	2.3	2.3	2.3	2.3	{log mg/L}
Total Suspended Solids - Storm Flow Concentration - Std Dev (log mg/L)	0.31	0.31	0.31	0.31	0.31	0.31	{log mg/L}
Total Suspended Solids - Storm Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Suspended Solids - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Phosphorus - Base Flow Concentration - Mean (log mg/L)	-0.88	-0.88	-0.88	-0.88	-0.88	-0.88	{log mg/L}
Total Phosphorus - Base Flow Concentration - Std Dev (log mg/L)	0.13	0.13	0.13	0.13	0.13	0.13	{log mg/L}
Total Phosphorus - Base Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Phosphorus - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Phosphorus - Storm Flow Concentration - Mean (log mg/L)	-0.27	-0.27	-0.27	-0.27	-0.27	-0.27	{log mg/L}
Total Phosphorus - Storm Flow Concentration - Std Dev (log mg/L)	0.3	0.3	0.3	0.3	0.3	0.3	{log mg/L}
Total Phosphorus - Storm Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Phosphorus - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Nitrogen - Base Flow Concentration - Mean (log mg/L)	0.074	0.074	0.074	0.074	0.074	0.074	{log mg/L}
Total Nitrogen - Base Flow Concentration - Std Dev (log mg/L)	0.13	0.13	0.13	0.13	0.13	0.13	{log mg/L}
Total Nitrogen - Base Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Nitrogen - Base Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Total Nitrogen - Storm Flow Concentration - Mean (log mg/L)	0.59	0.59	0.59	0.59	0.59	0.59	{log mg/L}
Total Nitrogen - Storm Flow Concentration - Std Dev (log mg/L)	0.26	0.26	0.26	0.26	0.26	0.26	{log mg/L}
Total Nitrogen - Storm Flow Concentration - Estimation Method	1	1	1	1	1	1	{Index from 0 to 1 for "Mean" | "Stochastically generated"}
Total Nitrogen - Storm Flow Concentration - Serial Correlation (R squared)	0	0	0	0	0	0	{R squared}
Import Flow Properties - Import Flow Enabled	1	1	1	1	1	1	

Import Flow Properties - Import Flow File							
Import Flow Properties - Header lines	0	0	0	0	0	0	
Import Flow Properties - Baseflow Column	0	0	0	0	0	0	
Import Flow Properties - Impervious Stormflow Column	0	0	0	0	0	0	
Import Flow Properties - Pervious Stormflow Column	0	0	0	0	0	0	
Import Flow Properties - Unit	5	5	5	5	5	5	{Index from 0 to 14 for "ML" | "kL" | "L" | "mL" | "ML/s" | "m3/s" | "L/s" | "mL/s" | "ML/day" | "kL/day" | "L/day" | "mL/day" | "km" | "m" | "mm"}
Import Flow Properties - Catchment Area for GP (ha)	1	1	1	1	1	1	{ha}
Node Type	BioRetentionNodeV4	BioRetentionNodeV4	BioRetentionNodeV4	BioRetentionNodeV4	BioRetentionNodeV4	BioRetentionNodeV4	{Node Type}
Node Name	Bioretention C1	Bioretention C2	Bioretention C3	Bioretention C4	Bioretention C5	Bioretention C6	{Node Name}
Node ID	2	5	6	22	24	25	{Node ID}
Coordinates	101.115935123573:73.9662673078239	101.115935123573:60.5068846947729	100.787657498864:46.2268080199506	180.230842678336:73.9662673078239	180.723259115399:60.0144682577101	180.559120303044:46.5550856446591	{Coordinates}{[X:Y]}
General - Location	Bioretention C1	Bioretention C2	Bioretention C3	Bioretention C4	Bioretention C5	Bioretention C6	
General - Notes							
General - Fluxes							
General - Flux File Timestep (in seconds)	86400	86400	86400	86400	86400	86400	{in seconds}
Inlet Properties - Low Flow By-pass (cubic metres per sec)	0	0	0	0	0	0	{cubic metres per sec}
Inlet Properties - High Flow By-pass (cubic metres per sec)	100	100	100	100	100	100	{cubic metres per sec}
Storage Properties - Extended Detention Depth (metres)	0	0	0	0	0	0	{metres}
Storage Properties - Surface Area (square metres)	1000	13500	1000	2300	1600	600	{square metres}
Filter and Media Properties - Filter Area (square metres)	800	1250	900	450	1400	400	{square metres}
Filter and Media Properties - Unlined Filter Media Perimeter (metres)	14	14	14	14	14	14	{metres}
Filter and Media Properties - Saturated Hydraulic Conductivity (mm/hr)	100	100	100	100	100	100	{mm/hr}
Filter and Media Properties - Filter Depth (metres)	0.5	0.5	0.5	0.5	0.5	0.5	{metres}
Filter and Media Properties - TN Content of Filter Media (mg/kg)	800	800	800	800	800	800	{mg/kg}
Filter and Media Properties - Orthophosphate Content of Filter Media (mg/kg)	80	80	80	80	80	80	{mg/kg}
Infiltration Properties - Exfiltration Rate (mm/hr)	0	0	0	0	0	0	{mm/hr}
Lining Properties - Base Lined	1	1	1	1	1	1	

Vegetation Properties - Vegetation Properties	0	0	0	0	0	0	{Index from 0 to 2 for "Vegetated with Effective Nutrient Removal Plants" | "Vegetated with Ineffective Nutrient Removal Plants" | "Unvegetated"}
Outlet Properties - Overflow Weir Width (metres)	2	2	2	2	2	2	{metres}
Outlet Properties - Underdrain Present	0	0	0	0	0	0	
Outlet Properties - Submerged Zone With Carbon Present	1	1	1	1	1	1	
Outlet Properties - Submerged Zone Depth (metres)	0.45	0.45	0.45	0.45	0.45	0.45	{metres}
Advanced Properties - Total Suspended Solids - k (m/yr)	8000	8000	8000	8000	8000	8000	{m/yr}
Advanced Properties - Total Suspended Solids - C* (mg/L)	20	20	20	20	20	20	{mg/L}
Advanced Properties - Total Phosphorus - k (m/yr)	6000	6000	6000	6000	6000	6000	{m/yr}
Advanced Properties - Total Phosphorus - C* (mg/L)	0.13	0.13	0.13	0.13	0.13	0.13	{mg/L}
Advanced Properties - Total Nitrogen - k (m/yr)	500	500	500	500	500	500	{m/yr}
Advanced Properties - Total Nitrogen - C* (mg/L)	1.4	1.4	1.4	1.4	1.4	1.4	{mg/L}
Advanced Properties - Filter Media Soil Type	1	1	1	1	1	1	{Index from 0 to 4 for "Sand" | "Loamy Sand" | "Sandy Loam" | "Silt Loam" | "Loam"}
Advanced Properties - Weir Coefficient	1.7	1.7	1.7	1.7	1.7	1.7	
Advanced Properties - Pet Scaling Factor	2.1	2.1	2.1	2.1	2.1	2.1	
Advanced Properties - Number of CSTR Cells	3	3	3	3	3	3	
Advanced Properties - Porosity of Filter Media	0.35	0.35	0.35	0.35	0.35	0.35	
Advanced Properties - Porosity of Submerged Zone	0.35	0.35	0.35	0.35	0.35	0.35	
Advanced Properties - Horizontal Flow Coefficient	3	3	3	3	3	3	
Node Type	PreDevelopmentNode	{Node Type}					
Node Name	Pre-Development Node	{Node Name}					
Node ID	8	{Node ID}					
Coordinates	141.633480387727:3.16877915101925	{Coordinates}{[X:Y]}					
General - Location	Pre-Development Node						
Node Type	PostDevelopmentNode	{Node Type}					
Node Name	Post-Development Node	{Node Name}					
Node ID	3	{Node ID}					
Coordinates	140.582375223201:46.3824375846556	{Coordinates}{[X:Y]}					
General - Location	Post-Development Node						

Link Name	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link
Source Node ID	2	5	6	9	10	11	22
Target Node ID	3	3	3	8	8	8	3
Routing	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed
Muskingum K	7200	7200	7200	7200	7200	7200	7200
Muskingum Theta	0.25	0.25	0.25	0.25	0.25	0.25	0.25

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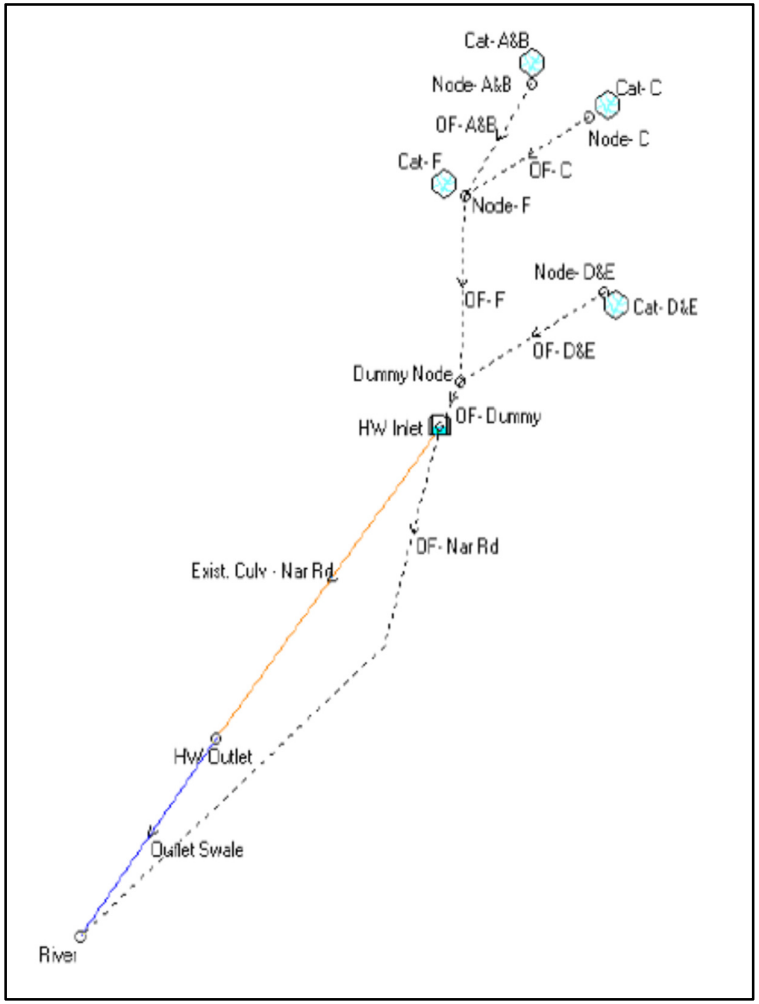
APPENDIX 1: DRAINS INPUT FOR PRE-DEVELOPMENT MODEL

Figure 6. Drains model for Pre-Developed catchment.



APPENDIX 2: DRAINS INPUT FOR POST-DEVELOPMENT MODEL

(Note: for full input data, please refer to attached Excel Sheet and Drains file attached)

PIT / NODE DETAILS

Version 13

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is
N-1	Node					3.5		0		538	-275		101		No	
N-1P	Node					3.5		0		584.163	-331.784		396		No	

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
B-1	2	2500		Pit/Sump				Surface Inlet Pits	1.6m x 1.6m Raised Grate Aug 03	589.167	-304.167	No			389
	2.25	2704													
	2.5	2916													
	2.75	3136													
	3	3364													
	3.25	3600													
	3.5	3844													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%)	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor	Rainfall Multiplier
C-1	N-1	14.226	0	100	0	0	4	0	0	100	0	0	4.5	0	0	0.053	0	0				1
C-1P	B-1	14.226	70	30	0	4	0	0	94	94	0	3.7	3.7	0	0.014	0.1	0	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)
P-1P	B-1	N-1P	6	1	0.88	2	Concrete, not under roads	675	675	0.3	NewFixed	1	B-1	0					

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg	Bottom	Height of Service	Chg	Bottom	Height of Service	Chg	Bottom	Height of Service	etc

	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id	
OF-1P	B-1	N-1P	0.1	3.25	6	1.7	Overflow From Basin	0.5	0.2	1	5	0	709	4

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover (m)	Cover (m)	
P-1P	Concrete, not under roads	675	0.6	0.27	Unsafe

DRAINS results prepared from Version 2016.07

PIT / NODE DETAILS

Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-1P	1.11		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-1	1.083	0	1.083	0	21.89	0	AR&R 5 year, 12 hours storm, Coastal Region
C-1P	4.188	4.188	0	7.52	11.44	0	AR&R 5 year, 20 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (9.96 impervious + 18.5 pervious = 28.5 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 5 year, 5 minutes storm, Coastal Region	4030.7	1410.74 (35.0%)	1410.74 (100.0%)	0.00 (0.0%)
AR&R 5 year, 10 minutes storm, Coastal Region	6259.44	2190.80 (35.0%)	2190.80 (100.0%)	0.00 (0.0%)
AR&R 5 year, 15 minutes storm, Coastal Region	7966.56	2788.30 (35.0%)	2788.30 (100.0%)	0.00 (0.0%)

AR&R 5 year, 20 minutes storm, Coastal Region	9294.32	3253.01 (35.0%)	3253.01 (100.0%)	0.00 (0.0%)
AR&R 5 year, 30 minutes storm, Coastal Region	11523.06	4033.07 (35.0%)	4033.07 (100.0%)	0.00 (0.0%)
AR&R 5 year, 1 hour storm, Coastal Region	15933.12	5576.59 (35.0%)	5576.59 (100.0%)	0.00 (0.0%)
AR&R 5 year, 2 hours storm, Coastal Region	20713.06	7249.57 (35.0%)	7249.57 (100.0%)	0.00 (0.0%)
AR&R 5 year, 3 hours storm, Coastal Region	24070.39	9078.50 (37.7%)	8424.64 (100.0%)	653.87 (4.2%)
AR&R 5 year, 6 hours storm, Coastal Region	30898.87	13206.82 (42.7%)	10814.62 (100.0%)	2392.21 (11.9%)
AR&R 5 year, 12 hours storm, Coastal Region	39946.61	18363.63 (46.0%)	13981.19 (100.0%)	4382.45 (16.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-1P	0.94	4.33	1.65	1.274	AR&R 5 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-1P	0	0	1.781	0	0	0	0	

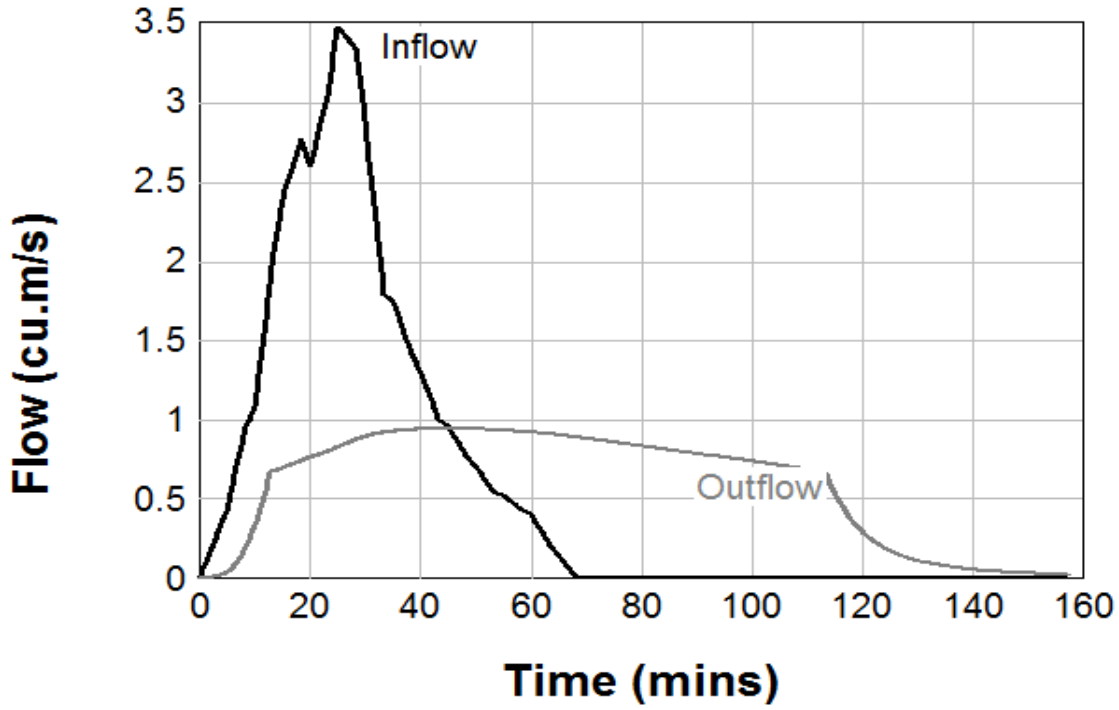
DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-1	3.07	3152.5	0.94	0.94	0

CONTINUITY CHECK for AR&R 5 year, 12 hours storm, Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-1	3374.41	3374.41	0	0
B-1	14989.33	15198.88	2.72	-1.4
N-1P	15198.88	15198.88	0	0

Run Log for C1 run at 15:40:10 on 23/5/2016
Flows were safe in all overflow routes.
Run Log for OSD PRE. VOLUME CALC_20 run at 13:23:05 on 23/5/2016
Flows were safe in all overflow routes.



DRAINS results
prepared from
Version 2016.07

PIT / NODE DETAILS

Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-1P	1.13			0			

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-1	4.586	0	4.586	0	11.41	0	AR&R 100 year, 1 hour storm, Coastal Region
C-1P	7.313	7.313	0.02	6.78	9.03	0	AR&R 100 year, 20 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (9.96 impervious + 18.5 pervious = 28.5 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, Coastal Region	6947.03	2431.46 (35.0%)	2431.46 (100.0%)	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, Coastal Region	11048.86	3867.10 (35.0%)	3867.10 (100.0%)	0.00 (0.0%)
AR&R 100 year, 15 minutes storm, Coastal Region	14226	4979.10 (35.0%)	4979.10 (100.0%)	0.00 (0.0%)
AR&R 100 year, 20 minutes storm, Coastal Region	16786.68	5877.82 (35.0%)	5875.34 (100.0%)	2.49 (0.0%)
AR&R 100 year, 30 minutes storm, Coastal Region	21054.48	9441.03 (44.8%)	7369.07 (100.0%)	2071.96 (15.1%)
AR&R 100 year, 1 hour storm, Coastal Region	30159.12	17473.18 (57.9%)	10555.69 (100.0%)	6917.49 (35.3%)
AR&R 100 year, 2 hours storm, Coastal Region	38125.68	24048.78 (63.1%)	13343.98 (100.0%)	10704.80 (43.2%)

AR&R 100 year, 3 hours storm, Coastal Region	43531.55	28333.72 (65.1%)	15236.00 (100.0%)	13097.72 (46.3%)
AR&R 100 year, 12 hours storm, Coastal Region	68967.66	45387.57 (65.8%)	24139.67 (100.0%)	21247.91 (47.4%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-1P	4.156	4.67	2.001	1.306	AR&R 100 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-1P	0	0	7.848	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

B-1		3.13	3382.1		4.156	4.156	0

CONTINUITY CHECK
for AR&R 100 year,
1 hour storm,
Coastal Region

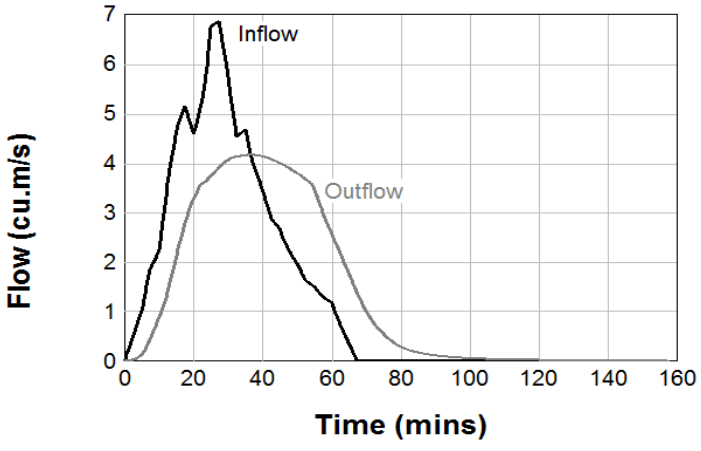
Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %	
N-1	5320.47	5320.47	0	0	
B-1	12152.71	12117.74	12.82	0.2	
N-1P	12117.74	12117.74	0	0	

Run Log for C1 run
at 15:43:26 on
23/5/2016

Flows were safe in
all overflow routes.

Run Log for OSD
PRE. VOLUME
CALC_20 run at
13:25:02 on
23/5/2016

Flows were safe in
all overflow routes.



PIT / NODE DETAILS

Version 13

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is
N-2	Node					4.5		0		538	-275		101		No	
N-2P	Node					4.5		0		584.163	-331.784		396		No	

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
B-2	3	1600		Pit/Sump				Surface Inlet Pits	1.6m x 1.6m Raised Grate Aug 03	589.167	-304.167	No			389
	3.25	1764													
	3.5	1936													
	3.75	2116													
	4	2304													
	4.25	2500													
	4.5	2704													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor	Rainfall Multiplier
C-2	N-2	11.3	0	100	0	0	5	0	0	100	0	0	5	0	0	0.053	0	0				1
C-2P	B-2	11.3	70	30	0	8	8	0	30	30	0	1	1	0	0.014	0.1	0	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)
P-2P	B-2	N-2P	6	2	1.88	2	Concrete, not under roads	600	600	0.3	NewFixed	1	B-2	0					

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	etc	etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
OF-2P	B-2	N-2P	0.1	4.25	6	1.7	Overflow From Basin	0.5	0.2	1	5	0	709

4

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover (m)	Cover (m)	
P-2P	Concrete, not under roads	600	0.6	0.36	Unsafe

DRAINS results prepared from Version 2016.07

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-2P	2.09			0			

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-2	0.86	0	0.86	0	22.34	0	AR&R 5 year, 12 hours storm, Coastal Region
C-2P	3.055	3.055	0	10.62	16.53	0	AR&R 5 year, 20 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (7.91 impervious + 14.7 pervious = 22.6 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 5 year, 5 minutes storm, Coastal Region	3201.67	1120.58 (35.0%)	1120.58 (100.0%)	0.00 (0.0%)
AR&R 5 year, 10 minutes storm, Coastal Region	4972	1740.20 (35.0%)	1740.20 (100.0%)	0.00 (0.0%)
AR&R 5 year, 15 minutes storm, Coastal Region	6328	2214.80 (35.0%)	2214.80 (100.0%)	0.00 (0.0%)
AR&R 5 year, 20 minutes storm, Coastal Region	7382.67	2583.94 (35.0%)	2583.94 (100.0%)	0.00 (0.0%)
AR&R 5 year, 30 minutes storm, Coastal Region	9153	3203.55 (35.0%)	3203.55 (100.0%)	0.00 (0.0%)
AR&R 5 year, 1 hour storm, Coastal Region	12656	4429.60 (35.0%)	4429.60 (100.0%)	0.00 (0.0%)
AR&R 5 year, 2 hours storm, Coastal Region	16452.8	5758.48 (35.0%)	5758.48 (100.0%)	0.00 (0.0%)
AR&R 5 year, 3 hours storm, Coastal Region	19119.6	7210.24 (37.7%)	6691.85 (100.0%)	518.39 (4.2%)
AR&R 5 year, 6 hours storm, Coastal Region	24543.6	10490.04 (42.7%)	8590.02 (100.0%)	1900.03 (11.9%)
AR&R 5 year, 12 hours storm, Coastal Region	31730.4	14584.73 (46.0%)	11105.70 (100.0%)	3479.03 (16.9%)
AR&R 5 year, 24 hours storm, Coastal Region	40734.25	17241.75 (42.3%)	14256.82 (100.0%)	2984.94 (11.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-2P	0.774	4.09	2.614	2.261	AR&R 5 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-2P	0	0	1.781	0	0	0	0	

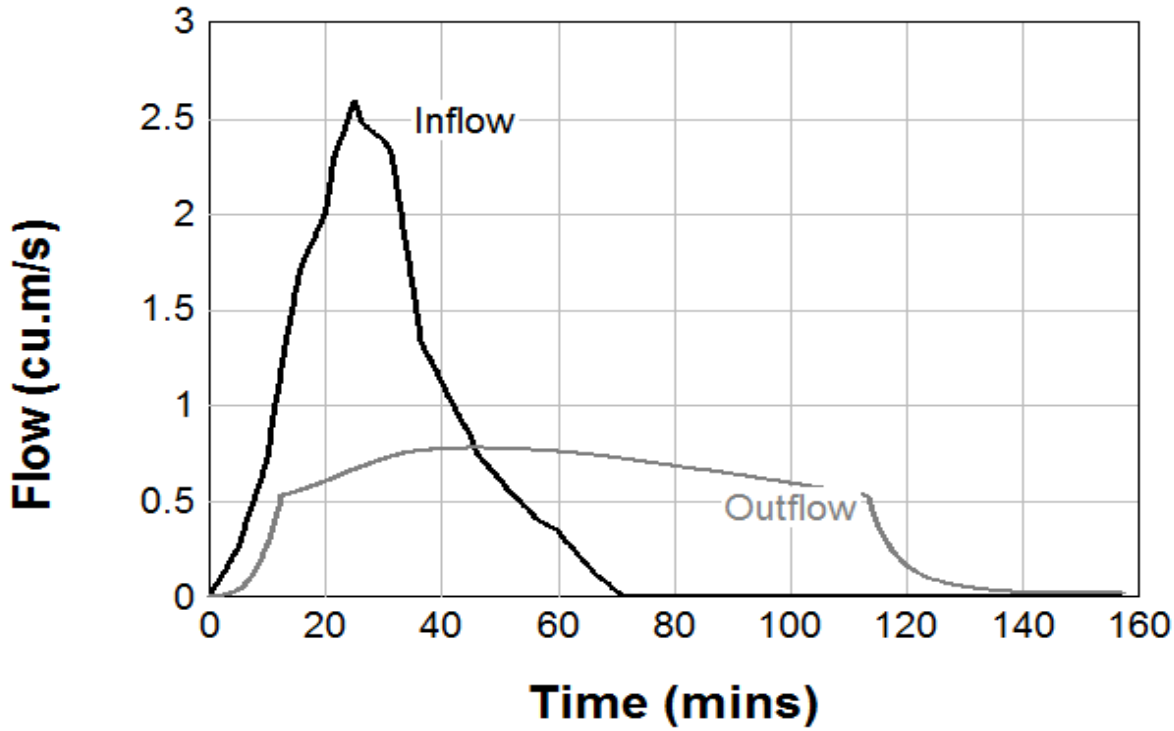
DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-2	4.2	2405.9	0.774	0.774	0

CONTINUITY CHECK for AR&R 5 year, 12 hours storm, Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-2	2679.18	2679.18	0	0
B-2	11905.46	12138.42	12.72	-2.1
N-2P	12138.42	12138.42	0	0

Run Log for C2 run at 15:55:51 on 23/5/2016
Flows were safe in all overflow routes.



DRAINS results
prepared from
Version 2016.07

PIT / NODE DETAILS

Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-2P	2.12		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-2	3.545	0	3.545	0	12.18	0	AR&R 100 year, 1 hour storm, Coastal Region
C-2P	5.428	5.428	0.01	10.07	14.74	0	AR&R 100 year, 20 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (7.91 impervious + 14.7 pervious = 22.6 total ha)

Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, Coastal Region	5518.17	1931.36 (35.0%)	1931.36 (100.0%)	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, Coastal Region	8776.33	3071.72 (35.0%)	3071.72 (100.0%)	0.00 (0.0%)
AR&R 100 year, 15 minutes storm, Coastal Region	11300	3955.00 (35.0%)	3955.00 (100.0%)	0.00 (0.0%)
AR&R 100 year, 20 minutes storm, Coastal Region	13334	4668.58 (35.0%)	4666.90 (100.0%)	1.68 (0.0%)
AR&R 100 year, 30 minutes storm, Coastal Region	16724	7472.76 (44.7%)	5853.40 (100.0%)	1619.36 (14.9%)
AR&R 100 year, 1 hour storm, Coastal Region	23956	13866.18 (57.9%)	8384.60 (100.0%)	5481.57 (35.2%)
AR&R 100 year, 2 hours storm, Coastal Region	30284	19093.49 (63.0%)	10599.40 (100.0%)	8494.08 (43.2%)
AR&R 100 year, 3 hours storm, Coastal Region	34578	22500.76 (65.1%)	12102.31 (100.0%)	10398.45 (46.3%)

AR&R 100 year, 12 hours storm, Coastal Region	54782.41	36045.59 (65.8%)	19173.67 (100.0%)	16871.91 (47.4%)	

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-2P	3.534	4.5	2.871	2.286	AR&R 100 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-2P	0	0	7.848	0	0	0	0	

DETENTION BASIN DETAILS

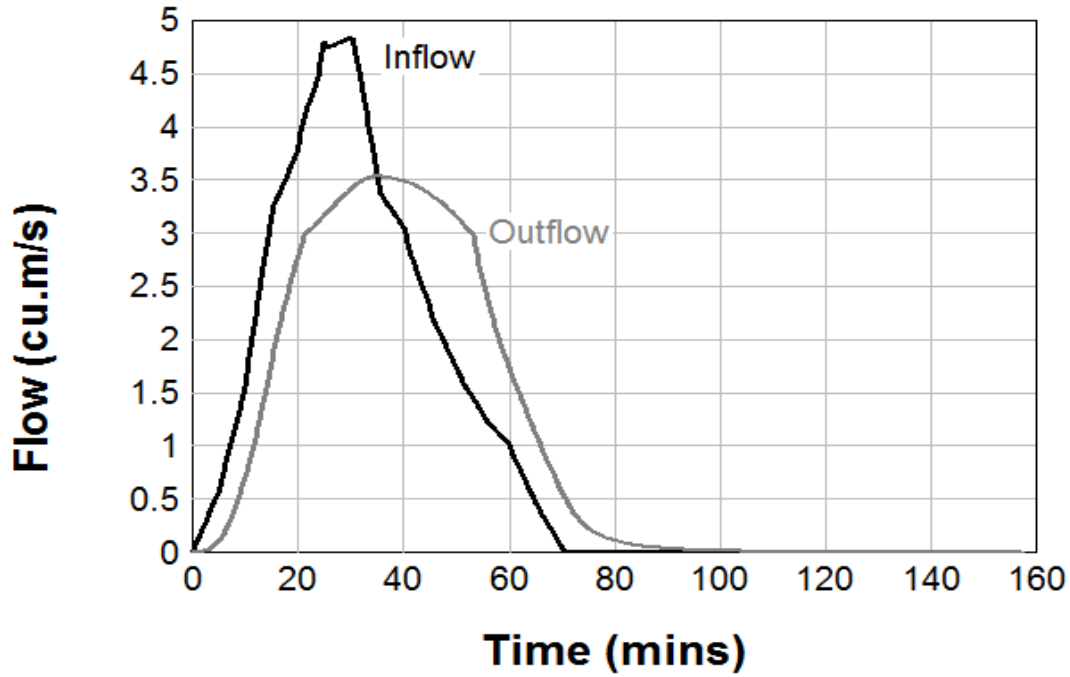
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-2	4.04	2044.2	3.534	3.534	0

CONTINUITY CHECK
for AR&R 100 year,
1 hour storm,
Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-2	4222.07	4222.07	0	0
B-2	9644.11	9636.31	7.33	0
N-2P	9636.31	9636.31	0	0

Run Log for C2 run
at 15:53:58 on
23/5/2016

Flows were safe in
all overflow routes.



PIT / NODE DETAILS

Version 13

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is
N-3	Node					4.5		0		538	-275		101		No	
N-3P	Node					4.5		0		584.163	-331.784		396		No	

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
B-3	3	1369		Pit/Sump				Surface Inlet Pits	1.6m x 1.6m Raised Grate Aug 03	589.167	-304.167	No			389
	3.25	1521													
	3.5	1681													
	3.75	1849													
	4	2025													
	4.25	2209													
	4.5	2401													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor	Rainfall Multiplier
C-3	N-3	9.6	0	100	0	0	3	0	0	100	0	0	8	0	0	0.053	0	0				1
C-3P	B-3	9.6	70	30	0	7	7	0	40	40	0	6	6	0	0.014	0.1	0	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)
P-3P	B-3	N-3P	6	2	1.88	2	Concrete, not under roads	750	750	0.3	NewFixed	3	B-3		0				

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	etc
										etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	Safe Depth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
OF-3P	B-3	N-3P	0.1	4.25	6	1.7	Overflow From Basin	0.5	0.2	1	5	0	709	4

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover (m)	Cover (m)	
P-3P	Concrete, not under roads	750	0.6	0.19	Unsafe

DRAINS results prepared from Version 2016.07

PIT / NODE DETAILS

Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-3P	2.08			0			

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-3	0.731	0	0.731	0	18.06	0	AR&R 5 year, 12 hours storm, Coastal Region
C-3P	2.732	2.732	0	8.82	12.92	0	AR&R 5 year, 20 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (6.72 impervious + 12.5 pervious = 19.2 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 5 year, 5 minutes storm, Coastal Region	2720	952.00 (35.0%)	952.00 (100.0%)	0.00 (0.0%)
AR&R 5 year, 10 minutes storm, Coastal Region	4224	1478.40 (35.0%)	1478.40 (100.0%)	0.00 (0.0%)
AR&R 5 year, 15 minutes storm, Coastal Region	5376	1881.60 (35.0%)	1881.60 (100.0%)	0.00 (0.0%)
AR&R 5 year, 20 minutes storm, Coastal Region	6272	2195.20 (35.0%)	2195.20 (100.0%)	0.00 (0.0%)
AR&R 5 year, 30 minutes storm, Coastal Region	7776	2721.60 (35.0%)	2721.60 (100.0%)	0.00 (0.0%)
AR&R 5 year, 1 hour storm, Coastal Region	10752	3763.20 (35.0%)	3763.20 (100.0%)	0.00 (0.0%)
AR&R 5 year, 2 hours storm, Coastal Region	13977.6	4892.15 (35.0%)	4892.15 (100.0%)	0.00 (0.0%)
AR&R 5 year, 3 hours storm, Coastal Region	16243.2	6128.33 (37.7%)	5685.11 (100.0%)	443.21 (4.2%)
AR&R 5 year, 6 hours storm, Coastal Region	20851.2	8912.75 (42.7%)	7297.95 (100.0%)	1614.80 (11.9%)
AR&R 5 year, 12 hours storm, Coastal Region	26956.8	12403.19 (46.0%)	9434.86 (100.0%)	2968.32 (16.9%)
AR&R 5 year, 24 hours storm, Coastal Region	34606.09	14656.93 (42.4%)	12112.26 (100.0%)	2544.67 (11.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-3P	0.61	3.8	2.642	2.245	AR&R 5 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-3P	0	0	1.781	0	0	0	0	

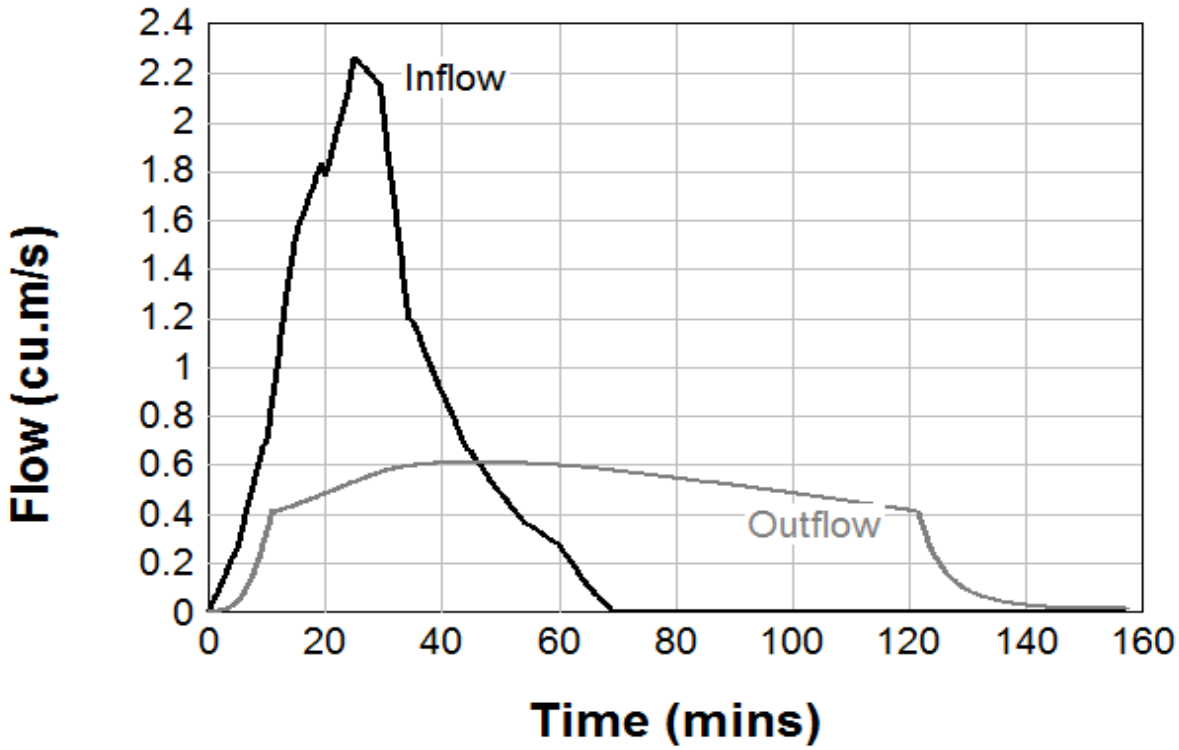
DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-3	4.21	2135.7	0.61	0.61	0

CONTINUITY CHECK for AR&R 5 year, 12 hours storm, Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-3	2284.6	2284.6	0	0
B-3	10118.67	10332.99	2.79	-2.1
N-3P	10332.99	10332.99	0	0

Run Log for C3 run at 16:24:26 on 23/5/2016
Flows were safe in all overflow routes.



DRAINS results prepared
from Version 2016.07

PIT / NODE DETAILS

Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-3P		2.1		0			

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-3		3.253	0	3.253	0	9.24	0 AR&R 100 year, 1 hour storm, Coastal Region
C-3P		4.766	4.357	0.802	9.12	13.9	0 AR&R 100 year, 2 hours storm, Coastal Region

Outflow Volumes for Total Catchment (6.72 impervious + 12.5 pervious = 19.2 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, Coastal Region	4688	1640.80 (35.0%)	1640.80 (100.0%)	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, Coastal Region	7456	2609.60 (35.0%)	2609.60 (100.0%)	0.00 (0.0%)
AR&R 100 year, 15 minutes storm, Coastal Region	9600	3360.00 (35.0%)	3360.00 (100.0%)	0.00 (0.0%)
AR&R 100 year, 20 minutes storm, Coastal Region	11328	3966.69 (35.0%)	3964.80 (100.0%)	1.90 (0.0%)
AR&R 100 year, 30 minutes storm, Coastal Region	14208	6382.91 (44.9%)	4972.80 (100.0%)	1410.11 (15.3%)
AR&R 100 year, 1 hour storm, Coastal Region	20352	11799.70 (58.0%)	7123.20 (100.0%)	4676.50 (35.4%)

AR&R 100 year, 2 hours storm, Coastal Region	25728	16237.22 (63.1%)	9004.78 (100.0%)	7232.43 (43.2%)	
AR&R 100 year, 3 hours storm, Coastal Region	29376	19126.36 (65.1%)	10281.58 (100.0%)	8844.77 (46.3%)	
AR&R 100 year, 12 hours storm, Coastal Region	46540.81	30643.09 (65.8%)	16289.11 (100.0%)	14353.97 (47.4%)	

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-3P	3.001	4.36	2.778	2.266	AR&R 100 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-3P	0	0	7.848	0	0	0	0	

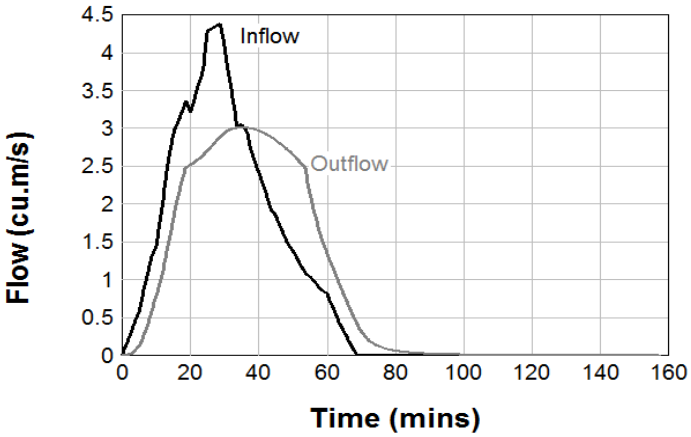
DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level	
B-3	4.01	1710.8	3.001	3.001		0

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %	
N-3	3601.33	3601.33	0	0	
B-3	8198.38	8194.83	5.51	0	
N-3P	8194.83	8194.83	0	0	

Run Log for C3 run at 16:22:13 on 23/5/2016
Flows were safe in all overflow routes.



PIT / NODE DETAILS

Version 13

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss	Inflow Hydrograph	Pit is
N-4	Node					3.5		0		538	-275		101		No	
N-4P	Node					3.5		0		584.163	-331.784		396		No	

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
B-4	2	2025		Pit/Sump				Surface Inlet Pits	1.6m x 1.6m Raised Grate Aug 03	589.167	-304.167	No			389
	2.25	2209													
	2.5	2401													
	2.75	2601													
	3	2809													
	3.25	3025													
	3.5	3249													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor	Rainfall Multiplier
C-4	N-4	12.9	0	100	0	0	3.2	0	0	100	0	0	5.6	0	0	0.053	0	0				1
C-4P	B-4	12.9	70	30	0	8	8	0	34	34	0	4.3	4.3	0	0.014	0.1	0	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)
P-4P	B-4	N-4P	6	1	0.88	2	Concrete, not under roads	900	900	0.3	NewFixed	3	B-4	0					

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	etc	
										etc	

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %		id
OF-4P	B-4	N-4P	0.1	3.25	6	1.7	Overflow From Basin	0.5	0.2	1	5	0		709

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover (m)	Cover (m)	
P-4P	Concrete, not under roads	900	0.6	0.03	Unsafe

DRAINS results prepared from Version 2016.07

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-4P	1.11		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-4	0.982	0	0.982	0	19.96	0	AR&R 5 year, 12 hours storm, Coastal Region
C-4P	3.597	3.597	0	9.83	13.94	0	AR&R 5 year, 20 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (9.03 impervious + 16.8 pervious = 25.8 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 5 year, 5 minutes storm, Coastal Region	3655	1279.25 (35.0%)	1279.25 (100.0%)	0.00 (0.0%)
AR&R 5 year, 10 minutes storm, Coastal Region	5676	1986.60 (35.0%)	1986.60 (100.0%)	0.00 (0.0%)
AR&R 5 year, 15 minutes storm, Coastal Region	7224	2528.40 (35.0%)	2528.40 (100.0%)	0.00 (0.0%)
AR&R 5 year, 20 minutes storm, Coastal Region	8428	2949.80 (35.0%)	2949.80 (100.0%)	0.00 (0.0%)
AR&R 5 year, 30 minutes storm, Coastal Region	10449	3657.15 (35.0%)	3657.15 (100.0%)	0.00 (0.0%)
AR&R 5 year, 1 hour storm, Coastal Region	14448	5056.80 (35.0%)	5056.80 (100.0%)	0.00 (0.0%)
AR&R 5 year, 2 hours storm, Coastal Region	18782.4	6573.84 (35.0%)	6573.84 (100.0%)	0.00 (0.0%)

AR&R 5 year, 3 hours storm, Coastal Region	21826.8	8233.71 (37.7%)	7639.38 (100.0%)	594.33 (4.2%)
AR&R 5 year, 6 hours storm, Coastal Region	28018.8	11976.12 (42.7%)	9806.50 (100.0%)	2169.61 (11.9%)
AR&R 5 year, 12 hours storm, Coastal Region	36223.2	16660.90 (46.0%)	12678.02 (100.0%)	3982.88 (16.9%)
AR&R 5 year, 24 hours storm, Coastal Region	46501.93	19691.29 (42.3%)	16276.01 (100.0%)	3415.27 (11.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-4P	0.946	4.34	1.644	1.276	AR&R 5 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-4P	0	0	1.781	0	0	0	0	

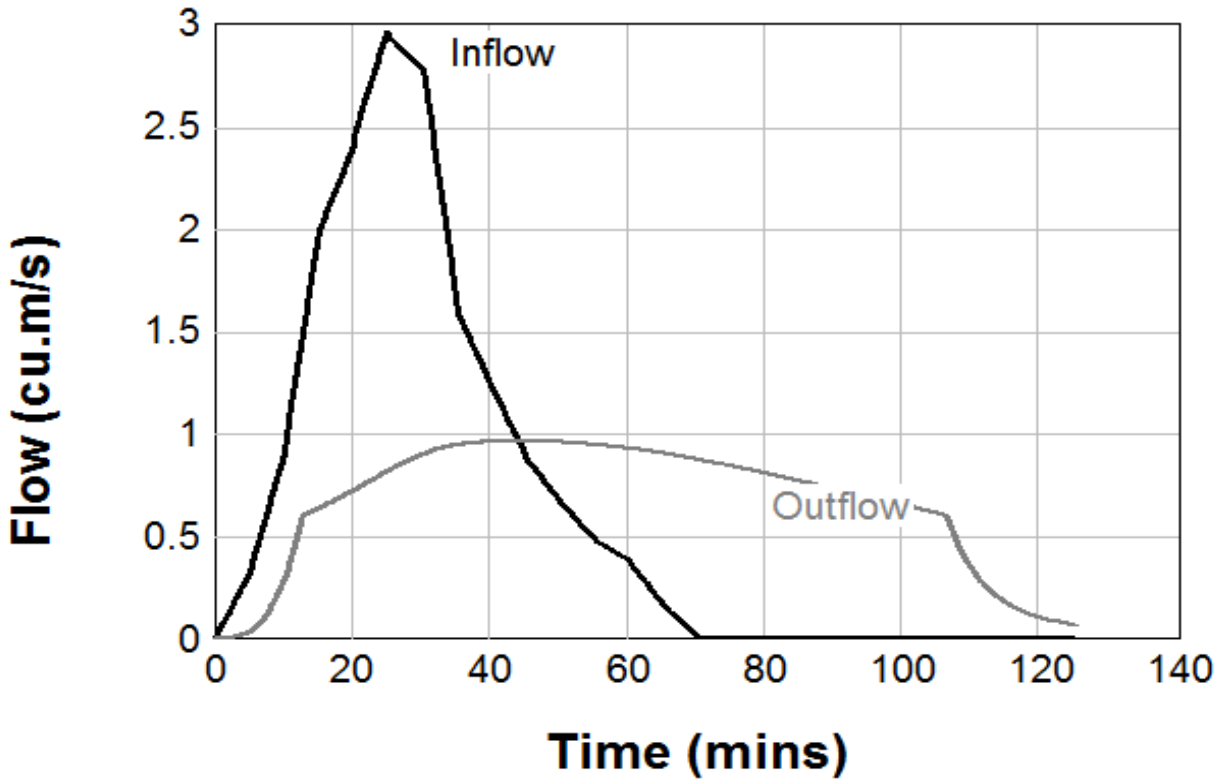
DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-4	3.09	2660.8	0.946	0.946	0

CONTINUITY CHECK for AR&R 5 year, 12 hours storm, Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-4	3064.91	3064.91	0	0
B-4	13595.94	13910.18	18.63	-2.4
N-4P	13910.18	13910.18	0	0

Run Log for C4 run at 17:04:14 on 23/5/2016
Flows were safe in all overflow routes.



DRAINS results prepared from Version 2016.07

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-4P	1.13		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-4	4.3	0	4.3	0	10.14	0	AR&R 100 year, 1 hour storm, Coastal Region
C-4P	6.349	5.723	1.032	10.13	14.91	0	AR&R 100 year, 2 hours storm, Coastal Region

Outflow Volumes for Total Catchment (9.03 impervious + 16.8 pervious = 25.8 total ha)

Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)

AR&R 100 year, 5 minutes storm, Coastal Region	6299.5	2204.82 (35.0%)	2204.82 (100.0%)	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, Coastal Region	10019	3506.65 (35.0%)	3506.65 (100.0%)	0.00 (0.0%)
AR&R 100 year, 15 minutes storm, Coastal Region	12900	4515.00 (35.0%)	4515.00 (100.0%)	0.00 (0.0%)
AR&R 100 year, 20 minutes storm, Coastal Region	15222	5330.02 (35.0%)	5327.70 (100.0%)	2.32 (0.0%)
AR&R 100 year, 30 minutes storm, Coastal Region	19092	8563.41 (44.9%)	6682.20 (100.0%)	1881.21 (15.2%)
AR&R 100 year, 1 hour storm, Coastal Region	27348	15847.83 (57.9%)	9571.80 (100.0%)	6276.03 (35.3%)
AR&R 100 year, 2 hours storm, Coastal Region	34572	21811.75 (63.1%)	12100.22 (100.0%)	9711.54 (43.2%)
AR&R 100 year, 3 hours storm, Coastal Region	39474	25696.66 (65.1%)	13815.94 (100.0%)	11880.72 (46.3%)
AR&R 100 year, 12 hours storm, Coastal Region	62539.21	41168.28 (65.8%)	21888.84 (100.0%)	19279.45 (47.4%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-4P	4.051	4.64	2	1.3	AR&R 100 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-4P	0	0	7.848	0	0	0	0	0

DETENTION BASIN DETAILS

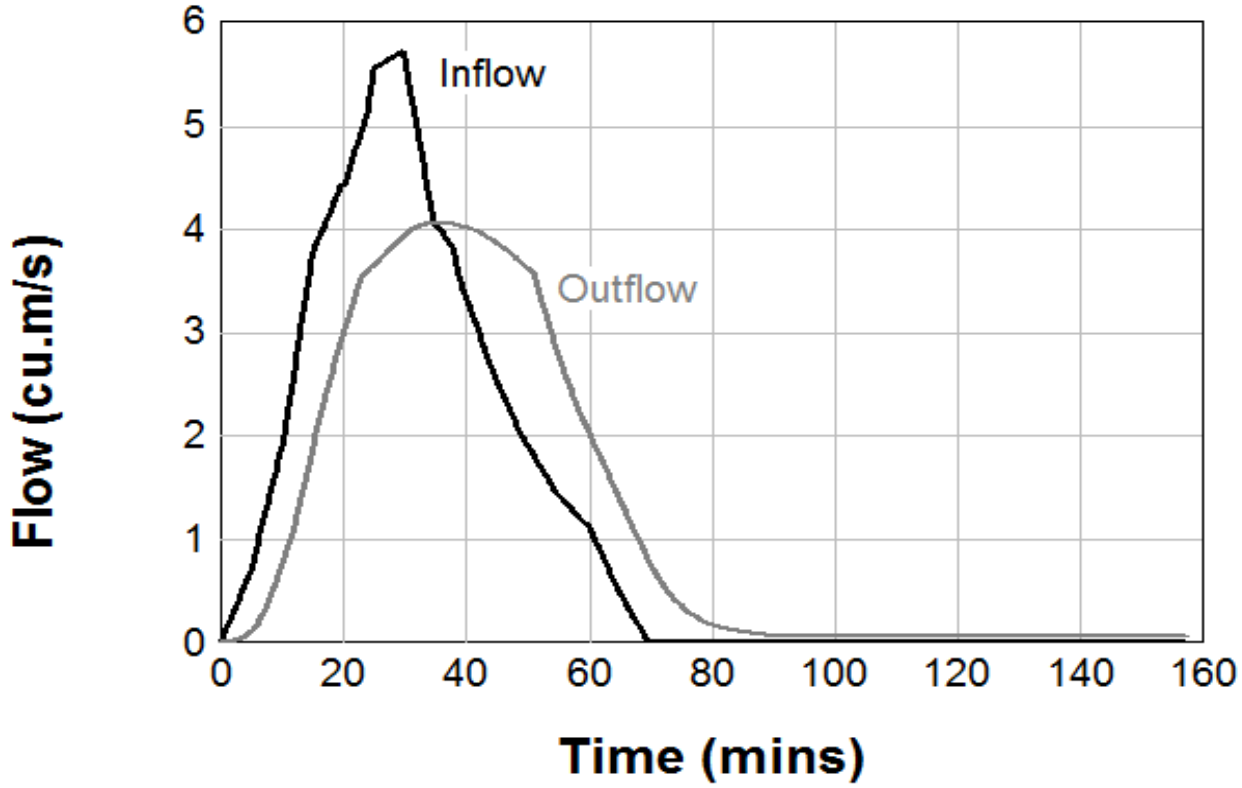
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-4	3.06	2563.8	4.051	4.051	0

CONTINUITY
CHECK for AR&R
100 year, 1 hour
storm, Coastal
Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-4	4833.24	4833.24	0	0
B-4	11014.58	11144.38	57.73	-1.7
N-4P	11144.38	11144.38	0	0

Run Log for C4 run
at 16:50:18 on
23/5/2016

Flows were safe in
all overflow routes.



PIT / NODE DETAILS — Version 13

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down id	Part Full Shock Loss	Inflow Hydrograph	Pit is lid
N-5	Node					3.5		0		538	-275	101		No	
N-5P	Node					3.5		0		584.163	-331.784	396		No	

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
B-5	2	1600		Pit/Sump				Surface Inlet Pits	1.6m x 1.6m Raised Grate Aug 03	589.167	-304.167	No		389	
	2.25	1764													
	2.5	1936													
	2.75	2116													
	3	2304													
	3.25	2500													
	3.5	2704													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor	Rainfall Multiplier
C-5	N-5	10.5	0	100	0	0	3	0	0	100	0	0	7.8	0	0	0.053	0	0				1
C-5P	B-5	10.5	70	30	0	3	3	0	44	44	0	7	7	0	0.014	0.1	0	0				1

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)
P-5P	B-5	N-5P	6	1	0.88	2	Concrete, not under roads	825	825	0.3	NewFixed	3	B-5		0				

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	etc	etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area	id

			Time	Level	Length	Coeff. C	Section	Major Storms	Minor Storms	DxV (sq.m/sec)	Slope	Contributing			
			(min)	(m)	(m)			(m)	(m)		(%)	%			
OF-5P	B-5	N-5P	0.1	3.25	6	1.7	Overflow From Basin	0.5	0.2	1	5	0	709	4	

PIPE COVER DETAILS

Name	Type	Dia (mm)	Safe Cover (m)	Cover (m)	
P-5P	Concrete, not under roads	825	0.6	0.12	Unsafe

DRAINS results prepared from Version 2016.07

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-5P	1.09			0			

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-5	0.8	0	0.8	0	18.17	0	AR&R 5 year, 12 hours storm, Coastal Region
C-5P	3.471	3.471	0	4.48	7.81	0	AR&R 5 year, 5 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (7.35 impervious + 13.6 pervious = 21.0 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 5 year, 5 minutes storm, Coastal Region	2975	1041.25 (35.0%)	1041.25 (100.0%)	0.00 (0.0%)
AR&R 5 year, 10 minutes storm, Coastal Region	4620	1617.00 (35.0%)	1617.00 (100.0%)	0.00 (0.0%)
AR&R 5 year, 15 minutes storm, Coastal Region	5880	2058.00 (35.0%)	2058.00 (100.0%)	0.00 (0.0%)
AR&R 5 year, 20 minutes storm, Coastal Region	6860	2401.00 (35.0%)	2401.00 (100.0%)	0.00 (0.0%)
AR&R 5 year, 30 minutes storm, Coastal Region	8505	2976.75 (35.0%)	2976.75 (100.0%)	0.00 (0.0%)
AR&R 5 year, 1 hour storm, Coastal Region	11760	4116.00 (35.0%)	4116.00 (100.0%)	0.00 (0.0%)
AR&R 5 year, 2 hours storm, Coastal Region	15288	5350.80 (35.0%)	5350.80 (100.0%)	0.00 (0.0%)
AR&R 5 year, 3 hours storm, Coastal Region	17766	6703.52 (37.7%)	6218.12 (100.0%)	485.40 (4.2%)
AR&R 5 year, 6 hours storm, Coastal Region	22806	9748.52 (42.7%)	7982.20 (100.0%)	1766.31 (11.9%)
AR&R 5 year, 12 hours storm, Coastal Region	29484	13568.47 (46.0%)	10319.57 (100.0%)	3248.90 (17.0%)
AR&R 5 year, 24 hours storm, Coastal Region	37850.41	16032.35 (42.4%)	13247.83 (100.0%)	2784.52 (11.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-5P	0.756	4.08	1.661	1.254	AR&R 5 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-5P	0	0	1.781	0	0	0	0	

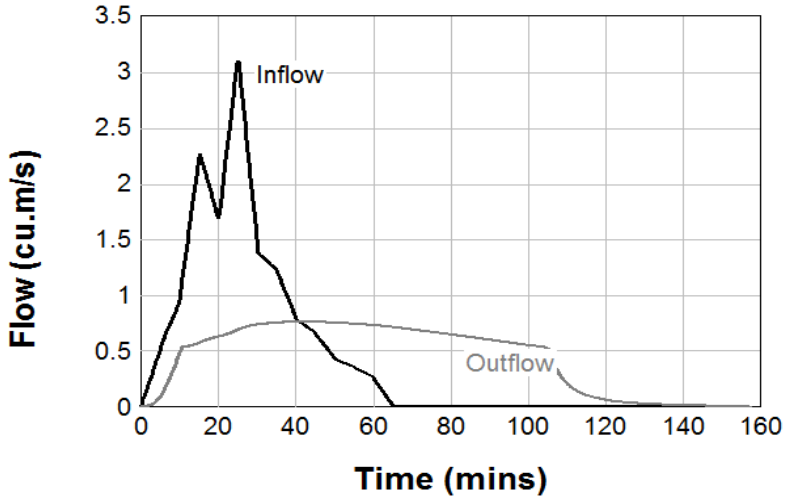
DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-5	3.11	2192.6	0.756	0.756	0

CONTINUITY CHECK for AR&R 5 year, 12 hours storm, Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-5	2498.59	2498.59	0	0
B-5	11069.75	11321.78	12.73	-2.4
N-5P	11321.78	11321.78	0	0

Run Log for C5 run at 17:30:00 on 23/5/2016
Flows were safe in all overflow routes.



DRAINS results
prepared from
Version 2016.07

PIT / NODE DETAILS

Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N-5P	1.11			0			

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C-5	3.558	0	3.558	0	9.28	0	AR&R 100 year, 1 hour storm, Coastal Region
C-5P	5.982	5.982	0	4.19	6.87	0	AR&R 100 year, 5 minutes storm, Coastal Region

Outflow Volumes for Total Catchment (7.35 impervious + 13.6 pervious = 21.0 total ha)

Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, Coastal Region	5127.5	1794.63 (35.0%)	1794.63 (100.0%)	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, Coastal Region	8155	2854.25 (35.0%)	2854.25 (100.0%)	0.00 (0.0%)
AR&R 100 year, 15 minutes storm, Coastal Region	10500	3675.00 (35.0%)	3675.00 (100.0%)	0.00 (0.0%)
AR&R 100 year, 20 minutes storm, Coastal Region	12390	4338.73 (35.0%)	4336.50 (100.0%)	2.23 (0.0%)
AR&R 100 year, 30 minutes storm, Coastal Region	15540	6993.38 (45.0%)	5439.00 (100.0%)	1554.38 (15.4%)
AR&R 100 year, 1 hour storm, Coastal Region	22260	12912.29 (58.0%)	7791.00 (100.0%)	5121.29 (35.4%)

AR&R 100 year, 2 hours storm, Coastal Region	28140	17763.76 (63.1%)	9849.01 (100.0%)	7914.76 (43.3%)
AR&R 100 year, 3 hours storm, Coastal Region	32130	20922.15 (65.1%)	11245.48 (100.0%)	9676.67 (46.3%)
AR&R 100 year, 12 hours storm, Coastal Region	50904.01	33521.21 (65.9%)	17816.92 (100.0%)	15704.29 (47.5%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
P-5P	3.428	4.47	1.872	1.279	AR&R 100 year, 1 hour storm, Coastal Region

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF-5P	0	0	7.848	0	0	0	0	0

DETENTION BASIN DETAILS

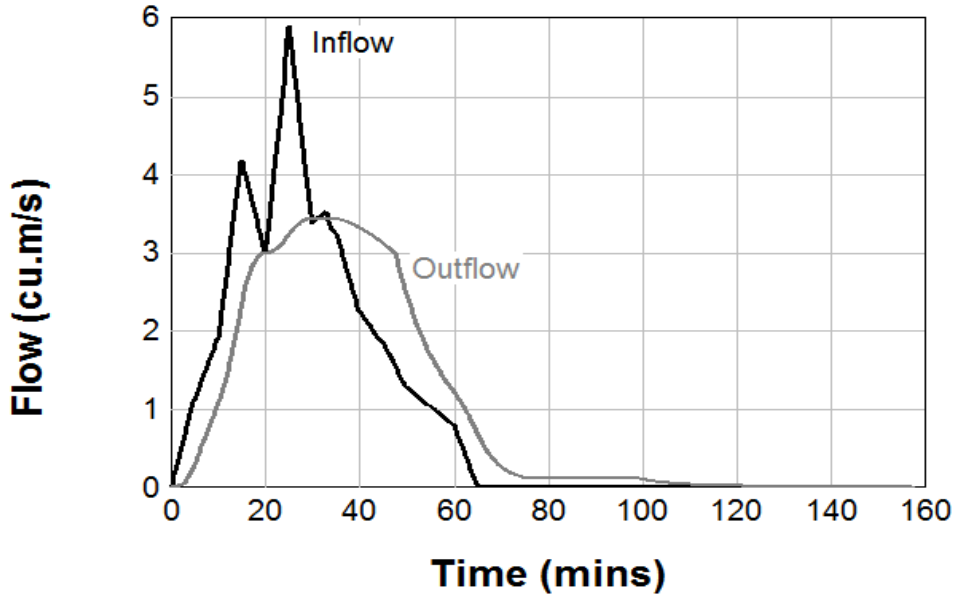
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
B-5	2.95	1834.7	3.428	3.428	0

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, Coastal Region

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
N-5	3938.95	3938.95	0	0
B-5	8973.35	9103.8	7.39	-1.5
N-5P	9103.8	9103.8	0	0

Run Log for C5 run at 17:27:17 on 23/5/2016

Flows were safe in all overflow routes.



B1						
level	W	L			Batter	
2	35	71			4	1
	H	Area	volume			
	2	2485	0			
	2.25	2701	675.25			
	2.5	2925	1462.5			
	2.75	3157	2367.75			
	3	3397	3397			
	3.25	3645	4556.25			
	3.5	3901	5851.5			
Req Volume From Calc (cum)				3400		
Maximum Height (m)				1.13		

B4						
level	W	L			Batter	
2	32	64			4	1
	H	Area	volume			
	2	2048	0			
	2.25	2244	561			
	2.5	2448	1224			
	2.75	2660	1995			
	3	2880	2880			
	3.25	3108	3885			
	3.5	3344	5016			
Req Volume From Calc (cum)				2670		
Maximum Height (m)				1.1		

B2						
level	W	L			Batter	
3	28	57			4	1
	H	Area	volume			
	3	1596	0			
	3.25	1770	442.5			
	3.5	1952	976			
	3.75	2142	1606.5			
	4	2340	2340			
	4.25	2546	3182.5			
	4.5	2760	4140			
Req Volume From Calc (cum)				2400		
Maximum Height (m)				1.2		

B5						
level	W	L			Batter	
2	28	57			4	1
	H	Area	volume			
	2	1596	0			
	2.25	1770	442.5			
	2.5	1952	976			
	2.75	2142	1606.5			
	3	2340	2340			
	3.25	2546	3182.5			
	3.5	2760	4140			
Req Volume From Calc (cum)				2195		
Maximum Height (m)				1.11		

B3						
level	W	L			Batter	
3	26	52			4	1
	H	Area	volume			
	3	1352	0			
	3.25	1512	378			
	3.5	1680	840			
	3.75	1856	1392			
	4	2040	2040			
	4.25	2232	2790			
	4.5	2432	3648			
Req Volume From Calc (cum)				2135		
Maximum Height (m)				1.21		

Partridge Creek Residential Precinct

Traffic Impact Assessment Thrumster Street

Port Macquarie, NSW

for

MJM Consulting Engineers
Structural • Civil • Building Design • Planning

March 2018

Traffic Impact Assessment Details

Generic Document No.				
Edition / Revision No.	1	2		
Event				
Document Status	Internal Review	Final for Approval		
Prepared By	Andy Davis Director	Andy Davis Director		
Reviewed By	Craig Nethery Director	Craig Nethery Director		
Date	July 2018	July 2018		
Internal Review Completed By / Date				

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CONTENTS

1. INTRODUCTION

1.1 General

StreetWise Road Safety and Traffic Services have been engaged to prepare a Traffic Impact Assessment report for a proposed residential development at Lot 1 DP 1087368, Thruster Street, Thrumster. The proposed residential development, which is located within the Area 13 Residential Precinct about 10kms west of Port Macquarie, will result in the release of 506 urban lots and includes a commercial lot and 2 open spaces.

It is planned to stage the construction of residential development over approximately 10 years. Access to the development will initially be via Thrumster Street, which connects with John Oxley Drive, and then the surrounding road network. Alternative access via connections with adjoining developments is also planned in the future.

This assessment includes estimates of future traffic movements to be generated by the proposed development, and the likely impacts of the additional traffic volumes on the adjoining road network.

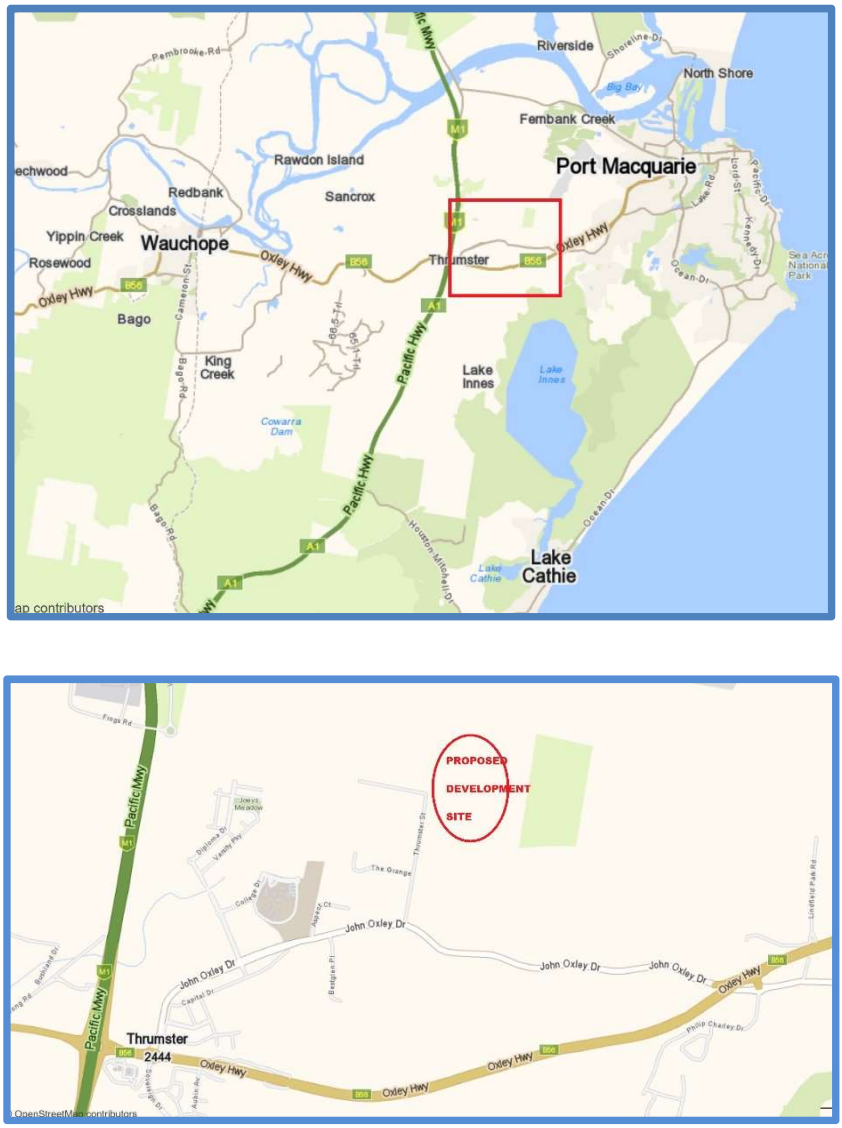


Figure 1 – LOCALITY SKETCH

1.2 Scope

The following methodology was reviewed and approved by Port Macquarie Hastings Council.

Step 1 – Documentation Review

Review all documentation provided including but not limited to the available background data and base traffic volumes provided by PMHC. This review will also include a determination of what extra (if any) traffic data needs to be collected prior to the commencement of the Traffic Impact Assessment.

Step 2 – Manage Collection of Traffic Data (if required)

Should it be found that after reviewing the provided traffic data further information is required StreetWise will engage an experienced Traffic Data Collection company, if required.

Step 3 – Compilation of Traffic Data (if required)

Once the collection of the extra traffic data (if required) has been completed it will be compiled for use in the traffic impact assessment. This data will form the base for building any detailed corridor or intersection analysis required as part of the assessment.

Step 4 – Calculation of Proposed Traffic Generation

The calculation of the proposed traffic generation for the residential release will be completed on a stage by stage basis with the traffic generation accumulated as each stage is added.

Step 5 – Determination of Future Road Network

Discussions with Council in regard to the likelihood of additional link roads and/or connections to relieve pressure on John Oxley Drive and Thrumster Street. At this stage, it is unlikely that any additional roads will be constructed within the next 10 years. Therefore, it is assumed that all traffic movements in and out of the proposed development will utilise the current Thrumster Street/John Oxley Drive intersection.

Step 6 – Determination of Traffic Growth

PMHC will be liaised with to determine a typical annual traffic growth assumption to be used in this assessment. Based on recent Traffic Assessments accepted by Council for nearby approved developments, a growth factor of 2% per annum will be adopted.

Step 7 - Surrounding Proposed Development Traffic Generation

It is assumed PMHC will be able to provide an indication of the surrounding proposed development considerations. This information will be used to calculate possible impacting traffic generation. Typically, this information will be used for a full development design horizon (typically 10 to 20 years into the future) to complete the ultimate assessment impacts.

Step 8 – Sidra Modelling

Once the necessary data has been compiled and calculated for the nodes in question they will be modelled using Sidra Intersection Modelling Software. As discussed in Step 4 of this methodology modelling will be completed for each stage and a fully developed design horizon.

Building a SIDRA model comprising of the following intersection and road network would be required for this analysis:

- Thrumster Street/ John Oxley Drive

Manual trip assignment at the intersection will be replicated and updated at half and full development. Separate SIDRA analysis will be undertaken to determine the accumulative impacts of the development at the completion of stage 5 & 10. These stages of intersection SIDRA modelling would be required for this analysis for the following intersection:

- Thrumster Street/ John Oxley Drive;

Step 9 – Reporting

1.3 Location of Project

The proposed residential housing development is part of the Partridge Creek development precinct, which is located approximately 10kms west of the Port Macquarie township, just east of the Pacific Highway/Oxley Highway interchange, and adjacent to the Sovereign Hills development area.

The land is described as Lot 1 DP 1087368, and is located on the eastern side of Thrumster Street. The lot is located at the northern end of Thrumster Street, approximately 640m north of an existing intersection with John Oxley Drive.

1.4 Description of Project

The total size of Lot 1 DP 1087368 is approximately 198ha. However, due mainly to environmental constraints, the proposed residential development will be limited to approximately 54ha on the north-eastern portion of the lot.

The preliminary layout of the development comprises 504 urban residential lots averaging approximately 600m^2 per lot. The layout also includes a neighbourhood shopping centre (approx. 2ha) and 2 recreational reserves.

It is proposed to construct the residential development in 10 stages, with a variable number of lots released per stage. The number of lots per stage is shown on the preliminary staging plan (Appendix A) but it is likely this release rate is dependent on market forces. For the purposes of this assessment, an average rate of 36 lots a year, (or 54 lots every 18 months) will be adopted to fit in with the 2026 (half development) and 2031 (full development), as discussed with council.

The preliminary staging plan indicates that Stage 1 will include re-alignment of the northern section of Thrumster Street, creation of an entry precinct (landscaped roundabout), release of 60 urban lots, construction of a neighbourhood shopping centre and an open space/reserve.

1.5 Planning Documents

1.5.1 Development Control Plan 2013

The development site is located within the area defined as the Area 13 Release Area. The Port Macquarie / Hastings Development Control Plan 2013 covers Area 13 as a whole, the designated neighbours within Area 13 and includes the development site.
The Development Control Plan (DCP) was developed specifically to guide development within the land known as Area 13. The key elements of the DCP which apply to traffic and transport matters include:

- Recommended locations of connections of surrounding road network
- Road hierarchy
- Road widths by type
- Pedestrian / cycle networks

1.5.2 Urban Growth Management Strategy

Thrumster is identified in the Port Macquarie-Hastings Urban Growth Management Strategy 2011-2031 as a key urban release area. Thrumster will play a major role in development of the Port Macquarie-Wauchope Corridor. The Corridor will contain the majority of urban growth and 'higher order' services and facilities needed to serve a catchment population in excess of 100,000 persons. The new Thrumster community will accommodate up to 10,000 people. The Thrumster Town Centre will offer convenience retail services to local residents to strengthen the structure of the corridor.

Thrumster comprises six distinct neighbourhoods, each comprising several precincts. The Partridge Creek Residential Precinct will make up one of the 6 distinct precincts, and the desired future character for the neighbourhood is described in Council's DCP as:

"The main objective of this local community is to retain and enhance the existing biodiversity, watercourses and riparian and Koala vegetation. Community groups undertaking bush regeneration and other works have achieved this objective. A small neighbourhood (village) centre is the focal point of this community. The village centre provides retail and community focus for the locality, incorporating a mix of uses and housing types.

Three development areas are proposed:

***Partridge Creek Village Precinct (Area 1)** is the gateway to the Partridge Creek Residential Neighbourhood. The area will become the neighbourhood hub for convenience shopping and services.*

Residential dwellings will be at a higher density than elsewhere in the neighbourhood to take advantage of the proximity to shops and public transport and may include a mix of detached houses on small lots as well as attached or multi-dwelling housing catering to a variety of residential needs. A key feature of the area will be an old growth tree, preserved within the landscaped entrance to the village.

***Partridge Creek Residential Precinct (Area 2)** represents the bulk of the Neighbourhood and is bordered by environmental lands to the north and east. This area forms the core residential area of the neighbourhood and includes two local parks within walking distance from the majority of homes. This area will be predominantly detached dwellings on a mix of lot sizes*

***John Oxley Drive Precinct (Area 3)** stands at the corner of Thrumster Street and John Oxley Drive and is the entrance to the neighbourhood. Residential dwellings will be predominantly detached houses on larger lots and will be responsive to Koala Habitat in the area.*

2. ROAD NETWORK

2.1 Local Road Network

Thrumster Street

The proposed development site is located on Thrumster Street, approximately 600m north of John Oxley Drive. Thrumster Street is a sealed rural road, approximately 1.2kms long and generally 6 metres wide. The existing road heads north from John Oxley Drive for 750m, then turns westwards for 450m, before ending in a sealed turning circle.

The existing road surface is 2-coat seal, with minimal gravelled shoulders and informal stormwater i.e. some tabledrains.

Figure 2.1 Thrumster Street, looking south towards John Oxley Drive

John Oxley Drive

The proposed development site is located on Thrumster Street, approximately 600m north of John Oxley Drive. John Oxley Drive was formerly the Oxley Highway, and the main link between Port Macquarie and the Pacific Highway. The current roadway is generally one lane in either direction but retains the high-quality formation which previously catered for high volumes and heavy vehicles (i.e. designated B-double route).

John Oxley Drive is approximately 5.8kms in length and connects with the new Oxley Highway in the west at the roundabout near the highway service centre, and in the east at the Wrights Road roundabout.

In the vicinity of Thrumster Street, John Oxley Drive is approximately 7m wide with sealed shoulders either side. However, the width of John Oxley Drive varies along it's length to provide auxiliary lanes, U-turn bays and channelised intersections. At the existing T-intersection with Thrumster Street, John Oxley Drive has been widened to provide a line-marked right turn lane for vehicles turning into the side road. The John Oxley Drive painted centreline has also been enhanced for a few hundred metres either side of the intersection to provide greater separation between the eastbound and westbound lanes. This is likely due to the curved and undulating nature of John Oxley Drive through this area.

Figure 2.2 John Oxley Drive, looking east towards Thrumster Street intersection

Figure 2.3 John Oxley Drive, looking west towards Thrumster Street intersection

2.2 Proposed Lot Releases

The subject development site is part of the overall Partridge Creek Residential Precinct. The separate areas in the Thrumster DCP which form the total area of the Partridge Creek Residential Precinct are Area 13, 14, 15 and 16 as shown below.

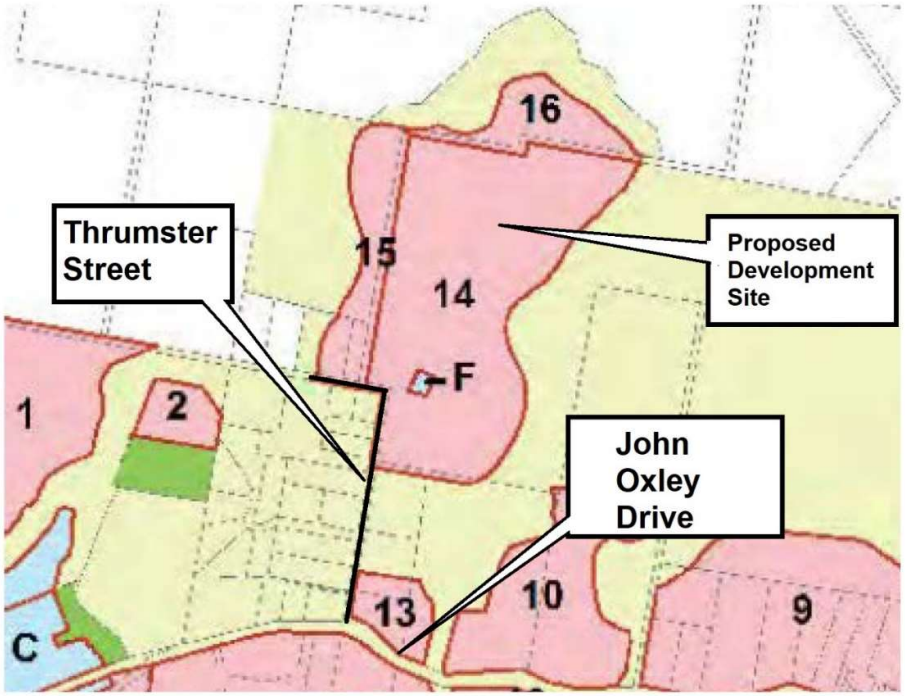


Figure 2.4 Partridge Creek Residential Precinct, showing numbered development areas

To gauge potential yield for these areas, Port Macquarie Council's DCP anticipates the following number of dwellings by area.

No.	*Zoning*	*Area (ha)*	*Dwellings*
13	R1	4.9	58
14	R1	51.9	622
15	R1	10.9	130
16	R1	8.3	8
Total		***76.0***	***818***

Figure 2.4 Partridge Creek Residential areas and estimated lot numbers

As can be seen from Figure 2/5 above, the subject development area (No.14) will provide the majority of residential lots in the Partridge Creek Residential Precinct. It should also be noted that a previous DA application for Area 15 (bordering the western boundary of the subject development) has been submitted to Council, which included 72 lots – almost 50 lots less than estimated in Council's DCP.

2.3 Proposed Development Access

Future access to the proposed residential development is proposed via Thrumster Street. It is planned to utilise the existing alignment for the majority of the road, then veer the northern end of the road towards the east, where a future roundabout will control traffic and create an entry to the new residential precinct (see Appendix A).

It is likely the future development will include some type of entry statement, incorporating a suitable intersection (roundabout), landscaped medians and widened entry road. However, as a minimum, the extension of Thrumster Street needs to meet Council's local road standard (as per Austroads Table D1.5) and have a minimum carriageway of 7m and either concrete kerb & gutter, or a minimum 4m verge width.

2.4 DCP Road Hierarchy

The following is an except from the Traffic Impact Assessment, submitted with the development application for the recently approved Manufactured Housing Estate at Lot 2 DP 1224314 at the northern end of Thrumster Street (i.e. Murcott Development).

'The original DCP road hierarchy in the vicinity of the Partridge Creek land area included boundary collector roads and a north – south central collector road linking to Thrumster Street in the south.

The network also included a proposed connection to the north (through existing swamp land) and a further connection to the north-east to / from Port Macquarie Airport. However, it is understood that both of these connections have now been abandoned.

Therefore, without these connections in place the revised network would include a collector road arrangement around the edge of the peninsula of residential development (functioning as a APZ) and a north-south central collector road forming a T-intersection at its northern end and a further T – intersection at its southern end with Thrumster Street.'

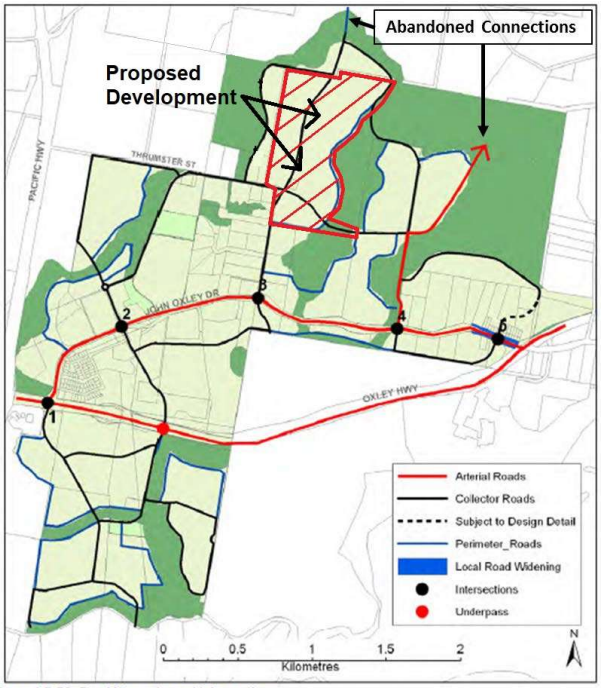


Figure 4.5-53: Road Hierarchy and intersections

Figure 2.3 Future Area 13 Road Hierarchy (from PMHC DCP)

The initial access therefore to the Partridge Creek Residential Precinct will be via the existing Thrumster Street. Future connections to adjacent developments (College Rise to the west and West Lindfield to the east) are shown on Council's planning documents, and will provide long-term alternative access to residential, commercial and planned industrial precincts.

However, for the purposes of this assessment, it is assumed the Partridge Creek Residential precinct will be developed over a period of 10 years, and that Thrumster Street will be the main access in and out of the area.

2.5 Section 94 Contributions

Developer contributions is a funding mechanism available to Councils that permits the levying of funds (typically a monetary contribution or dedication of land) from developers to provide extra, or upgrade existing public amenities, facilities or infrastructure that will be required to meet the demand created by the additional development.

Port Macquarie Hastings Council's Roads Contributions Plan enables Council to levy Section 94 developer contributions for the augmentation works required of the road network to the accommodate future traffic growth resulting from development.

Council's Road Contribution Plan for Area 13 includes a future upgrade of Thrumster Street and construction of major road connections with adjacent precincts (see roads marked 14, 2 and 6 in Figure 2.4 below). The Plan also indicates Developer Contributions will fund an upgrade of the existing intersection of Thrumster Street and John Oxley Drive to a future roundabout.

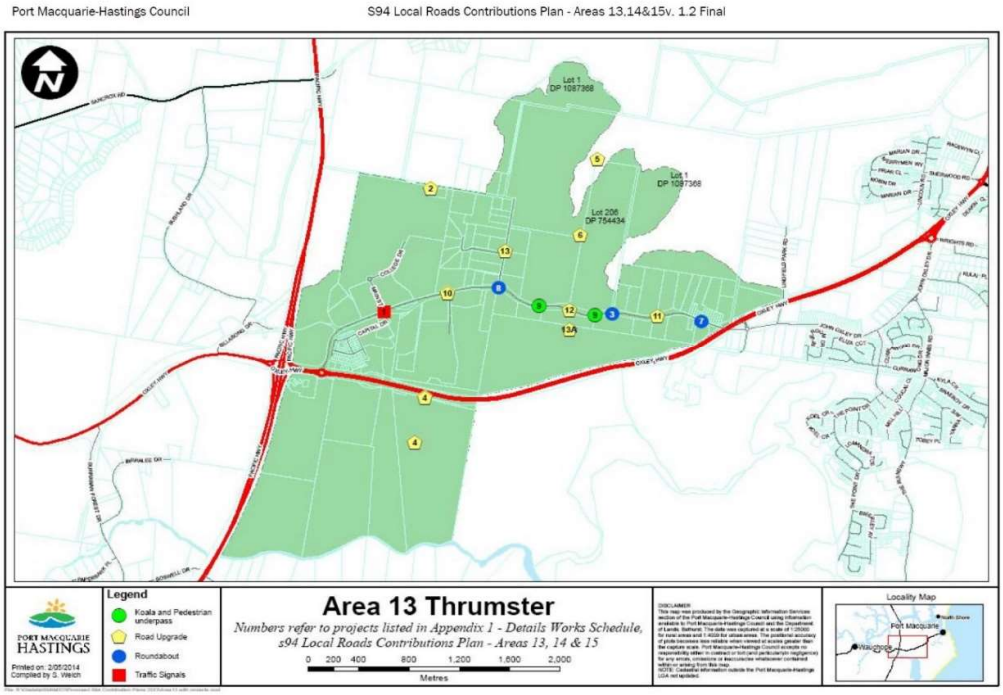


Table 1 – Extract of projects from Section 94 Local Roads Contributions Plan relevant to The Heritage

	Local catchment	Project description	Project location - street	Apport. to new development growth (%)	s.94 Contribution ($)	Council's schedule (commencement of Preconstruction activities)
1	Area 13 - Thrumster	Traffic Signals and Road works	Town Centre Main Street and John Oxley Drive	100%	$3,749,870	Completed
2	Area 13 - Thrumster	Extension of Thrumster Street from substation and collector link across Partridge Creek (MR850A&B) 400m plus bridge over Partridge Creek	Collector link	100%	$4,946,500	Short term
4	Area 13 – Thrumster	South Oxley including Type 3 & 4 Fauna/Koala Crossings per A13 DCP 450m and Oxley Highway underpass link 150 (MR866 & MR 854) Total 600m	Collector links Carlie Jane Drive	100%	$2,301,000	Medium term Currently under construction with completion programmed for April 2018
8	Area 13 - Thrumster	Intersection (No 3) with Thrumster Street – 2 lane rural roundabout (MR766A&B)	John Oxley Drive	100%	$2,500,000	Long term
12	Area 13 - Thrumster	Partridge Creek access to Thrumster Street within road cycleways, edge treatments, footpath and buffers (local works only) (MR864) 900m	John Oxley Drive	100%	$1,620,000	Long term

Figure 2.4 PMHC Road Contribution Plan for Area 13

- Project 2 – this is the proposed upgrade of the current Thrumster Street. The existing rural road will be widened to increase the capacity to cater for the Partridge Creek residential precinct.

- Project 8 – this is the proposed upgrade of the John Oxley Drive and Thrumster Street intersection. The current T-intersection will be upgraded to a 2 lane roundabout, which will control traffic speeds on the through road, and also allow efficient movement of vehicles in and out of the Partridge Creek precinct.

All these projects are relevant to the subject site, as they will provide:

- a direct connection (Carlie Jane Drive), via improved road infrastructure, between South Oxley, including The Heritage, to Thrumster Town Centre and North Oxley, which will be grade separated from Oxley Highway, thereby avoiding conflicts between site traffic and Oxley Highway traffic.
- elements of an emerging road network along the Thrumster Street alignment (northern edge of the study area), which will eventually connect the Pacific Highway's Sancrox Interchange's south-eastern roundabout, via Thrumster Street link (including projects 2, 8 and 12), to the Partridge Creek area sites and eventually to John Oxley Drive (potentially via several links, including Project 12)

The above form parts of key improvements to the John Oxley Drive alignment between Thrumster Town centre and the Phillip Charley Drive intersection, which will increase capacity and provide access to the Port Macquarie CBD and coastal area.

It is anticipated that the contributions plans will apply funds to the upgrade of John Oxley Drive from Thrumster Town centre east to Phillip Charley Drive, because of its significance as a key link within Area 13. PMHC as the road authority controls the timing of this project.

2.6 Broader Road Network

Key elements of the broader road network include:

- Pacific Highway upgrade between Port Macquarie and Kempsey was recently completed, replacing the previous single carriageway with a divided carriageway motorway
- Sancrox Interchange has been completed, providing the potential for a connection between the Pacific Highway and the Thrumster Street alignment. This has the potential to provide:
  - Better accessibility between the employment area at Sancrox and the residential areas within Area 13, as well as Thrumster Town Centre, which is likely to provide some service functions for businesses at Sancrox
  - A potential east west link to support the development of sites, such as Partridge Creek, providing an alternative to John Oxley Drive, thereby strengthening the road network by introducing alternative routes, and achieving a more diffuse balance of traffic loadings
- The RMS have confirmed the proposed upgrade of the Oxley Highway through Spencers Cutting and the Rawdon Island Road intersection area, will commence in early 2018. This will improve access between Wauchope and the employment lands at Sancrox, as well as an alternative connection to the Pacific Highway corridor.

2.7 Future Road Capacity

2.7.1 Thrumster Street

Council's Auspec Development Design Specifications (Section D1 - Geometric Road Design) describes *'A hierarchical road network which is essential to maximise road safety, residential amenity and legibility. Each class of road in the network serves a distinct set of functions and is designed accordingly.*'

The specification is based on RMS Guidelines, and includes a description of road classifications according to the role they fulfil and the volume of traffic they should appropriately carry. Council has set down the following guidelines for the functional classification of roads:

- Arterial Road – typically a main road carrying up to 20,000 vehicles per day and fulfilling a role as a major inter-regional link (2,000 vehicles per hour)
- Distributer Road – defined as secondary inter-regional links, typically carrying volumes up to 10,000 vehicles per day (1,000 vehicles per peak hour) A distributor within a development should have as its main function the conveyance of traffic generated by the development. Direct access should not be provided for single dwelling lots but access can be provided to multi-unit developments and non-residential land uses. The local distributor should serve only the development and should not attract through traffic.
- Collector Road – provides a link between local roads and major roads, typically carrying up to 6,000 vehicles per day (600 vehicles per hour). Possibly providing bus routes and giving restricted access to lots.
- Local Road – provides access to individual allotments, carrying low volumes, typically less than 2,000 vehicles per day (200 vehicles per hour).

Based upon the future lot numbers when Partridge Creek is fully developed (820 lots from Figure 2.2 above), we can estimate additional future peak hour volumes on Thrumster Street to be approximately 820 x 0.85 trips = 697 per peak hour, based on RMS Guidelines. If we include the existing peak hour volumes on Thrumster Street (27vph PM) and potential dwellings/development of existing rural lots (say 30 extra trips), and the proposed neighbourhood shopping centre, we can assume a maximum peak hour volume on Thrumster Street of approximately 1000 vehicles per hour, or over 10,000 daily vehicles by 2031.

To cater for the future traffic volumes to be generated by development in the Partridge Creek precinct, Thrumster Street will ultimately require upgrading from the current rural-standard, local road to an urban distributer road. Alternatively, consideration should be given to providing additional roads to connect the various precincts in the Thrumster area, particularly if the connections result in local trips i.e. vehicles do not need to utilise John Oxley Drive and Thrumster Street for local trips.

Council's Auspec Development Design Specifications describe the characteristics of a typical urban distributer road as:

- 13m carriageway with 40mm AC surface
- 4.5m verge
- 22m reserve width

However, it is likely the upgrade of Thrumster Street can be staged incrementally, with the current 6m wide local road suitable for volumes up to 2000 vpd. Widening to 9m will increase the capacity to approximately 6000.

Also, the traffic volumes will increase gradually of the first 5 stages, before the completion of the neighbourhood shopping centre adds a significant amount to the peak and daily volumes.

2.7.2 John Oxley Drive

John Oxley Drive currently caters for around 2500 vehicle trips a day. This average volume is significantly less than a few years ago, when John Oxley Drive was known as the Oxley Highway, and provided the main traffic route between the Pacific Highway and the Port Macquarie township.

As discussed later in this report, John Oxley Drive will provide access to and from a number of future residential, commercial and industrial precincts with Area 13, and carry over 20,000 vehicles per day by 2031, and over 25,000 by the time all of the Area 13 precincts are completed and occupied. The subject Partridge Creek residential development will contribute approximately 10,000 of the future movements on John Oxley Drive.

By the time the Partridge Creek residential development is completed and fully occupied, John Oxley Drive will require upgrading to an arterial road i.e. 13m carriageway and 2 lanes in either direction.

3. TRAFFIC VOLUMES

3.1 Existing Traffic Volumes

3.1.1 Thrumster Street/John Oxley Drive Intersection

StreetWise undertook a manual traffic count at the existing intersection of Thrumster Street and John Oxley Drive on the morning and afternoon of Wednesday 8 November 2017. The morning peak occurred between 8 – 9am, while the afternoon peak was 3:15 – 4:15pm.

The results of the manual count are in tabulated form below:

Thrumster Street	*Northbound (In)*	*Southbound (Out)*	*Total*
AM Peak Hour	5	14	19
PM Peak Hour	13	14	27

Similarly, the peak hour volumes on John Oxley Drive, east of the intersection with Thrumster Street:

John Oxley Dr	*Eastbound*	*Westbound*	*Total*
AM Peak Hour	323	168	491
PM Peak Hour	273	164	437

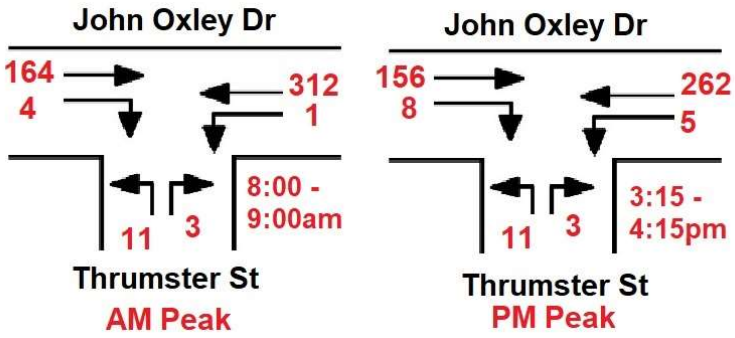


Figure 3.1 Traffic Volumes through John Oxley Drive and Thrumster Street Intersection

3.1.2 John Oxley Drive

Port Macquarie Hastings Council also provided recent tube count assessments for a number of locations on John Oxley Drive. The location of these traffic counts are shown in Figure 3.2 below.

Figure 3.2 Location of recent PMHC traffic (tube) counts on John Oxley Drive

Site 1: West of Main Street

This site is a few hundred metres east of the intersection with the Oxley Highway.

Volumes	*North*	*South*	*Combined*
Weekday Average (day)	1472	985	2457
7 Day Average (per day)	1295	875	2170
AM Peak Hour (8:00am)	267	116	383
PM Peak Hour (3:00pm)	166	149	315

Percentage of Light Vehicles 94%

85% percentile speed 71.8kmh

Site 2: East of Bestglen Close

This site is approximately 400m west of Thrumster Street, with no other roads adding traffic to the volume through the Thrumster Street intersection i.e. the traffic volumes at this collection site should be similar to those through the subject intersection.

Volumes	*Eastbound*	*Westbound*	*Combined*
Weekday Average (day)	1762	1245	3007
7 Day Average (per day)	1546	1100	2646
AM Peak Hour (8:00am)	312	179	491
PM Peak Hour (3:00pm)	255	148	403

Percentage of Light Vehicles 93.4% HV 6.6%

85% percentile speed 77.0kmh

Site 3: East Phillip Charley Drive

This traffic count site is located east of Phillip Charley Drive, approximately 2kms west of the Wrights Road interchange (near PM Base hospital). It should be noted that the tube count at this location is impacted by:

- Trips generated by the Innes Lake precinct, which head towards the Oxley Hwy via the Phillip Charley Drive roundabout (and therefore do not continue east on John Oxley Drive)
- Trips generated by the 'Ascot Park' residential precinct, the majority of which head east towards Port Macquarie
- Trips generated by Port Macquarie crematorium and chapel, the majority of which head east towards Port Macquarie

Volumes	***Eastbound***	***Westbound***	***Combined***
Weekday Average (day)	1222	2167	3389
7 Day Average (per day)	1112	1977	3089
AM Peak Hour (8:00am)	165	192	357
PM Peak Hour (3:00pm)	169	262	403

Percentage of Light Vehicles 95.3% HV 4.7%

85% percentile speed 70.6kmh

Figure 3.2 below shows an hourly breakdown of current traffic volumes on John Oxley Drive, just west of the Thrumster Street intersection. The graph indicates hourly volumes in both directions, as well as a total hourly volume. As can be seen from the graph:

- There are 2 clear peak times – 8:00am and 3:00pm – which co-incide with local school times
- Outside of these peak hours, the total volumes are less than 200 vph
- The hourly volumes travelling eastwards on John Oxley Drive are generally higher than those heading westwards

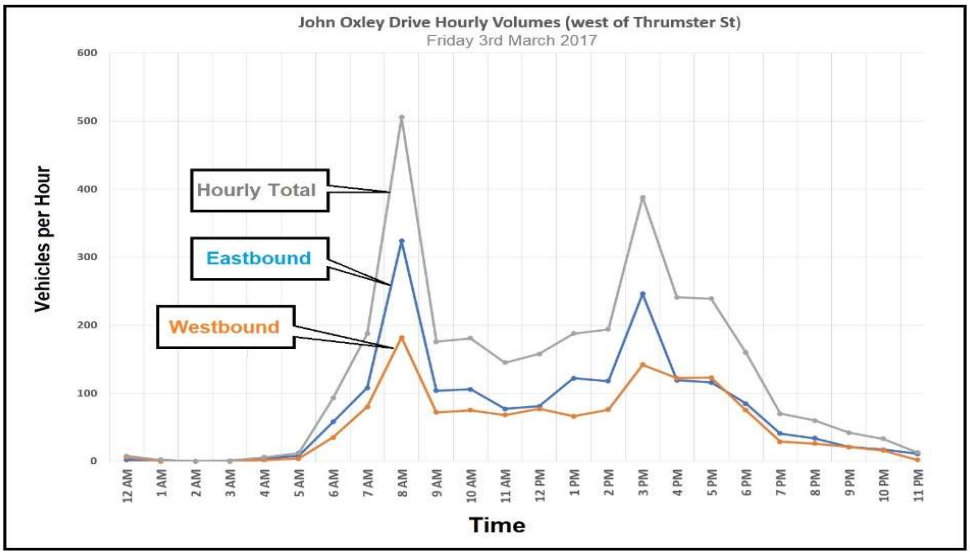


Figure 3.3 Hourly Traffic Volumes - John Oxley Drive (Friday 3/3/17)

3.2 Future Traffic Volumes

The Partridge Creek residential area is located within the Area 13 residential precinct – a land release area that is planned to cater for a significant number of additional residents, as well as new businesses and industry over the next 20 – 30 years. It is also estimated that Area 13 will also generate 10's of thousands of additional vehicle movements in that time.

3.2.1 Method

To determine the future traffic volumes on John Oxley Drive for this assessment and report, StreetWise worked were provided with a list of development precincts within Area 13 by Port Macquarie Council, which included:

- The approximate number of residential lots to be released
- The approximate gross floor area of proposed commercial & industrial precincts
- The approximate number of units for proposed nursing homes

StreetWise used the information provided to estimate the number of vehicle trips to be generated by each development precinct, based on the landuse and other details.

Council then provided an estimate of development progress (i.e. percentage completion) for each precinct for the years 2026 and 2031, which StreetWise were able to convert into approximate hourly and daily traffic volumes.

StreetWise then assessed each precinct to determine the future distribution of traffic, particularly in regard to the number of vehicles that may utilise John Oxley Drive. It is assumed that a number of future growth areas will have minimal impact on John Oxley Drive, due to either the distance from the Thrumster Street area, or easier access to the Oxley Highway.

The following is a discussion of the various Area 13 precincts, and the likely distribution of traffic from each. A spreadsheet describing the various Area 13 precincts and estimated future traffic generation is also included in the appendices.

3.2.2 Area 13 – Future Traffic Distribution

North Oxley ('College Rise' Precinct)

North Oxley can be divided into 2 sub-areas, with the future precincts of (1) Gateway, (2) Vaughan, (3) College Rise and (4) Racecourse located on the northern side of John Oxley Drive and accessed via the existing Chancellor Drive. This area is currently about 30% completed and generates approximately 940 daily trips or 135 peak hour trips. A large number of trips are also generated by the existing high school (St Josephs). By 2026, this area will be significantly developed and then completed by 2031. It is assumed that as this area develops, including the provision of schools, shops and other facilities, an increasing number (up to 30%) of vehicle movements will be within the North Oxley precinct.

Year	Total Volumes		Peak Hour Splits	
	Daily	*Peak Hr*	*70%*	*30%*
2018	935	135	95	40
2026	1670	240	170	70
2031	2690	385	270	115

Figure 3.4 Current and future traffic movements generated by 'College Rise' precinct

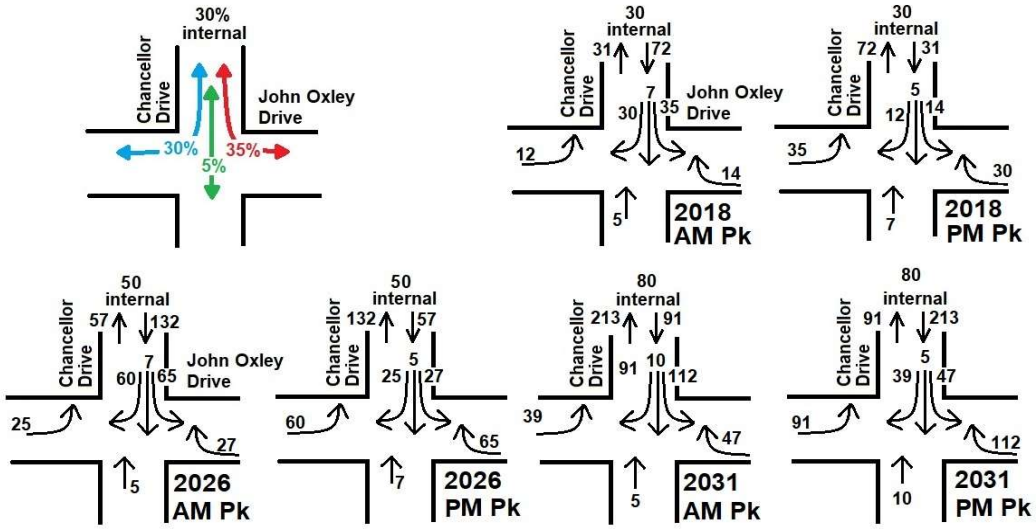


Figure 3.5 Estimated traffic distribution from College Rise via Chancellor Drive

North Oxley ("Barton Ridge' Precinct)

On the southern side of John Oxley Drive, the various stages of 'Barton Ridge' (4 – 7) will enter and exit via Carlie Jane Drive. A small number (5%) is expected to turn to and from Carlie Jane Drive (south) towards Sovereign Hills. It is expected that the majority will utilise Carlie Jane Drive (north) then head:

- north (50%) via Chancellor Drive to the school & future amenities at the future Town Centre
- west (30%) via John Oxley Drive and connect with the Oxley and/or Pacific Highway
- east (15%) via John Oxley Drive to Thrumster, Port Macquarie CBD or future industrial area

Note that Carlie Jane Drive (south), connecting John Oxley Drive to the Sovereign Hills residential development, was under construction at the time of preparing this report. However, by 2026, it will be completed and catering for a Sovereign Hills traffic movements.

Year	Total Volumes		Peak Hour Splits	
	Daily	*Peak Hr*	*70%*	*30%*
2018	1045	145	100	45
2026	1700	235	165	70
2031	2765	380	265	115

Figure 3.4 Current and future traffic movements generated by 'Barton Ridge' precinct

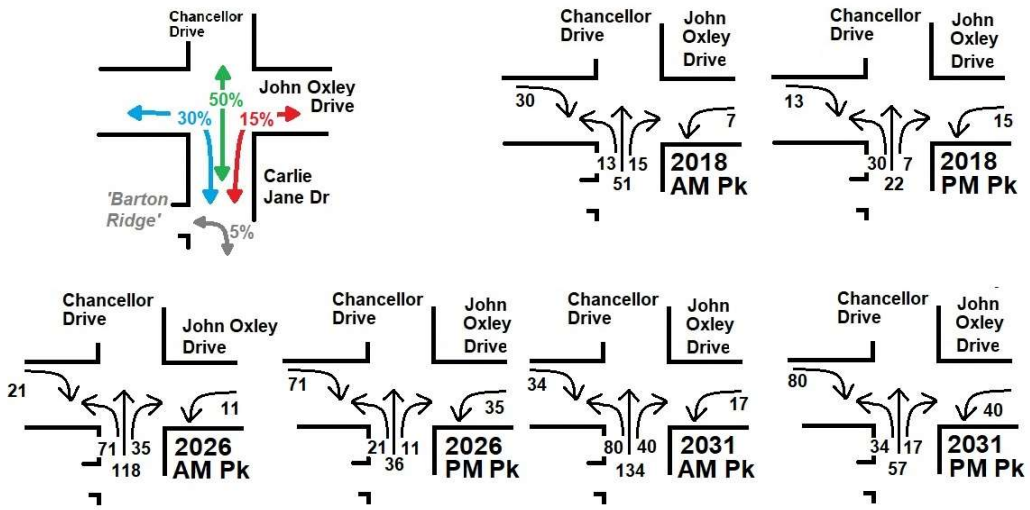


Figure 3.5 Estimated traffic distribution from 'Barton Ridge' via Carlie Jane Drive

South Oxley ('Sovereign Hills' Precinct)

Sovereign Drive

The South Oxley precinct is located on the southern side of the existing Oxley Highway, and is currently under construction. The South Oxley precinct includes the 'Stirling Green' and 'The Heritage' residential developments, which will also include neighbourhood commercial areas, pre-schools and other landuses. The first few stages of Sterling Green have been completed, with approximately 150 residences currently occupied.

The majority (approx. 90%) of the future traffic generated by the South Oxley area will utilise Sovereign Drive for access. The remainder will utilise Carlie Jane Drive, to the east of the development. Traffic utilising Sovereign Drive will pass through the existing roundabout at the Oxley Highway, then turn

- north (30%) via John Oxley Drive to Thrumster, Port Macquarie CBD, future Partridge Creek industrial area or the school & future amenities at the future Town Centre
- west (20%) via the Oxley Hwy, or turn onto the Pacific Highway via the adjacent interchange
- east (15%) via the Oxley Highway to Port Macquarie CBD, beaches, major shopping etc.

Year	Total Volumes		Peak Hour Splits	
	Daily	*Peak Hr*	*70%*	*30%*
2018*	2190	262	185	80
2026	8505	1155	810	345
2031	9485	1295	905	390

Figure 3.6 Current and future traffic movements generated by 'South Oxley' precinct, via Sovereign Drive

- 2018 - All traffic via Sovereign Drive (Carlie Jane Drive not completed)

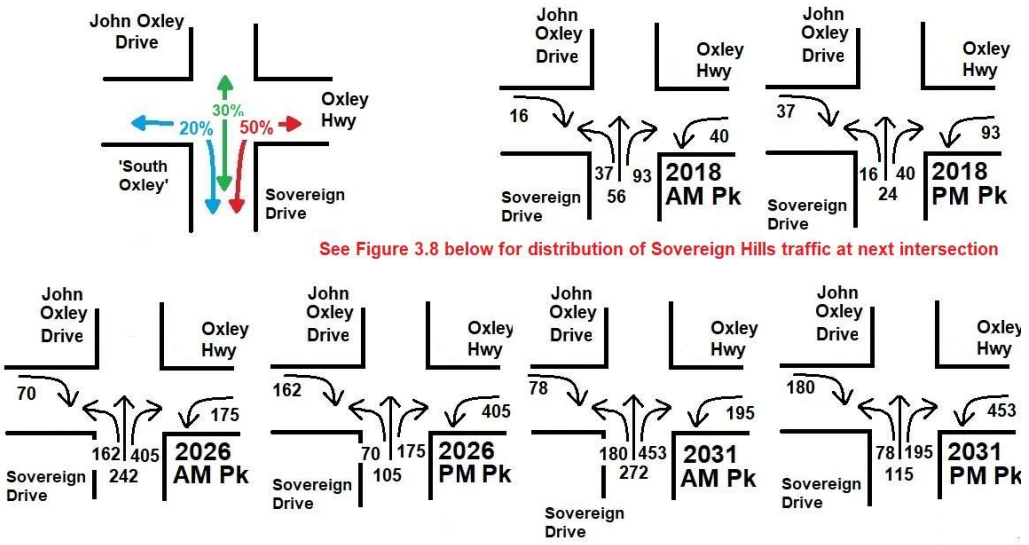


Figure 3.7 Estimated traffic distribution from 'South Oxley' via Sovereign Drive

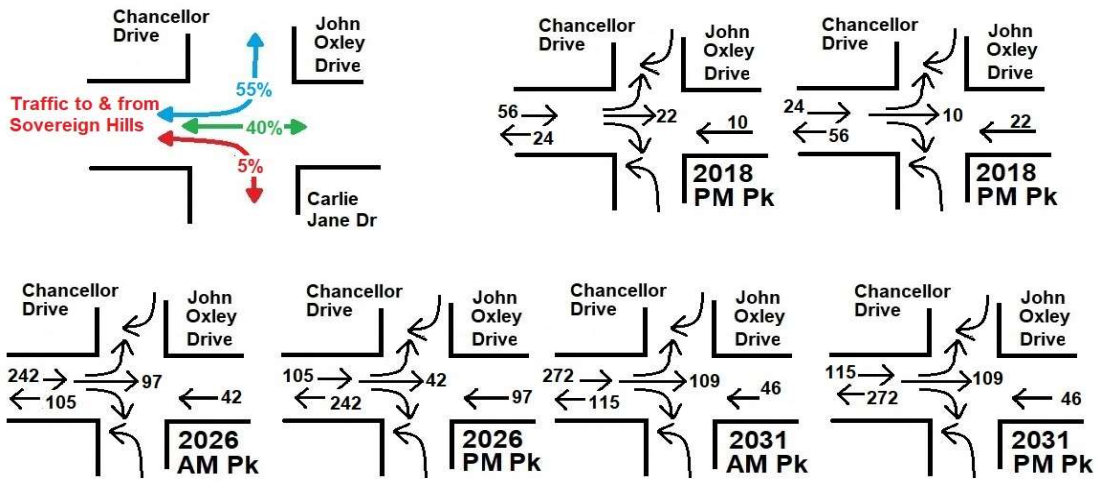


Figure 3.8 Estimated traffic distribution from 'South Oxley' via Sovereign Drive at intersection with Carlie Jane Drive & Chancellor Drive

Carlie Jane Drive

Carlie Jane Drive is currently under construction, and nearing completion. The new road passes under the Oxley Highway, and will connect the South Oxley residential precinct with John Oxley Drive, College Rise precinct, St Josephs school and the future Town Centre via the existing intersection at Chancellor Drive.

Carlie Jane Drive is located near the eastern boundary of the South Oxley precinct, and will serve as an alternative access to John Oxley Drive for approximately 10% of South Oxley residents, while the majority of Sovereign Hills and The Heritage residents will continue to utilise Sovereign Drive, as it is the easier and more direct route.

Year	Total Volumes		Peak Hour Splits	
	Daily	*Peak Hr*	*70%*	*30%*
2018	Carlie Jane Drive not completed			
2026	945	129	90	39
2031	1054	144	101	43

Figure 3.9 Current and future traffic movements generated by 'South Oxley' precinct, via Carlie Jane Drive

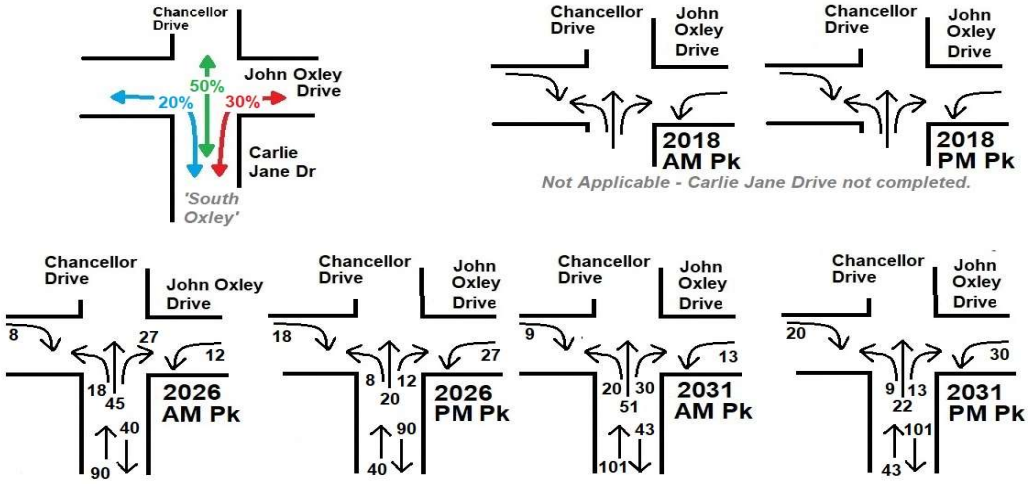


Figure 3.10 Estimated traffic distribution from 'South Oxley' via Carlie Jane Drive

Thrumster Town Centre (via Chancellor Drive)

The future Thrumster Town Centre is to be located on the northern side of John Oxley Drive, near the existing St Josephs High School. Access will initially be via Chancellor Drive to John Oxley Drive, with alternative connection to the Partridge Creek precinct being considered via an extension of Thrumster Street. For this assessment, all access will be assumed to via Chancellor Drive, with only vehicles heading to and from the east on John Oxley Driving having impacts on the Thrumster Street intersection.

The Thrumster Town Centre precinct is likely to include commercial, industrial and entertainment landuses, as well as some residential development. Vehicle trips to this precinct will be generated by the nearby residential areas, with the Sovereign Hills/South Oxley area being potentially the largest contributor. It is also Assumed that approximately 20% of vehicle trips will be contained within the College Rise precinct i.e. short local trips that do not utilise John Oxley Drive.

Year	Total Volumes		Peak Hour Splits	
	Daily	*Peak Hr*	*70%*	*30%*
2018	Thrumster Town Centre not commenced			
2026	2276	365	255	110
2031	3815	555	390	165

Figure 3.11 Estimated traffic distribution from future 'Thrumster Town Centre'

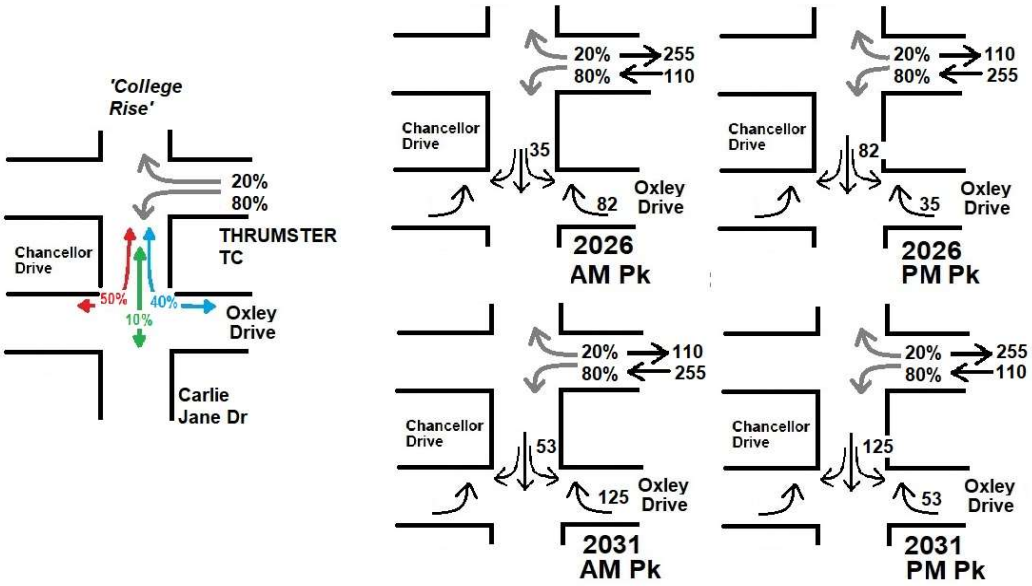


Figure 3.12 Estimated traffic distribution from 'Thrumster Town Centre via Chancellor Drive

Future Industrial Areas

The future Thrumster (Partridge Creek) Industrial Precinct will be located to the east of the subject Partridge Creek residential development, and access is proposed via a new road off John Oxley Drive, to the east of Thrumster Street.

It is also likely that some vehicles will gain access to the future industrial area through the subject Partridge Creek residential precinct.

However, it should be noted that the future industrial area is not likely to be constructed for another 10 years, and an estimate of 50% completion has been adopted for the 2031 assessment.

Similarly, there is an industrial precinct planned to the west of the current Lindfield Park Road. This area is likely to generate vehicle trips from the subject Partridge Creek residential precinct, due to commuter trips (i.e. residents working in the industrial areas) or occasional trips to purchase items.

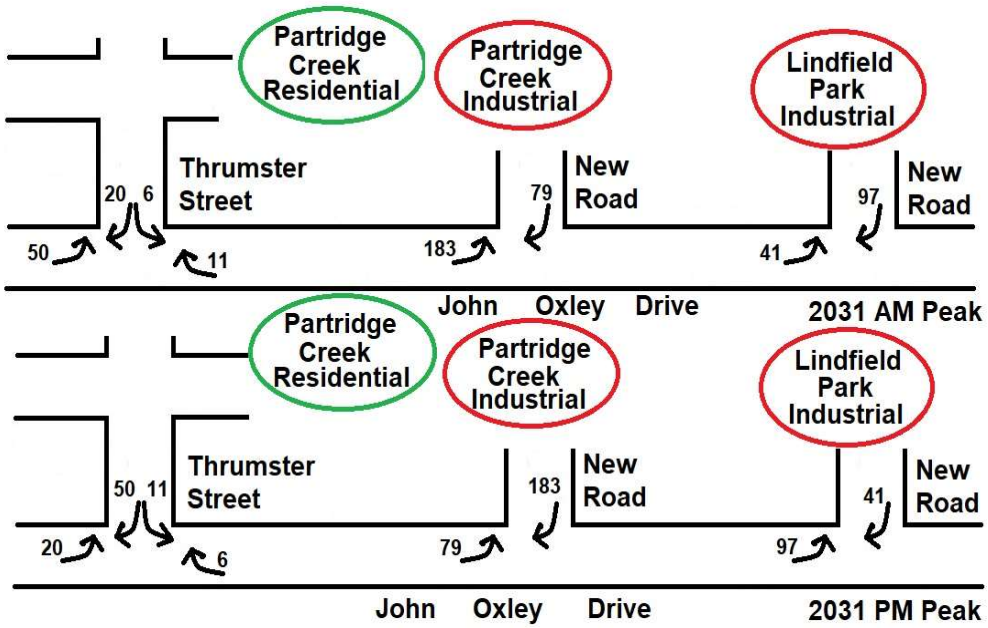


Figure 3.13 Estimated traffic distribution from future industrial precincts

Other traffic generators

The Area 13 residential, commercial and industrial precincts discussed above will directly impact on future John Oxley Drive traffic volumes through the Thrumster Street intersection as these precincts are generally within a kilometre of the subject development, and proximity of the properties and landuses will result in commuter, recreational and other vehicle trips passing through the intersection.

Other development precincts within Area 13, such as Kingfisher Road, Sancrox, Highfields Circuit etc are further away, and less likely to utilise John Oxley Drive. Also, there are shops, schools and other closer facilities which will mean trips to the Thrumster area are less likely to occur.

An annual growth rate of 2% has been adopted and applied to existing John Oxley Drive traffic volumes to account for 'background traffic' increases.

Estimated Future Volumes

The Area 13 development precincts discussed in this report include existing residential areas, partially completed developments and proposed future developments. Therefore, to estimate the future traffic volumes on John Oxley Drive, we can't simply add the numbers estimated in the previous section, particularly as a significant number of these vehicle trips are already being generated by existing precincts such as South Oxley, College Rise and Barton Ridge.

Therefore, we need to add the future increases (utilising the approximate percentage of completion/uptake recently provided by Council) to the existing traffic volumes on John Oxley Drive (as obtained by StreetWise), as well as the annual increase to background volumes (2% p.a. has been adopted for this assessment).

We then need to add the traffic to be generated by the future Partridge Creek residential precinct i.e. the subject of this assessment (see Section 9.3 below).

3.3 Development Generated Volumes

The proposed development will provide a total of 502 residential lots and a commercial site which will include a neighbourhood shopping centre. It is proposed to construct the residential development in 10 stages over a period of approximately 15 years. StreetWise have adopted 2026 as the mid-point of the construction, and 2031 as the completion year, in accordance with the traffic data provided by Council, although it is likely that market forces will determine the actual timing of the construction stages and release of residential lots. StreetWise have adopted 1.5 years per stage, with 54 lots per stage (or 36 lots per year) for the purpose of this assessment.

3.3.1 Residential

As discussed above, a rate of 36 lots per year has been adopted as an average release rate. At 9 trips per day, this amounts to an additional 486 daily vehicle trips generated per stage, or 324 daily trips per year.

At the midway point of the development (2026 and 5 stages), the fully occupied development will be generating approximately 2430 daily vehicle trips, or 243 peak hour trips.

Stage 10 should be completed around 2031/2032, and by the time all residential lots are occupied, the Partridge Creek residential development will generate around 5436 daily trips, or 544 peak hour trips.

3.3.2 Commercial

The Partridge Creek development includes a future neighbourhood shopping centre at the southern boundary of the site. The proposed commercial lot is approximately 15,130m^2, and is similar size to the Lake Cathie shopping centre off Ocean Drive (14,175m^2). Using the Lake Cathie example, we

can assume approximately 4000m^2 of the site will be gross leasable floor area (GLFA), with the remainder of the site being carparking, service buildings, awnings etc. The RMS 'Guide to Traffic Generating Developments' indicates that 100m^2 of shopping centre GLFA generates approximately 7.6 peak vehicle trips, and 78 daily trips. Therefore, we can assume the future shopping centre will generate about 305 peak hour and 3120 daily vehicle trips.

For the purposes of this assessment, we have assumed that the shopping centre will be completed at the mid-point of the overall development i.e. 2026.

The following chart shows the annual and stage-by-stage increase in traffic generated by the proposed Partridge Creek development.

					Trips	
Stage	Date		Lots	Total Lots	Daily	Pk Hr
1	Jan	2019	18	18	162	16
	July	2019	18	36	324	32
	Jan	2020	18	54	486	49
2	July	2020	18	72	648	65
	Jan	2021	18	90	810	81
	July	2021	18	108	972	97
3	Jan	2022	18	126	1134	113
	July	2022	18	144	1296	130
	Jan	2023	18	162	1458	146
4	July	2023	18	180	1620	162
	Jan	2024	18	198	1782	178
	July	2024	18	216	1944	194
5	Jan	2025	18	234	2106	211
	July	2025	18	252	2268	227
	Jan	2026	18	270	2430	243
Commercial		2026			+ 3120	+ 305
6	July	2026	18	288	5712	564
	Jan	2027	18	306	5874	580
	July	2027	18	324	6036	597
7	Jan	2028	18	342	6198	613
	July	2028	18	360	6360	629
	Jan	2029	18	378	6522	645
8	July	2029	18	396	6684	661
	Jan	2030	18	414	6846	678
	July	2030	18	432	7008	694
9	Jan	2031	18	450	7170	710
	July	2031	18	468	7332	726
	Jan	2032	18	486	7494	742
10	July	2032	18	504	7656	759

Figure 3.14 Estimated stage-by-stage traffic generation

3.4 Trip Assignment

For the purposes of this assessment, the following assumptions have been adopted:

- Traffic movements generated by the residential component of the development during morning peak hours will generally be 70% out of the site and 30% in. The afternoon peak hour residential movements will be reversed i.e. 30% out and 70% in.
- The neighbourhood shopping centre will likely attract staff, suppliers and customers into the area via John Oxley Drive during the morning peak. In the afternoon, a greater number of trips will exit the Partridge Creek precinct than be attracted to the area. A ratio of 70% in & 30% out has been adopted for the AM peak. This ratio has been reversed (30% in & 70% out) for the PM peak.
- The majority of movements are likely to be to and from the John Oxley Drive intersection via Thrumster Street. The remainder are likely to be movements within the Partridge Creek residential precinct, and therefore not impact on the John Oxley Drive intersection. The assessment does not include any consideration of future alternative accesses to the Partridge Creek area.
- It is likely that a large percentage of the trips generated by the residential and commercial components will overlap i.e. many commuter trips by residents will be via the future shopping centre. However, for the purposes of this assessment, they have been considered as separate trips, and the total volumes are therefore conservative. .

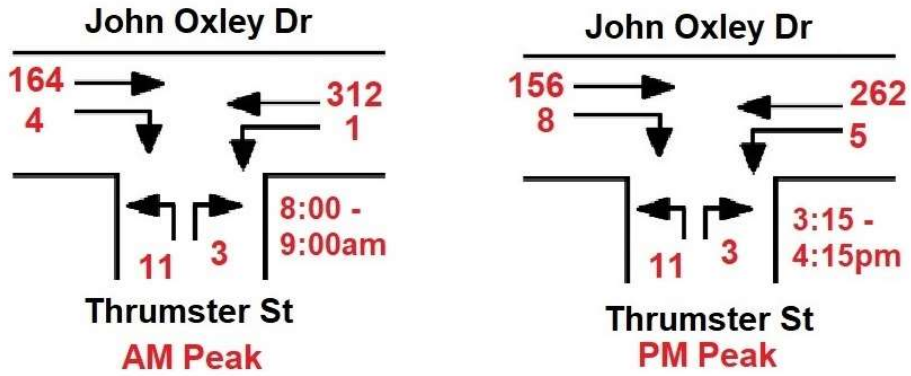
4. INTERSECTION MODELLING

4.1 John Oxley Drive & Thrumster Street intersection

StreetWise utilised SIDRA to model existing and future traffic volumes through the John Oxley Drive and Thrumster Street intersection. The modelling was undertaken for the following scenarios:

- AM and PM peak periods
- Existing (2018), half development (2026) and full development (2031)
- T-intersection, single lane roundabout and 2-lane roundabout

The following diagrams and estimated traffic volumes have been utilised for the SIDRA intersection modelling.



Current - 2018

Figure 4.1 Existing traffic volumes used for SIDRA modelling

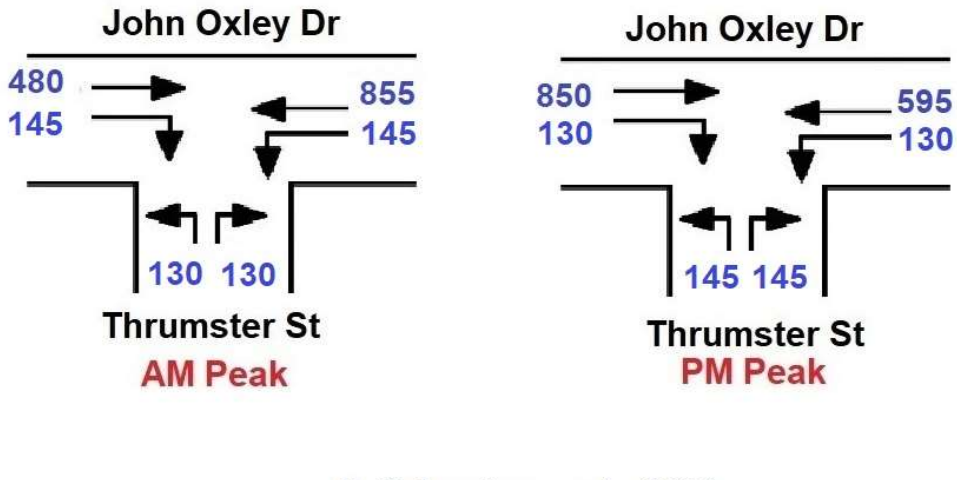


Figure 4.2 Estimated half-development traffic volumes used for SIDRA modelling

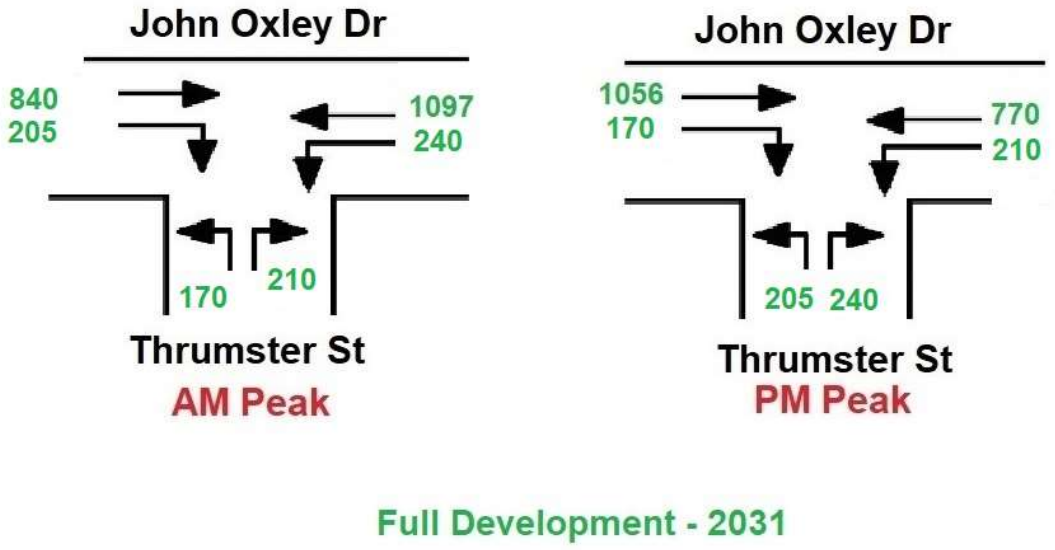


Figure 4.3 Estimated full - development traffic volumes used for SIDRA modelling

The full results of the SIDRA modelling is included in Appendix B. However, the following is a summary of the modelling results:

4.1.1 2018 Existing conditions

The current traffic volumes utilising the Thrumster Street & John Oxley Drive intersection are relatively low, and the existing T-intersection operates efficiently, with minimal delays. Each of the 6 movements at the intersection currently operates at a Level of Service of 'A', which equates to *'a condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.'* The results of the modelling are similar for both the existing morning and afternoon peak periods.

It should be noted that John Oxley Drive was previously the Oxley Highway i.e. the main connection between the Port Macquarie township and the Pacific Highway. Traffic volumes through the

Thrumster Street intersection were significantly higher prior to the recent opening of the new section of the Oxley Highway.

4.1.2 2026 Half development

By the time Stage 5 of the development has been completed and fully occupied, peak traffic volumes on Thrumster Street will be around 600 vehicles an hour, while close to 2000 vehicles will utilise John Oxley Drive. Stage 5 will also see the completion of the proposed neighbourhood shopping centre at Partridge Creek, which will contribute approximately 300 trips an hour at peak times.

The SIDRA modelling indicates that the existing T-intersection will not be adequate to cater for the increased traffic movements in 2016, with significant delays for the 2 movements out of Thrumster Street (i.e. left & right turn). These movements indicated a LoS of 'F' at both morning and afternoon peak times i.e. '*In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.'* However, the remaining through and turn movements at John Oxley Drive are satisfactory.

StreetWise also modelled a roundabout layout at the intersection of Thrumster St and John Oxley Dr. At half development, a single lane roundabout would operate efficiently, with all movements operating at a Level of Efficiency of 'A' .

4.1.3 2031 Full development

T-intersection

The completion and occupation of Stage 10 of the subject development will increase peak traffic volumes on Thrumster Street to around 900 vehicles an hour, while volumes on John Oxley Drive will be approximately 2500 vehicles an hour at peak times. As discussed previously, an unsignalized T-intersection layout will not adequately cater for these volumes. Also, as shown by the SIDRA modelling results, a single lane roundabout will not satisfactorily cater for all movements.

The SIDRA modelling indicates that the existing T-intersection will not be adequate to cater for the increased traffic movements in 2031, with significant delays for the 2 movements out of Thrumster Street (i.e. left & right turn). These movements indicated a LoS of 'F' at both morning and afternoon peak times i.e. '*In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.'*

Eastbound flows on John Oxley Drive will also be delayed during the morning peak times, due to the large numbers of vehicles turning left into Thrumster Street.

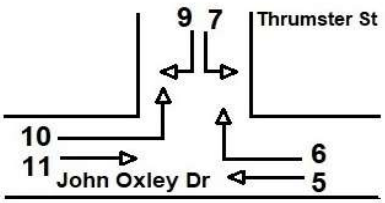
Single Lane Roundabout

According to the SIDRA modelling results, the traffic volumes generated by the full development (2031), will result in congestion and delays if a single lane roundabout is still operating at the intersection of John Oxley Drive and Thrumster Street. During the AM peak times, the high volume of vehicles turning right in and out of Thrumster Street will create lengthy delays on John Oxley Drive. Flows will be better during the PM peak, but delays will still be lengthy (Los of 'F') on John Oxley Drive (westbound).

Two Lane Roundabout

According to the SIDRA modelling results, a 2-lane roundabout will cater satisfactorily for the traffic volumes generated by the full development (2031). During the AM peak period, all movements through the intersection will operate satisfactorily, with all movements having an LoS of 'A' or 'B' and minimal delays. Vehicles turning out of Thrumster Street onto John Oxley Drive may experience short delays but an LoS of 'B' indicates efficient flows in both directions.

During the afternoon peak period, all movements can be expected to operate at a Level of Service of 'A', with average delays of less than 20 seconds.



			Movement					
			JOD eastbnd		Thrumster St		JOD westbnd	
			10	11	7	9	5	6
2018	AM	T-Intn	A	A	A	A	A	A
		RAB	A	A	A	A	A	A
		2 Ln RAB	A	A	A	A	A	A
	PM	T-Intn	A	A	A	A	A	A
		RAB	A	A	A	A	A	A
		2 Ln RAB	A	A	A	A	A	A
2026	AM	T-Intn	A	A	F	F	A	A
		RAB	A	A	A	A	A	B
		2 Ln RAB	A	A	A	A	A	A
	PM	T-Intn	A	A	F	F	A	A
		RAB	A	A	A	A	A	B
		2 Ln RAB	A	A	A	A	A	A
2031	AM	T-Intn	A	A	F	F	F	F
		RAB	F	F	B	B	B	B
		2 Ln RAB	A	A	B	B	A	A
	PM	T-Intn	A	A	F	F	A	B
		RAB	A	A	A	A	F	F
		2 Ln RAB	A	A	A	A	A	A

Figure 4.4 Summary of SIDRA modelling results for existing, half-development & full development

4.1.4 Future Volumes - comment

The estimated future traffic volumes shown in this report, and used in the SIDRA intersection modelling, is based on a regular completion, release and occupation of the Partridge Creek residential lots, as per Figure 3.4 above. Similarly, it has been assumed that the proposed neighbourhood shopping centre, which will generate a significant amount of the daily trips on Thrumster Street, will be completed by Stage 5 of the development. However, the adopted daily and peak hour volumes is based on a fully complete shopping centre and every shop occupied.

It should therefore be noted that the traffic volumes shown in this assessment are the maximum that could be expected, and the numbers are likely to be less, based on market forces, vacant lots, staged construction of the shopping centre, unoccupied shops etc.

5. SUMMARY

- The proposed 504 lot Partridge Creek residential development will generate an estimated 5436 vehicle movements per day, and 544 peak hour movements. The commercial component will add an additional 3120 vehicles a day or 305 trips at peak times. The total trips generated by the development, when completed and fully occupied, will be around 7650 per day, or 760 peak hour trips.
- It is proposed to construct the development in 10 stages, at an average of 50 lots per stage. The timing and number of lots released per stage will be subject to market forces. For the purposes of this assessment, half-development was adopted as 2026 and completion by 2031. This equates to approximately 18 months and 54 lots per stage. It is assumed the

neighbourhood shopping centre will be constructed and operational by 2026 i.e. half development.

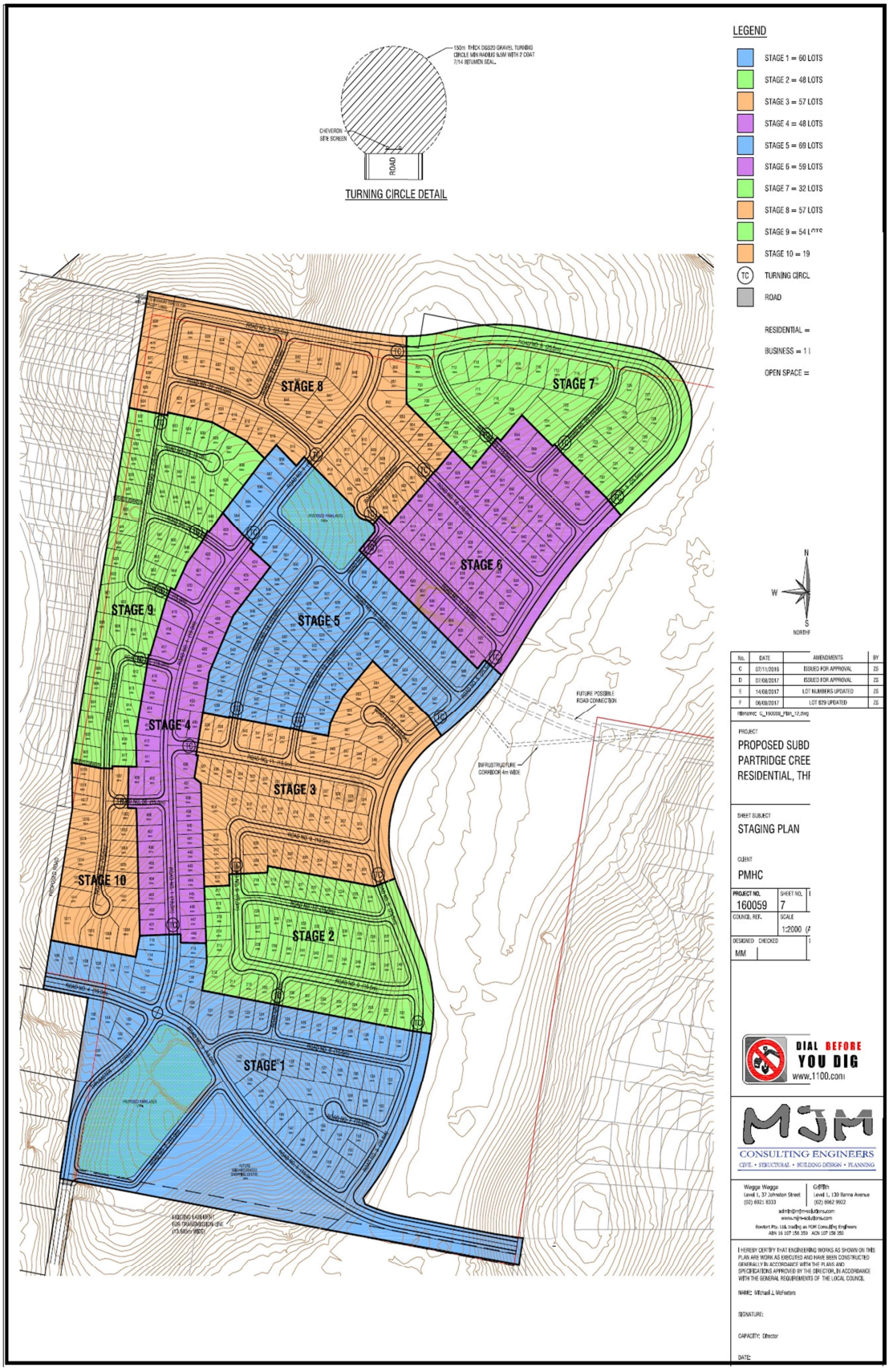
- The current traffic volumes on John Oxley Drive are significantly less than when the road was the main connection between Port Macquarie and the Pacific Highway (until the completion of the new section of Oxley Highway approx. 5 years ago). However, it is planned that John Oxley Drive will provide access to a number of future Area 13 residential, commercial and industrial precincts, and the current volumes will increase significantly in the next 15 – 20 years.
- The existing T-intersection at John Oxley Drive and Thrumster Street has previously catered for higher traffic volumes, and currently operates efficiently. The SIDRA modelling that the existing T-intersection layout will operate satisfactorily up to approximately Stage 5 of the residential development. It is estimated the completion of the neighbourhood shopping centre will increase traffic volumes in Thrumster Street to a level where delays become unsatisfactory.
- Upgrading the existing T-intersection at Thrumster Street and John Oxley Drive to a single lane roundabout will cater for the additional trips generated by the half-development (2026), including the proposed neighbourhood shopping centre. However, the roundabout may require upgrading to a 2-lane layout to cater for the traffic generated by the fully completed development.
- The status of the existing Thrumster Street generally meets Council's requirements for a rural standard local road. This will need to be upgraded to a Local Street to cater for the increased traffic volumes generated by Stages 1 – 4. Further upgrade to a Collector Road will be required to cater for Stage 5 and the completion of the proposed neighbourhood shopping centre. By the time the development is fully completed (2031), Thrumster Street will require upgrade to 'Distributor' standard to cater for the estimated 8,000 trips per day.
- Future John Oxley Drive traffic volumes are predicted to exceed 20,000 within the next 20 years, and will require upgrading to Arterial standard to cater for these volumes.
- The required upgrade of Thrumster Street, John Oxley Drive and the existing intersection is based on the total increase in traffic volumes in the Area 13 precinct, whereas this assessment considers the trip generation of the subject Partridge Creek residential development. The actual timing of the required upgrades is subject to the timing of a variety of developments throughout the Thrumster and Area 13, and not solely upon the staging of the subject development.
- The estimated traffic volumes utilised in this assessment and used in the SIDRA modelling are a conservative estimate, and actual volumes are expected to be lower than those shown, due to the following:
    - The distribution of traffic from other developments within Area 13 is an estimate only, based on assumed future attractors i.e. shopping centres, schools, pre-schools, workplaces etc. If these future landuses are not completed within the assessment period, i.e. 2031, then many trips will continue utilise the Oxley Highway to Port Macquarie, rather than use John Oxley Drive.
    - The assessment assumes that the current rate of release for Area 13 will continue over the next 15 – 20 years. However, it is likely that the rate of development will vary during that time, with some slowing down expected within that period
    - The estimated trips to be generated by the subject Partridge Creek residential development, and other precincts within Area 13, are likely to overlap i.e. a commute from South Oxley may include a drop-off at St Josephs school and/or a stop at the future neighbourhood shopping centre, before heading to work the Thrumster

industrial area. This would count as multiple vehicle trip in this assessment, whereas a reduction in vehicle numbers should be adopted.

6. RECOMMENDATIONS

- The existing formation of Thrumster Street will require upgrading to:
  - A minimum 'Local Road' standard (as per Council's Austroads Table D1.5) to cater for Stages 1 - 4 of the Partridge Creek residential development.
  - A 'Collector Road' standard to cater for Stage 5 and the completed neighbourhood shopping centre
  - A 'Distributor Road' standard to cater for Stages 9 – 10
- John Oxley Drive will require upgrading to:
  - A minimum 'Distributor' standard (as per Council's Austroads Table D1.5) to cater for increased traffic volumes by approximately 2026, based upon the estimated trips generated by Partridge Creek residential development, and also estimated volumes from other developments within the Area 13 precinct.
  - By 2031, based upon completion of Partridge Creek residential development, and traffic generated by other Area 13 precincts, John Oxley Drive may require further upgrade to an Arterial Road to cater for estimated volumes.
- The existing layout at intersection of John Oxley Drive and Thrumster Street will satisfactorily cater for Stages 1 – 4 of the Partridge Creek residential development. Consideration should be given to upgrading the existing layout to cater for queuing and turn movements, if required.
- The intersection of John Oxley Drive and Thrumster Street should be upgraded to a single lane roundabout by Stage 5 and the completion of the neighbourhood shopping centre, to cater for the increased traffic volumes.
- By full development of the Partridge Creek residential precinct, the intersection of John Oxley Drive and Thrumster Street may require upgrading to a 2-lane roundabout, dependent upon the rate of development within the overall Area 13 and surrounding precints.
- The above recommendations are based on the traffic estimated to be generated by the Partridge Creek residential precinct, and the estimated future volumes on John Oxley Drive. However, the timing of other developments within Area 13 may have a significant impact on future volumes, and it is recommended that regular traffic counts and modelling be undertaken to monitor the capacity and efficiency of roads and intersections in the area.
- This assessment is based mainly on future traffic to be generated by the Partridge Creek residential precinct, with access to and from the site generally via Thrumster Street. Alternative connections have not been included in any of the modelling. However, it is recommended that consideration be given to providing direct access to adjoining precincts, particularly to the future Thrumster Town Centre (to the west) and Thrumster Industrial development (to the east) to reduce the number of local trips that utilise John Oxley Drive.

Appendix A
Preliminary Staging Plan


TURNING CIRCLE DETAIL
CHEVERON SITE SCREEN
ROAD
LEGEND
STAGE 1 = 60 LOTS
STAGE 2 = 48 LOTS
STAGE 3 = 57 LOTS
STAGE 4 = 48 LOTS
STAGE 5 = 69 LOTS
STAGE 6 = 59 LOTS
STAGE 7 = 32 LOTS
STAGE 8 = 57 LOTS
STAGE 9 = 54 LOTS
STAGE 10 = 19
TURNING CIRCL
ROAD
RESIDENTIAL =
BUSINESS = 1 l
OPEN SPACE =
STAGE 1
STAGE 2
STAGE 3
STAGE 4
STAGE 5
STAGE 6
STAGE 7
STAGE 8
STAGE 9
STAGE 10
FUTURE POSSIBLE ROAD CONNECTION
INFRASTRUCTURE CORRIDOR 4m WIDE
N
W
S
NORTH
No. DATE AMENDMENTS BY
C 07/11/2016 ISSUED FOR APPROVAL ZS
D 07/08/2017 ISSUED FOR APPROVAL ZS
E 14/08/2017 LOT NUMBERS UPDATED ZS
F 06/09/2017 LOT 829 UPDATED ZS
PROJECT
PROPOSED SUBD
PARTRIDGE CREE
RESIDENTIAL, THI
SHEET SUBJECT
STAGING PLAN
CLIENT
PMHC
PROJECT NO. 160059
SHEET NO. 7
COUNCIL REF.
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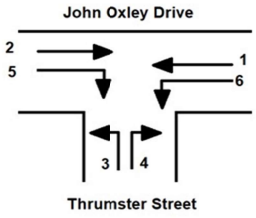
(02) 6962 9922
admin@mjm-solutions.com
www.mjm-solutions.com
Rowton Pty. Ltd. trading as MJM Consulting Engineers
ABN 36 107 156 359 ACN 107 156 359
I HEREBY CERTIFY THAT ENGINEERING WORKS AS SHOWN ON THIS PLAN ARE WORK AS EXECUTED AND HAVE BEEN CONSTRUCTED GENERALLY IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS APPROVED BY THE DIRECTION, IN ACCORDANCE WITH THE GENERAL REQUIREMENTS OF THE LOCAL COUNCIL.
NAME: Mitchell J. McFeeters
SIGNATURE:
CAPACITY: Director
DATE:

Appendix B
Manual Traffic Count Results

Onsite traffic count - 8 Nov 2017

Time		Movement 1 Oxley Hwy - eastbound (towards Pt Macq)				Movement 2 Oxley Hwy - westbound (towards Wauchope)				Move 3	4	5	6	Total	
		LV	Bus	HV	Total	LV	Bus	HV	Total						
7:00	7:15	8	1	2	**11**	12	1	1	**14**	3	1	3	0	**32**	
7:15	7:30	22	2	1	**25**	12	1		**13**	3	1	0	3	**45**	
7:30	7:45	34	0	2	**36**	14	0	2	**16**	3	1	0	2	**58**	
7:45	8:00	55	0	0	**55**	26	0	1	**27**	3	0	0	0	**85**	220
8:00	8:15	73	4	0	**77**	42	3	0	**45**	2	2	1	0	**127**	315
8:15	8:30	85	7	1	**93**	45	1	0	**46**	4	0	1	1	**145**	415
8:30	8:45	84	**1**	1	**86**	42	1	1	**44**	3	1	1	0	**135**	492
8:45	9:00	55	0	1	**56**	29	0	0	**29**	2	0	1	0	**88**	**495**
9:00	9:15	43	0	0	**43**	20	0	0	**20**	1	0	0	0	**64**	432

Time		Movement 1 Oxley Hwy - eastbound (towards Pt Macq)				Movement 2 Oxley Hwy - westbound (towards				Move 3	4	5	6	Total	
		LV	Bus	HV	Total	LV	Bus	HV	Total						
15:00	15:15	24	0	0	**24**	31	0	0	**31**	1	4	5	1	**66**	
15:15	15:30	96	2	1	**99**	49	1	0	**50**	4	1	4	0	**158**	
15:30	15:45	72	1	0	**73**	33	4	0	**37**	3	0	1	2	**116**	
15:45	16:00	48	5	0	**53**	29	1	0	**30**	2	0	1	1	**87**	427
16:00	16:15	37	0	0	**37**	36	3	0	**39**	2	2	2	2	**84**	**445**
16:15	16:30	43	0	0	**43**	26	0	0	**26**	1	0	1	0	**71**	358
16:30	16:45	37	0	0	**37**	35	0	0	**35**	0	0	1	0	**73**	315
16:45	17:00	24	1	0	**25**	25	0	0	**25**	2	0	4	0	**56**	284



Appendix C
Estimated Traffic Generation from Area 13 Precincts

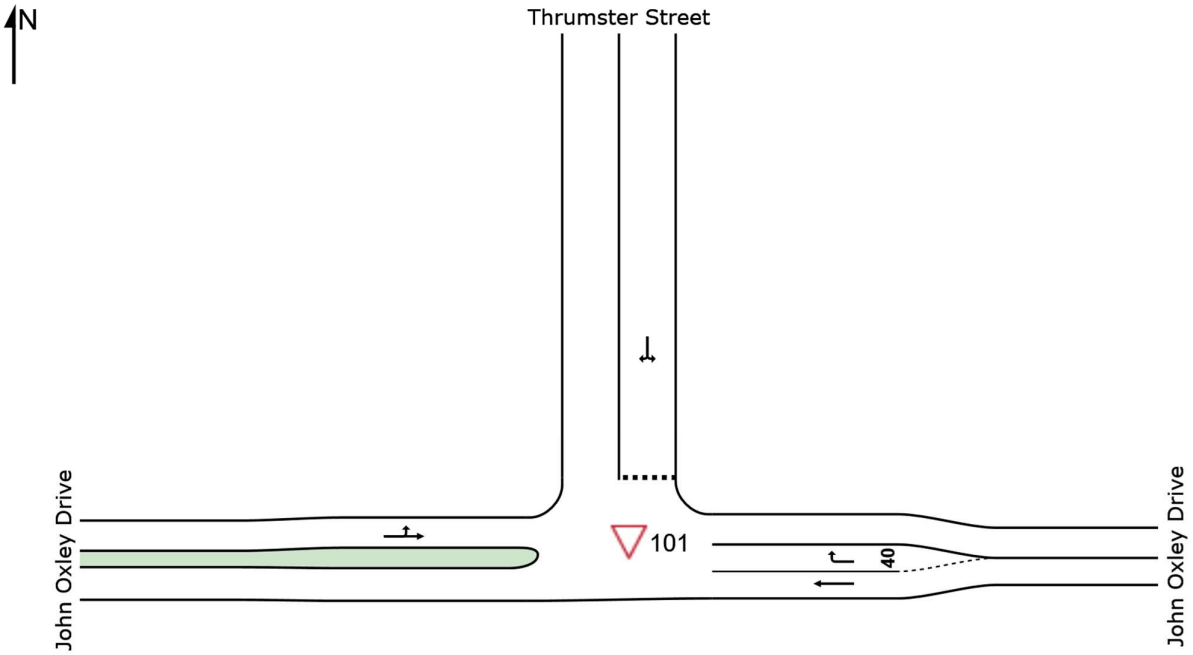
Site No	Location/Precinct	Landuse	Corridor Model			Traffic Generation				Comments	Uptake								
											2018			2026			2031		
												Daily	Peak Hr		Daily	Peak Hr		Daily	Peak Hr
			Dwellings	GFA (m2)	Units	Rate	per	Daily	Pk Hr										
	North Oxley																		
1	Gateway	Residential	42			7	Dwelling	294	42		50%	147	21	100%	294	42	100%	294	42
2	Vaughan	Residential	51			7	Dwelling	357	51		50%	179	26	100%	357	51	100%	357	51
3	College Rise (Sovereign Views)	Residential	291			7	Dwelling	2037	291		30%	611	87	50%	1019	146	100%	2037	291
	Racecourse	Residential	51			7	Dwelling	357	51	Now playing fields		*937*	*134*		*1670*	*239*		*2688*	*384*
	Barton Ridge West	Residential	329			7	Dwelling	2303	329	Now covered in site 6 and 7									
4	Barton Ridge East	Aged Care			160	2	Unit	320	32		25%	80	8	50%	160	16	100%	320	32
5	Barton Ridge East - Res	Residential	256			7	Dwelling	1792	256	Large lots in core Koala Habitat	25%	448	64	50%	896	128	100%	1792	256
6	Barton Ridge West (Stages 1-2)	Residential	92			7	Dwelling	644	92	Complete	80%	515	74	Complete			Complete		
7	Barton Ridge West (Barton Heights)	Residential	93			7	Dwelling	651	93	Not due until town centre developed				0%			100%	651	93
												1043	*146*		*1056*	*144*		*2763*	*381*
								8755	1237						2726	383		5451	765
	Partridge Creek Residential																		
8	Area 1 - Res	Residential	74			7	Dwelling	518	74					Subject of this TIA					
9	Area 2 - Res	Residential	680			7	Dwelling	4760	680										
	Area 3 - Res	Residential	58			7	Dwelling	406	58										
								5684	812										
	Partridge Creek Industrial																		
	Industrial	Industrial		175,000		6	100sq m	8750	1750					0%	0		50%	4375	875
10																			
								8750	1750									4375	875
	West Lindfield																		
11	Area 1 - Ind	Industrial		71,000		6	100sq m	3550	710	See comments in text regarding industrial land				0%			50%	1775	355
	Area 2a - Res	Residential	690			7		4830	690					0%			0%	0	0
	Area 3 - Res	Residential	235			7		1645	235					0%			0%	0	0
								10025	1635									1775	355
	Greater Sancrox																		
	Residential	Residential	1143			7	Dwell	8001	1143	Not zoned				Suggest this will be covered in background traffic calculations					
	Office	Office		7,600		10	100sq m	760	152	part of industrial?									
12	Macquarie Park Stage 1 and 2	Industrial		12,313		6	100sq m	616	123	See comments in text regarding indutrial land									
13	Macquarie Park residual land (Stg 3 to 6)	Industrial		8775		6	100sq m	439	88	See comments in text regarding indutrial land									
14	Sancrox West	Industrial		48,750		6	100sq m	2438	488	See comments in text regarding indutrial land									
	Industrial	Industrial		395,800		6	100sq m	19790	3958	See comments in text regarding indutrial land									
								32043	5951										
	South Oxley																		
	Area 1 - Res	Residential	610			7	Dwell	4270	610	Covered under sites 15 to 22 below									
	Area 2 - Res	Residential	250			7	Dwell	1750	250	Covered under sites 15 to 22 below									
	Area 3 - Res	Residential	460			7	Dwell	3220	460	Covered under sites 15 to 22 below									
15	Stirling Green	Residential	378			7	Dwell	2646	378		30%	794	113	100%	2646	378	100%	2646	378
16	Stirling Green - Neighbourhood centre (zoning B1)	Commercial		1400		121	100sq m	1694	175	Small scale retail (B4) Stirling Green	50%	847	88	100%	1694	175	100%	1694	175
17	Stirling Green - Stage 1C	Residential	68			7	Dwell	476	68		50%	238	34	100%	476	68	100%	476	68
18	Stirling Green - Residual (under Transgrid)	Residential	89			7	Dwell	623	89		50%	312	27	50%	312	45	100%	623	89
19	The Heritage	Residential	508			7	Dwell	3556	508		0%			100%	3556	508	100%	3556	508
21	SOX East	Residential	220			7	Dwell	1540	220		0%			50%	770	110	100%	1540	220
22	SOX East - South	Residential	25			7	Dwell	175	25		0%			0%	0	0	0%	0	0
								10710	1085			2190	262		9454	1284		10535	1438
	Thrumster Town Centre																		
23	Office	Office		16072		10	100sq m	1607	321	Office space may be viable 2025 to 2031				0%	0	0	20%		
	Industrial	Industrial		6888		6	100sq m	344	69					0%	0	0	0%	0	0
	Residential (sq m)	Residential	6,468			7	Dwell	45276	6468					0%	0	0	0%	0	0
24	Shopping Centre	Commercial		14592		78	100sq m	11382	1824	Commence with 1,800 sqm in 2019				20%	2276	365	25%	2845	456
	Tavern	Tavern		1000		0	1sq m	400	80	11am - 11pm i.e. PM peak only				0%	0	0	0%	0	0
	Cinema	Cinema	300		Seats	3	seat	750	75					0%	0	0	0%	0	0
	Library	Library		600		40	100sq m	240	48	Community Library at 1,250 lots				0%	0	0	0%	0	0
	Bulky Goods Retail	Bulky Goods		4480		8	100sq m	224	45					0%	0	0	0%	0	0
25	Hardware	Hardware		800		121	100sq m	968	100					0%	0	0	100%	968	100
								13964	2172						*2276*	*365*		*3813*	*556*
	John Oxley Drive Precinct									See text regarding inclusion in The Heritage TIA									
	18 John Oxley Drive - hardware	Hardware		13457										Suggest this will be covered in background traffic calculations					
	18 John Oxley Drive - bulky goods	Bulky Goods		6228		8	100sq m	311	62										
	Charles Sturt University - 2000 students	University			2000	1.8	Student	3600	720										
	Sienna Grange	Residential	40			7	Dwell	280	40										
	Lake Innes Shopping Village	Commercial		1060		121	100sq m	1282.6	133										
	John Oxley Drive Precinct 1	Industrial		10000		6	100sq m	500	100										
	John Oxley Drive Precinct 2	Residential	80			7	Dwell	560	80										
	John Oxley Drive Precinct 3	Residential	80			7	Dwell	560	80										
								7094	1215										
	Highfield Circuit Precinct									See text regarding inclusion in The Heritage TIA									
	6 Highfield Circuit - 32 x 2 bed units and 8 x 1 bd	Residential	72	Bdrms		2.5	bedrm	180	18					Not applicable					
	8 Highfield Circuit	Residential	2,000	sqm		4	100sq m	80	8										
	4 Highfield Circuit - 79 x 1 bed units	Residential	79	1 bdrm		2.5	bedrm	198	20										
	12 Highfield Circuit	Medical		430	sqm	0.4	sq m	172	17										
	2 Wrights Road - res units	Residential	23	Units		2.5	bedrm	58	6										
	Medical	Medical		2500	sqm	0.4	sq m	1000	100										
	Commercial	Commercial		2500	sqm	121	100sq m	3025	313										
	Residential units	Residential	300	1 bdrm		2.5	bedrm	750	75										
	Base Hospital Mental Health	Medical		1200	sqm	0.4	sq m	480	48										
								5942	604										
	Kingfisher Road Precinct									See text regarding inclusion in The Heritage TIA									
	Student Accomodation - 500 rooms	Residential	500	1 bdrm		2.5	bedrm	1250	125					Not applicable					
	Commercial	Commercial		2000	sqm	121	100sq m	2420	250										
	Residential - 80 x 1 bdrm	Residential	80	1 bdrm		2.5	bedrm	200	20										
								3870	395										
	L'Estrange Industrial Land																		
	Industrial Land	Industrial		13480		6	100sq m	674	135					50%	337	67	75%	506	101
26								674	135										

Appendix D
SIDRA Traffic Modelling Results

SITE LAYOUT

Site: 101 [Thrumster Street/JOD - 2018 AM Base T-intersection]

New Site
Giveway / Yield (Two-Way)



MOVEMENT SUMMARY

Site: 101 [Thrumster Street/JOD - 2018 AM Base T-intersection]

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	164	3.7	0.086	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
6	R2	4	0.0	0.003	8.0	LOS A	0.0	0.1	0.38	0.57	53.5
Approach		168	3.6	0.086	0.2	NA	0.0	0.1	0.01	0.01	79.0
North: Thrumster Street											
7	L2	11	0.0	0.014	5.6	LOS A	0.1	0.4	0.40	0.55	52.9
9	R2	3	0.0	0.014	7.7	LOS A	0.1	0.4	0.40	0.55	53.0
Approach		14	0.0	0.014	6.0	LOS A	0.1	0.4	0.40	0.55	53.0
West: John Oxley Drive											
10	L2	1	0.0	0.162	7.0	LOS A	0.0	0.0	0.00	0.00	74.6
11	T1	312	4.8	0.162	0.0	LOS A	0.0	0.0	0.00	0.00	79.9
Approach		313	4.8	0.162	0.0	NA	0.0	0.0	0.00	0.00	79.9
All Vehicles		495	4.2	0.162	0.3	NA	0.1	0.4	0.01	0.02	78.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

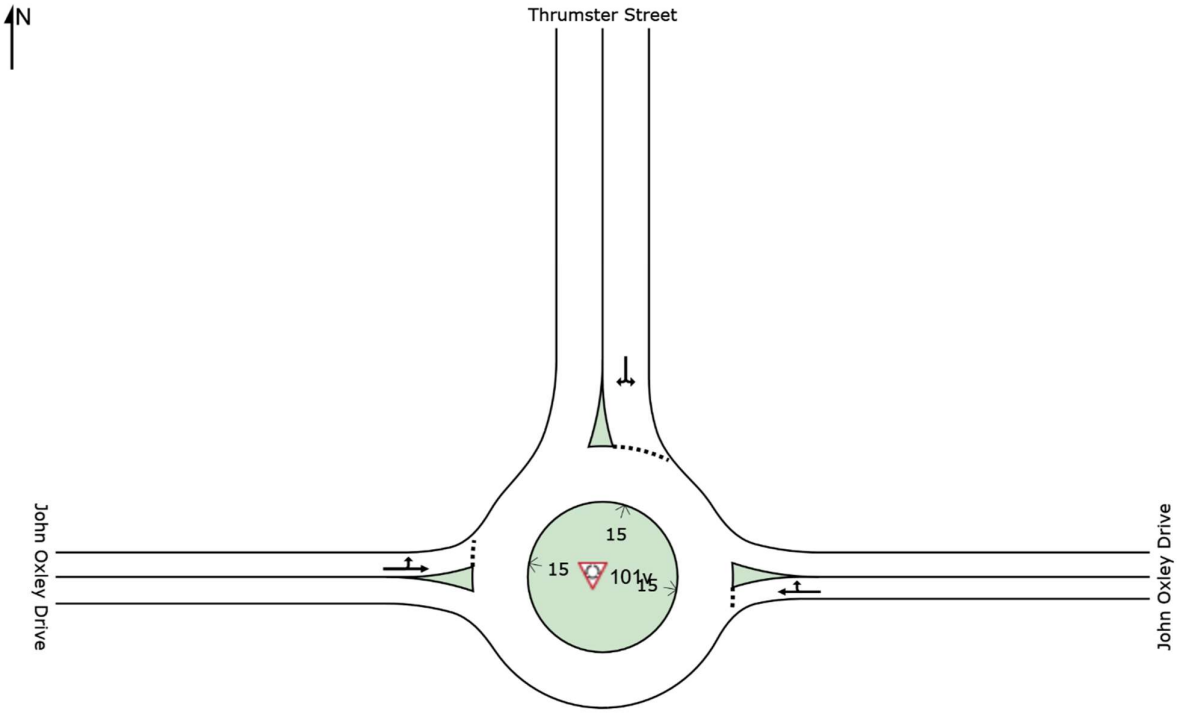
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

Site: 101v [Thrumster Street/JOD - 2018 AM Base 1-lane Roundabout]

New Site
Roundabout



MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2018 AM Base 1-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

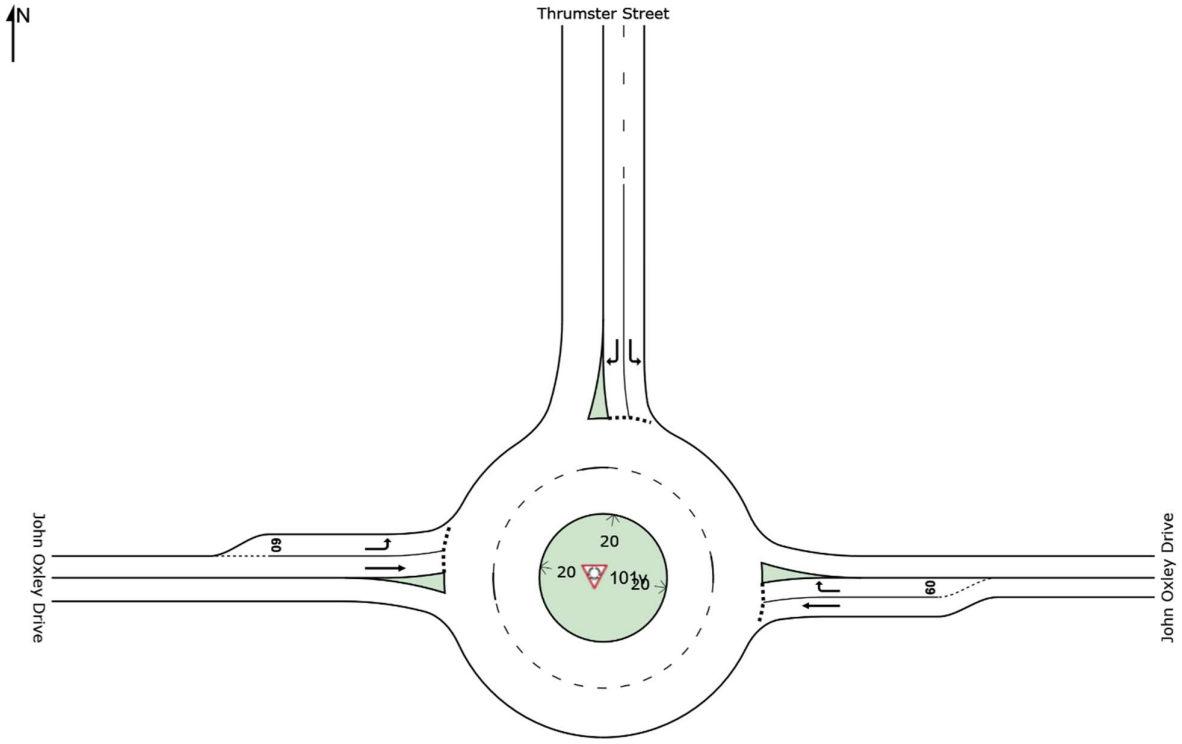
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	164	3.7	0.104	6.3	LOS A	0.6	4.6	0.04	0.53	66.4
6	R2	4	0.0	0.104	10.1	LOS A	0.6	4.6	0.04	0.53	56.6
Approach		168	3.6	0.104	6.4	LOS A	0.6	4.6	0.04	0.53	66.2
North: Thrumster Street											
7	L2	11	0.0	0.012	4.1	LOS A	0.0	0.2	0.27	0.53	53.7
9	R2	3	0.0	0.012	7.8	LOS A	0.0	0.2	0.27	0.53	54.5
Approach		14	0.0	0.012	4.9	LOS A	0.0	0.2	0.27	0.53	53.9
West: John Oxley Drive											
10	L2	1	0.0	0.193	5.7	LOS A	1.1	8.0	0.04	0.52	55.4
11	T1	312	4.8	0.193	6.4	LOS A	1.1	8.0	0.04	0.52	66.2
Approach		313	4.8	0.193	6.4	LOS A	1.1	8.0	0.04	0.52	66.1
All Vehicles		495	4.2	0.193	6.3	LOS A	1.1	8.0	0.05	0.53	65.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

SITE LAYOUT

Site: 101v [Thrumster Street/JOD - 2018 AM Base 2-lane Roundabout]

New Site
Roundabout



MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2018 AM Base 2-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	164	3.7	0.097	6.4	LOS A	0.5	3.9	0.03	0.50	67.8
6	R2	4	0.0	0.004	11.0	LOS A	0.0	0.1	0.04	0.68	54.6
Approach		168	3.6	0.097	6.6	LOS A	0.5	3.9	0.03	0.50	67.4
North: Thrumster Street											
7	L2	11	0.0	0.009	4.2	LOS A	0.0	0.3	0.39	0.45	54.7
9	R2	3	0.0	0.004	9.4	LOS A	0.0	0.1	0.44	0.58	51.9
Approach		14	0.0	0.009	5.3	LOS A	0.0	0.3	0.40	0.48	54.0
West: John Oxley Drive											
10	L2	1	0.0	0.001	5.9	LOS A	0.0	0.0	0.04	0.55	56.1
11	T1	312	4.8	0.184	6.5	LOS A	0.9	6.2	0.03	0.50	67.5
Approach		313	4.8	0.184	6.5	LOS A	0.9	6.2	0.03	0.50	67.4
All Vehicles		495	4.2	0.184	6.5	LOS A	0.9	6.2	0.04	0.50	67.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Thrumster Street/JOD - 2018 PM Base T-intersection]

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	156	5.8	0.083	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
6	R2	8	0.0	0.006	7.8	LOS A	0.0	0.2	0.35	0.57	53.6
Approach		164	5.5	0.083	0.4	NA	0.0	0.2	0.02	0.03	78.1
North: Thrumster Street											
7	L2	11	0.0	0.013	5.4	LOS A	0.0	0.3	0.36	0.54	53.0
9	R2	3	0.0	0.013	7.2	LOS A	0.0	0.3	0.36	0.54	53.2
Approach		14	0.0	0.013	5.8	LOS A	0.0	0.3	0.36	0.54	53.1
West: John Oxley Drive											
10	L2	5	0.0	0.137	7.0	LOS A	0.0	0.0	0.00	0.01	74.4
11	T1	262	3.4	0.137	0.0	LOS A	0.0	0.0	0.00	0.01	79.7
Approach		267	3.4	0.137	0.1	NA	0.0	0.0	0.00	0.01	79.6
All Vehicles		445	4.0	0.137	0.4	NA	0.0	0.3	0.02	0.03	77.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2018 PM Base 1-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	156	5.8	0.102	6.4	LOS A	0.6	4.5	0.04	0.54	65.7
6	R2	8	0.0	0.102	10.1	LOS A	0.6	4.5	0.04	0.54	56.5
Approach		164	5.5	0.102	6.6	LOS A	0.6	4.5	0.04	0.54	65.2
North: Thrumster Street											
7	L2	11	0.0	0.012	4.0	LOS A	0.0	0.2	0.24	0.52	53.8
9	R2	3	0.0	0.012	7.6	LOS A	0.0	0.2	0.24	0.52	54.6
Approach		14	0.0	0.012	4.8	LOS A	0.0	0.2	0.24	0.52	53.9
West: John Oxley Drive											
10	L2	5	0.0	0.169	5.7	LOS A	0.9	6.8	0.06	0.52	55.3
11	T1	262	3.4	0.169	6.4	LOS A	0.9	6.8	0.06	0.52	66.5
Approach		267	3.4	0.169	6.4	LOS A	0.9	6.8	0.06	0.52	66.2
All Vehicles		445	4.0	0.169	6.4	LOS A	0.9	6.8	0.06	0.53	65.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2018 PM Base 2-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	156	5.8	0.093	6.5	LOS A	0.5	3.7	0.03	0.50	67.2
6	R2	8	0.0	0.008	11.0	LOS A	0.0	0.3	0.04	0.69	54.6
Approach		164	5.5	0.093	6.7	LOS A	0.5	3.7	0.03	0.51	66.4
North: Thrumster Street											
7	L2	11	0.0	0.009	4.0	LOS A	0.0	0.3	0.35	0.44	54.8
9	R2	3	0.0	0.004	9.1	LOS A	0.0	0.1	0.41	0.58	52.1
Approach		14	0.0	0.009	5.1	LOS A	0.0	0.3	0.36	0.47	54.1
West: John Oxley Drive											
10	L2	5	0.0	0.005	5.9	LOS A	0.0	0.1	0.06	0.55	56.0
11	T1	262	3.4	0.158	6.4	LOS A	0.7	5.2	0.05	0.50	67.7
Approach		267	3.4	0.158	6.4	LOS A	0.7	5.2	0.05	0.50	67.5
All Vehicles		445	4.0	0.158	6.5	LOS A	0.7	5.2	0.05	0.50	66.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Thrumster Street/JOD - 2026 AM Half-Dev T-intersection]

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	480	3.7	0.252	0.0	LOS A	0.0	0.0	0.00	0.00	79.9
6	R2	145	0.0	0.319	16.4	LOS B	1.3	9.2	0.81	0.97	48.1
Approach		625	2.8	0.319	3.8	NA	1.3	9.2	0.19	0.22	69.3
North: Thrumster Street											
7	L2	130	0.0	1.698	655.6	LOS F	73.6	515.0	1.00	5.37	4.9
9	R2	130	0.0	1.698	680.5	LOS F	73.6	515.0	1.00	5.37	4.9
Approach		260	0.0	1.698	668.1	LOS F	73.6	515.0	1.00	5.37	4.9
West: John Oxley Drive											
10	L2	145	0.0	0.519	7.0	LOS A	0.0	0.0	0.00	0.09	72.9
11	T1	855	4.8	0.519	0.1	LOS A	0.0	0.0	0.00	0.09	77.9
Approach		1000	4.1	0.519	1.1	NA	0.0	0.0	0.00	0.09	77.1
All Vehicles		1885	3.1	1.698	94.0	NA	73.6	515.0	0.20	0.86	25.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2026 AM Half-Dev 1-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	480	3.7	0.517	7.6	LOS A	5.2	37.4	0.57	0.59	62.7
6	R2	145	0.0	0.517	11.3	LOS A	5.2	37.4	0.57	0.59	53.9
Approach		625	2.8	0.517	8.4	LOS A	5.2	37.4	0.57	0.59	60.4
North: Thrumster Street											
7	L2	130	0.0	0.425	8.6	LOS A	3.0	21.3	0.87	0.96	49.8
9	R2	130	0.0	0.425	12.3	LOS A	3.0	21.3	0.87	0.96	50.6
Approach		260	0.0	0.425	10.4	LOS A	3.0	21.3	0.87	0.96	50.2
West: John Oxley Drive											
10	L2	145	0.0	0.808	8.1	LOS A	12.4	89.9	0.85	0.63	52.1
11	T1	855	4.8	0.808	8.9	LOS A	12.4	89.9	0.85	0.63	61.6
Approach		1000	4.1	0.808	8.8	LOS A	12.4	89.9	0.85	0.63	60.1
All Vehicles		1885	3.1	0.808	8.9	LOS A	12.4	89.9	0.76	0.66	58.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2026 AM Half-Dev 2-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	480	3.7	0.364	7.1	LOS A	2.7	19.8	0.41	0.53	65.1
6	R2	145	0.0	0.166	12.1	LOS A	0.9	6.6	0.39	0.66	53.3
Approach		625	2.8	0.364	8.3	LOS A	2.7	19.8	0.41	0.56	61.9
North: Thrumster Street											
7	L2	130	0.0	0.193	8.4	LOS A	1.3	9.1	0.82	0.80	51.8
9	R2	130	0.0	0.222	13.5	LOS A	1.4	10.0	0.83	0.87	49.2
Approach		260	0.0	0.222	10.9	LOS A	1.4	10.0	0.82	0.83	50.4
West: John Oxley Drive											
10	L2	145	0.0	0.177	7.1	LOS A	0.9	6.0	0.36	0.59	54.9
11	T1	855	4.8	0.627	7.5	LOS A	5.6	41.0	0.51	0.56	64.1
Approach		1000	4.1	0.627	7.4	LOS A	5.6	41.0	0.49	0.56	62.6
All Vehicles		1885	3.1	0.627	8.2	LOS A	5.6	41.0	0.51	0.60	60.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Thrumster Street/JOD - 2026 PM Half-Dev T-intersection]

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	850	5.8	0.452	0.1	LOS A	0.0	0.0	0.00	0.00	79.8
6	R2	130	0.0	0.167	10.9	LOS A	0.7	4.7	0.62	0.86	51.8
Approach		980	5.0	0.452	1.5	NA	0.7	4.7	0.08	0.11	74.4
North: Thrumster Street											
7	L2	145	0.0	2.031	953.0	LOS F	99.9	699.0	1.00	6.41	3.5
9	R2	145	0.0	2.031	979.1	LOS F	99.9	699.0	1.00	6.41	3.5
Approach		290	0.0	2.031	966.1	LOS F	99.9	699.0	1.00	6.41	3.5
West: John Oxley Drive											
10	L2	130	0.0	0.374	7.0	LOS A	0.0	0.0	0.00	0.12	72.7
11	T1	595	3.4	0.374	0.1	LOS A	0.0	0.0	0.00	0.12	77.7
Approach		725	2.8	0.374	1.3	NA	0.0	0.0	0.00	0.12	76.7
All Vehicles		1995	3.5	2.031	141.6	NA	99.9	699.0	0.19	1.03	18.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2026 PM Half-Dev 1-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	850	5.8	0.808	9.2	LOS A	13.1	95.4	0.90	0.63	60.7
6	R2	130	0.0	0.808	12.8	LOS A	13.1	95.4	0.90	0.63	52.7
Approach		980	5.0	0.808	9.7	LOS A	13.1	95.4	0.90	0.63	59.5
North: Thrumster Street											
7	L2	145	0.0	0.319	5.7	LOS A	1.7	11.8	0.61	0.77	51.9
9	R2	145	0.0	0.319	9.3	LOS A	1.7	11.8	0.61	0.77	52.7
Approach		290	0.0	0.319	7.5	LOS A	1.7	11.8	0.61	0.77	52.3
West: John Oxley Drive											
10	L2	130	0.0	0.588	6.9	LOS A	6.3	44.8	0.59	0.57	53.2
11	T1	595	3.4	0.588	7.6	LOS A	6.3	44.8	0.59	0.57	63.5
Approach		725	2.8	0.588	7.5	LOS A	6.3	44.8	0.59	0.57	61.3
All Vehicles		1995	3.5	0.808	8.6	LOS A	13.1	95.4	0.74	0.63	58.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2026 PM Half-Dev 2-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	850	5.8	0.641	7.7	LOS A	6.7	48.9	0.59	0.57	63.4
6	R2	130	0.0	0.164	12.4	LOS A	0.9	6.2	0.40	0.67	53.3
Approach		980	5.0	0.641	8.3	LOS A	6.7	48.9	0.56	0.58	61.8
North: Thrumster Street											
7	L2	145	0.0	0.159	6.0	LOS A	0.9	6.5	0.64	0.66	53.7
9	R2	145	0.0	0.176	10.6	LOS A	1.0	7.0	0.65	0.76	51.1
Approach		290	0.0	0.176	8.3	LOS A	1.0	7.0	0.65	0.71	52.3
West: John Oxley Drive											
10	L2	130	0.0	0.157	7.0	LOS A	0.7	5.2	0.34	0.58	55.0
11	T1	595	3.4	0.434	7.1	LOS A	3.0	21.5	0.37	0.53	65.4
Approach		725	2.8	0.434	7.1	LOS A	3.0	21.5	0.37	0.54	63.3
All Vehicles		1995	3.5	0.641	7.9	LOS A	6.7	48.9	0.50	0.59	60.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Thrumster Street/JOD - 2031 AM Full-Dev T-intersection]

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	840	3.7	1.119	205.7	LOS F	135.3	976.5	1.00	0.00	14.4
6	R2	205	0.0	1.220	260.2	LOS F	29.0	203.1	1.00	2.51	11.3
Approach		1045	2.9	1.220	216.4	NA	135.3	976.5	1.00	0.49	13.7
North: Thrumster Street											
7	L2	170	0.0	18.509	15801.1	LOS F	269.2	1884.6	1.00	2.57	0.2
9	R2	210	0.0	18.509	15815.7	LOS F	269.2	1884.6	1.00	2.57	0.2
Approach		380	0.0	18.509	15809.1	LOS F	269.2	1884.6	1.00	2.57	0.2
West: John Oxley Drive											
10	L2	240	0.0	0.695	7.1	LOS A	0.0	0.0	0.00	0.12	72.3
11	T1	1097	4.8	0.695	0.2	LOS A	0.0	0.0	0.00	0.12	77.2
Approach		1337	3.9	0.695	1.4	NA	0.0	0.0	0.00	0.12	76.3
All Vehicles		2762	3.0	18.509	2257.6	NA	269.2	1884.6	0.52	0.60	1.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2031 AM Full-Dev 1-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	840	3.7	0.952	24.1	LOS B	34.7	248.9	1.00	1.00	50.1
6	R2	205	0.0	0.952	27.7	LOS B	34.7	248.9	1.00	1.00	44.3
Approach		1045	2.9	0.952	24.8	LOS B	34.7	248.9	1.00	1.00	48.8
North: Thrumster Street											
7	L2	170	0.0	0.757	19.2	LOS B	8.4	59.0	1.00	1.22	43.5
9	R2	210	0.0	0.757	22.9	LOS B	8.4	59.0	1.00	1.22	44.1
Approach		380	0.0	0.757	21.2	LOS B	8.4	59.0	1.00	1.22	43.8
West: John Oxley Drive											
10	L2	240	0.0	1.178	174.6	LOS F	160.1	1158.5	1.00	3.05	15.6
11	T1	1097	4.8	1.178	175.4	LOS F	160.1	1158.5	1.00	3.05	16.4
Approach		1337	3.9	1.178	175.3	LOS F	160.1	1158.5	1.00	3.05	16.2
All Vehicles		2762	3.0	1.178	97.1	LOS F	160.1	1158.5	1.00	2.02	24.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2031 AM Full-Dev 2-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	840	3.7	0.689	8.4	LOS A	7.8	56.6	0.76	0.65	62.8
6	R2	205	0.0	0.283	13.2	LOS A	1.7	12.2	0.55	0.73	52.8
Approach		1045	2.9	0.689	9.3	LOS A	7.8	56.6	0.72	0.67	60.5
North: Thrumster Street											
7	L2	170	0.0	0.543	21.8	LOS B	4.7	32.7	1.00	1.12	43.5
9	R2	210	0.0	0.545	23.9	LOS B	5.2	36.7	1.00	1.12	43.3
Approach		380	0.0	0.545	23.0	LOS B	5.2	36.7	1.00	1.12	43.4
West: John Oxley Drive											
10	L2	240	0.0	0.313	7.9	LOS A	1.7	12.1	0.49	0.66	54.5
11	T1	1097	4.8	0.853	10.9	LOS A	15.0	109.1	0.90	0.74	61.6
Approach		1337	3.9	0.853	10.3	LOS A	15.0	109.1	0.82	0.72	60.2
All Vehicles		2762	3.0	0.853	11.7	LOS A	15.0	109.1	0.81	0.76	57.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Thrumster Street/JOD - 2031 PM Full-Dev T-intersection]

New Site
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	1056	5.8	0.562	0.1	LOS A	0.0	0.0	0.00	0.00	79.6
6	R2	170	0.0	0.352	16.2	LOS B	1.5	10.7	0.81	0.97	48.2
Approach		1226	5.0	0.562	2.3	NA	1.5	10.7	0.11	0.14	73.0
North: Thrumster Street											
7	L2	205	0.0	11.146	9160.3	LOS F	281.8	1972.7	1.00	4.03	0.4
9	R2	240	0.0	11.146	9174.2	LOS F	281.8	1972.7	1.00	4.03	0.4
Approach		445	0.0	11.146	9167.8	LOS F	281.8	1972.7	1.00	4.03	0.4
West: John Oxley Drive											
10	L2	210	0.0	0.506	7.0	LOS A	0.0	0.0	0.00	0.14	72.2
11	T1	770	3.4	0.506	0.1	LOS A	0.0	0.0	0.00	0.14	77.1
Approach		980	2.7	0.506	1.6	NA	0.0	0.0	0.00	0.14	76.0
All Vehicles		2651	3.3	11.146	1540.6	NA	281.8	1972.7	0.22	0.79	2.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2031 PM Full-Dev 1-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	1056	5.8	1.163	165.2	LOS F	140.6	1025.8	1.00	3.09	17.1
6	R2	170	0.0	1.163	168.7	LOS F	140.6	1025.8	1.00	3.09	16.4
Approach		1226	5.0	1.163	165.7	LOS F	140.6	1025.8	1.00	3.09	17.0
North: Thrumster Street											
7	L2	205	0.0	0.652	10.7	LOS A	6.1	42.5	0.93	1.09	48.4
9	R2	240	0.0	0.652	14.3	LOS A	6.1	42.5	0.93	1.09	49.1
Approach		445	0.0	0.652	12.7	LOS A	6.1	42.5	0.93	1.09	48.8
West: John Oxley Drive											
10	L2	210	0.0	0.803	8.0	LOS A	12.8	91.7	0.90	0.63	52.1
11	T1	770	3.4	0.803	8.7	LOS A	12.8	91.7	0.90	0.63	61.9
Approach		980	2.7	0.803	8.5	LOS A	12.8	91.7	0.90	0.63	59.5
All Vehicles		2651	3.3	1.163	81.9	LOS F	140.6	1025.8	0.95	1.84	27.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101v [Thrumster Street/JOD - 2031 PM Full-Dev 2-lane Roundabout]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: John Oxley Drive											
5	T1	1056	5.8	0.887	14.2	LOS A	19.8	145.6	1.00	0.86	59.1
6	R2	170	0.0	0.240	13.4	LOS A	1.4	9.6	0.54	0.74	52.8
Approach		1226	5.0	0.887	14.1	LOS A	19.8	145.6	0.94	0.85	58.2
North: Thrumster Street											
7	L2	205	0.0	0.322	8.5	LOS A	2.1	14.7	0.82	0.85	51.7
9	R2	240	0.0	0.323	12.1	LOS A	2.2	15.7	0.82	0.86	50.1
Approach		445	0.0	0.323	10.5	LOS A	2.2	15.7	0.82	0.85	50.8
West: John Oxley Drive											
10	L2	210	0.0	0.254	7.3	LOS A	1.4	9.5	0.42	0.62	54.7
11	T1	770	3.4	0.583	7.5	LOS A	5.0	35.9	0.53	0.58	64.4
Approach		980	2.7	0.583	7.5	LOS A	5.0	35.9	0.50	0.58	62.1
All Vehicles		2651	3.3	0.887	11.1	LOS A	19.8	145.6	0.76	0.75	58.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.