Department of Transport and Main Roads

Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Job No. 232/10A/7, Invitation No. WBYD-1335 EPBC Act Referral

April 2017

GHD

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Appendices

1. Summary of proposed action

NOTE: You must also attach a map/plan(s) and associated geographic information system (GIS) vector (shapefile) dataset showing the location and approximate boundaries of the area in which the project is to occur. Maps in A4 size are preferred. You must also attach a map(s)/plan(s) showing the location and boundaries of the project area in respect to any features identified in 3.1 & 3.2, as well as the extent of any freehold, leasehold or other tenure identified in 3.3(i).

1.1 Short description

Use 2 or 3 sentences to uniquely identify the proposed action and its location.

The Department of Transport and Main Roads (TMR) proposes to upgrade and realign 26 km of the Bruce Highway (requiring construction of 30 km of new highway and tie-in works), including a bypass to the east of Gympie, Queensland. This project, titled the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project, is the fourth and final section of a 62 km upgrade of the Bruce Highway between Cooroy and Curra. This highway upgrade is one of Queensland's high priority road projects, providing an effective transport link as part of the national highway network and improved safety and flood immunity (Queensland Government, 2012).

The Section D: Woondum to Curra project (herein referred to as 'the project'), has been separated into two Contracts. The southern extent, Contract 1, extends from Woondum at the connection to the Section C project (approximately 10 km south of Gympie). The northern extent, Contract 2, includes the Curra Interchange that connects the realigned highway to the existing Bruce Highway at Curra (approximately 18 km north of Gympie). The division of this project into Contract 1 and Contract 2 is an administrative requirement to assist in the future management of contractual risks inherent with such a large project. Both contracts are being referred as a single action under the *Environment and Biodiversity Conservation Act 1999* (EPBC Act).

A locality plan of the project is shown in Appendix A.

1.2 Latitude and longitude

Also attach the associated GIS-compliant file that delineates the proposed referral area. If the area is less than 5 hectares, please provide the location as a point layer. If greater than 5 hectares, please provide a polygon layer. If the proposed action is linear (e.g. a road or pipeline) please provide a polyline layer.

Table 1 provides latitudes and longitudes for a 430 ha area encompassing the highway corridor and associated civil, drainage and complimentary local road works, and is referred to herein as the 'project area'. The project area has been developed based on the following:

- The bottom of embankments (i.e. volume of earthern material that is placed and compacted for the purpose of raising the grade of the roadway above the level of the existing surrounding ground level) plus 25 metres to be cleared of vegetation to provide adequate room for haul routes, light vehicle access, drainage structures, stockpiles and temporary and permanent sediment basins.
- The top of cuttings (i.e. where soil or rock material from a hill or mountain is cut) plus 15 metres to be cleared of vegetation to provide adequate room for drainage structures and light vehicle access tracks.

- Where cuttings are required to be installed on a wider slope, or spoil areas required to dispose of material, additional areas within the footprint has been provided.
- Proposed site office locations as identified in the constructability review.
- Incorporation of areas of cleared agricultural land owned by TMR adjacent to the construction area for the purposes of site laydown, site offices etc.

It is noted that the project area does not encompass all areas required for the relocation or augmentation of existing public utility and plant and material borrow and spoil areas due to the uncertainty around the locations of these items at present. Mitigation measures and environmental outcomes have been incorporated into the project to address the placement of construction features outside the project area, these are discussed in Section 4. The project area has been refined during the Detailed Design phase to avoid impacts to MNES where possible.

A survey area was established during the Business Case phase of the project for the purposes of conducting terrestrial flora, terrestrial fauna and aquatic ecology surveys. The survey area is selected to gain an appreciation of ecological values that are present within and immediately adjacent to the project area; for example, fauna species that may transition through the alignment and vegetation communities that may be fragmented by the project area. The survey area was defined by the project area (as of January 2015), plus a buffer of approximately 50 – 100 m around the alignment, with some broader areas on surrounding properties and additional upstream and downstream extents within waterways or within adjacent habitats. As a result of the project area being refined further during the Detailed Design phase, some areas of the project area are outside the survey area. However, these areas include only previously cleared agricultural or grazing land due to their useability for construction related purposes (i.e. site laydown, site offies etc.).

The project area and survey area are provided in the locality plan included in Appendix A.

Table 1 Latitude and longitude

Location Point (Chainage, m)	Latitude (decimal degrees)	Longitude (decimal degrees)
133500	-26.27042	152.7154
134500	-26.26201	152.7117
135500	-26.25348	152.7085
136500	-26.24494	152.7052
137500	-26.23613	152.7032
138500	-26.2271	152.703
139500	-26.21809	152.7026
140500	-26.20948	152.6997
141000	-26.20535	152.6977
141500	-26.2009	152.697
142500	-26.19194	152.6959

Location Point (Chainage, m)	Latitude (decimal degrees)	Longitude (decimal degrees)
143500	-26.183	152.6948
144500	-26.17402	152.6941
145500	-26.1657	152.6903
146500	-26.15876	152.6839
147500	-26.15185	152.6775
148500	-26.14313	152.6755
149500	-26.1348	152.6721
150500	-26.12857	152.6649
151000	-26.12573	152.661
151500	-26.12301	152.657
152500	-26.11698	152.6496
153500	-26.10855	152.6462
154500	-26.10034	152.6421
155500	-26.09291	152.6365
156500	-26.08447	152.6329
157500	-26.07634	152.6288
158500	-26.071	152.6208
159500	-26.06623	152.6123
160500	-26.06185	152.6036
161000	-26.06029	152.5989
161500	-26.05874	152.5942
162500	-26.05487	152.5852
163500	-26.04922	152.5774
164500	-26.04212	152.5714

1.3 Locality and property description

Provide a brief physical description of the property on which the proposed action will take place and the project location (e.g. proximity to major towns, or for off-shore projects, shortest distance to mainland).

The project is located in TMR's Wide Bay Burnett Region, within the Gympie Regional Council (GRC) local government area. Land uses within this local government area are predominantly agriculture and residential; however, commercial and industrial land uses occur along the project alignment intermittently. The project area is located between Woondum Road, Woondum (approximately 10 km south of Gympie) and the township of Curra (approximately 18 km north of Gympie). Refer to Appendix A for a locality plan.

1.4 Size of the development footprint of work area

The project area that will contain the final project footprint is approximately 430 ha. The project area may increase or decrease slightly during the final stages of the Detailed Design phase.

1.5 Street address of the site

There is no street address for the project. The area on which the proposed action will be undertaken is located within the Queensland Government's gazetted future state-controlled road corridor, which was gazetted on 11 May 2016.

1.6 Lot description

Describe the lot numbers and title description, if known.

Real property descriptions and land tenure of the properties impacted by the project are listed in Appendix B. The entire project area will be transferred to road reserve prior to construction works commencing.

Provision will be required for native title to be considered for land on which native title has not been extinguished (e.g. unallocated State land or reserve tenure land). While there are no formally recognised native title rights over the project area, GRC local government area is currently subject to active claims. The project area is subject to the Kabi Kabi First Nation Claim (National Native Title Tribunal Ref: QC2013/003, Federal Court Ref: QUD280/2013).

1.7 Local government area and council contact

If the project is subject to local government planning approval, provide the name of the relevant council contact officer.

The project is located within the GRC local government area; however, is not subject to local government approval. Although TMR have consulted widely with GRC with regards to the project, there is no local council contact officer for this project.

1.8 Timeframe

Specify the time frame in which the action will be taken including the estimated start date of construction/operation.

The proposed action does not currently have a scheduled start date, as there is currently no construction funding committed for this project. Once provided, a construction period of five years is anticipated. A scheduled start date for construction is dependent on the provision of funding.

1.9 Alternatives to proposed action

Were any feasible alternatives to taking the proposed action (including not taking the action) considered but are not proposed?

Yes; alternatives to taking the proposed action have been considered and are discussed in Section 2.2.

1.10 Alternative time frames, locations or activities

Does the proposed action include alternative time frames, locations or activities?

Yes; additional locations outside of the current project area may be required and are discussed in Section 2.3.

1.11 State assessment

Is the action subject to a state or territory environmental impact assessment?

No; the proposed action is not currently subject to any State or territory environmental impact assessments. Further information is provided in Section 2.4.

1.12 Component of larger action

Is the proposed action a component of a larger action?

Yes; the proposed action is a component of a larger action. Further information is provided in Section 2.7.

1.13 Related actions/proposals

Is the proposed action related to other actions or proposals in the region (if known)?

Yes; the proposed action is related to other actions or proposals in the region. Further information is provided in Section 2.7.

1.14 Australian Government funding

Has the person proposing to take the action received any Australian Government grant funding to undertake this project?

Yes; the Australian Government has committed funding to undertake the planning and design phases of the project and commence landowner acquisition negotiations.

1.15 Great Barrier Reef Marine Park

Is the proposed action inside the Great Barrier Reef Marine Park?

The proposed action is not located inside the Great Barrier Reef Marine Park.

2. Detailed description of proposed action

NOTE: It is important that the description is complete and includes all components and activities associated with the action. If certain related components are not intended to be included within the scope of the referral, this should be clearly explained in Section 2.7.

2.1 Description of proposed action

This should be a detailed description outlining all activities and aspects of the proposed action and should reference figures and/or attachments, as appropriate.

2.1.1 Proponent

TMR ABN 39 407 690 291 (the proponent) is seeking approval to construct and operate the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project.

2.1.2 Key elements

The project is the final stage of the Cooroy to Curra Upgrade and provides for a new four lane divided highway from Woondum to Curra, including a bypass of Gympie, Queensland. The new section of highway will have a posted speed limit of 110 km/hr and directional separation from Woondum to Curra; a realigned highway length of 26 km (30 km including tie-in works).

A Southern Contract (Contract 1) will extend from the northern tie in to the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project at Woondum, to approximately 200 m north of Sandy Creek Road. At approximately 12 km in length, the Southern Contract will involve the following key work elements:

- Integration with the Woondum Interchange at the northern extent of the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project
- Provision of new interchanges at Penny Road / Noosa Road and Gympie Connection Road
- Realignment and crossing of local roads via bridges and underpasses to retain local road connectivity
- Provision of bridge crossings at key waterways including Six Mile Creek, Tannery Creek, Deep Creek and Moody Creek (north and south)
- Construction of a new bridge over the existing North Coast Rail Line
- Construction of high embankments and deep cuts to allow for highway construction, including associated drainage infrastructure
- Construction of heavy duty pavements to TMR standard
- Acquisition of land within Woondum State Forest
- Provision of fauna connectivity structures to maintain connectivity across the project, including through the Woondum State Forest
- Inclusion of water quality and spill containment treatments to assist in maintaining water quality
- Permanent waterway diversions of Tannery Creek and Moody Creek (north and south).

A Northern Contract (Contract 2) of approximately 18 km in length will extend from north of Sandy Creek Road to Curra and will involve the following key elements:

- Construction of a new major interchange at the tie in to the existing Bruce Highway at Curra
- Realignment and crossing of local roads via bridges and underpasses to retain local road connectivity
- Construction of multi-span bridges over major waterways including Banks Creek, Tamaree Creek, Upper Curra Creek, Keilher Creek, Curra Creek overflow and Curra Creek north
- Construction of high embankments and deep cuts to allow for highway construction, including associated drainage infrastructure
- Construction of heavy duty pavements to TMR standard
- Acquisition of areas of Curra State Forest
- Construction of fauna connectivity structures through Curra State Forest to maintain connectivity across the project area
- Inclusion of water quality and spill containment treatments to assist in maintaining water quality
- Permanent waterway diversions of Banks Creek, Tamaree Creek and Tamaree Creek tributary.

2.1.3 Alignment

The project area for construction is approximately 30 km in length and is aligned in an approximate north to south direction. The project encompasses an area of 430 ha. The southern extent of the alignment will connect to the northern extent of the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project at Woondum (Ch 134900 m), and the northern extent of the project area will integrate with the existing Bruce Highway north of Curra (Ch 164100 m).

2.1.4 Planning and Design phases

The Business Case phase of the project undertaken by Jacobs commenced in March 2014 and was completed in December 2015.

The Detailed Design phase commenced in March 2016 and is currently being undertaken by GHD. The Detailed Design phase is anticipated to be completed early 2018.

2.1.5 Construction and ancillary activities

During the Construction phase of the project, a significant amount of bulk earthworks will be required along the entire greenfield corridor. Approximately, 5,500,000 m^3 of cut and 5,200,000 m^3 of fill are required for the project. The earthworks will be required for the road formation and construction of related infrastructure. Bulk earthworks is likely to include reusing and or replacing existing material (with treatment as required) to provide for the required subgrade, general fill and structural fill for the road formation. Cut and fill operations will also be required in some areas to achieve the required road grades. Road formation, embankments, and cuttings have been designed to provide the relevant flood immunity applicable to this section of the Bruce Highway.

The new section of highway has been designed to achieve flood immunity during a 1% AEP (including climate change) design storm event and climate change.

Construction activities will also include the following:

- Temporary sediment basins and other erosion and sediment controls
- Erection of fencing
- Vegetation clearing and grubbing
- Drainage channels and permanent waterway diversions
- Drainage structures including placement of culverts
- Bridges over both waterways and local roads
- Haul routes
- Borrow and spoil areas
- Access to construction water sources such as farm dams and/or water bores
- Blasting
- Site offices and laydown/stockpile areas
- Chemical and waste storage areas
- Pavement works
- Ancillary activities such as lighting, public utility and plant and information technology systems
- Landscaping and rehabilitation

2.2 Alternatives to taking the proposed action

This should be a detailed description outlining any feasible alternatives to taking the proposed action (including not taking the action) that were considered but are not proposed (note, this is distinct from any proposed alternatives relating to location, time frames, or activities – see Section 2.3).

The current alignment of the Bruce Highway through Gympie has considerable safety, flooding and capacity issues, and therefore not undertaking the action was not considered.

This existing route is the primary heavy vehicle freight route connecting South Queensland to North Queensland and due to its current geometric deficiencies and an inability to meet future demands, is required to be signed at 90 km/hr north and south of Gympie. The current alignment of the Bruce Highway intersects Gympie at a signed speed of 60 km/hr with numerous signalised intersections causing congestion issues within the city which in turn impacts the functionality and performance of the highway. Upgrading the existing Bruce Highway through Gympie will not address current congestion, safety and flooding issues currently experienced by users.

TMR and the Australian Government commissioned a four-year Bruce Highway Cooroy to Curra Strategic Planning Study (ARUP, 2008) in 2008 to document the outcome of the overall corridor refinement between Cooroy and Curra. During this study, two alternative options were considered in relation to the Section D project which included the following:

- An alternative option was considered for the Gympie Connection Road Interchange, which involved moving the interchange to Tin Can Bay Road, this option was not progressed due to issues associated with flood immunity (ARUP, 2008).
- The alignment in the vicinity of the Curra State Forest was revised based on community feedback indicating the proposed corridor alignment impacted too many private (freehold) properties (ARUP, 2008). The proposed project corridor was shifted to the east, reducing

the number of private (freehold) properties impacted, while still providing acceptable elevation grades and reasonable earthworks construction (ARUP, 2008).

In summary, minor alterations were made during the Business Case phase of the project to reduce environmental impacts, assist in reducing and balancing earthworks and minimising the requirement to acquire freehold properties. These alternatives are summarised in Table 2.

Table 2 Alternative options considered

Location	Description	Benefit	Phase
Interface with Section C project through to Woondum Interchange	The main alignment is approximately 80 m to 100 m further west than the Strategic Planning Study alignment (ARUP, 2008).	Provide beneficial useability.	Business Case
Penny Road interchange	The main alignment is approximately 80 m further west than the Strategic Planning Study alignment (ARUP, 2008) between approximate Ch 138800 m to Ch 141000 m. The preferred option provides a greater distance between the alignment and the tailings dam associated with the Gympie Eldorado Mining activities on Lot 51 on SP286014.	This change minimised earthworks volumes, changes to local road networks, and additional property impacts. This option also represented the lowest construction cost.	Business Case
Southern portion of Curra State Forest	The main alignment was shifted approximately 65 m to the east to avoid impacts on this section of Tamaree Creek. The original alignment directly impacted Tamaree Creek in this location. This change resulted in the toe of the embankment being located approximately 25 m from the top of the bank.	Reduced impacts to Tamaree Creek, avoidance of the requirement to divert approximately 250 m of Tamaree Creek.	Business Case
Tamaree Creek main diversion	The proposed diversion of Tamaree Creek was originally two separate diversion channels which connected to the existing Queensland Rail (QR) diversion. During a pre-lodgement meeting with State regulatory agencies on 15 September 2015, it was recommended that the option of replacing this section of the waterway with a new diversion channel be investigated.	Reduced impacts to Tamaree Creek and aquatic species through one sinuous channel, rather than numerous diversions.	Business Case

Location	Description	Benefit	Phase
	This recommended change was included in the final Business Case design.		
Curra State Forest	The main alignment was shifted approximately 250 m to the west at approximately Ch 159000 m, and affected the alignment between upper Curra Creek and the Curra Creek overflow.	Reduced impacts on remnant vegetation by approximately 20 ha.	Business Case
Embankments on Six Mile Creek floodplain	The embankment included in the Strategic Planning Study alignment (ARUP, 2008) encroached into the Six Mile Creek channel at the meander bend to the south of the North Coast Rail Line. This embankment has been shifted slightly west during the Business Case phase and will be constructed at a steeper grade.	Reduced impacts to Six Mile Creek.	Business Case
Six Mile Creek bridge	The design proposed a super T-girder bridge with 38 m spans. Span widths were increased to the maximum allowable span width of 44 m to reduce instream impacts on the waterway. Construction of a temporary crossing using reinforced concrete pipes and rock or a culvert crossing (as proposed in the Strategic Planning Study (ARUP, 2008)) has been excluded due to environmental impacts, regulatory risks and associated upstream afflux impacts.	Reduced instream impacts to Six Mile Creek.	Business Case
Six Mile Creek bridge	Design review of the bridge over Six Mile Creek resulting in the following: • Individual span widths being rationalised • Raising the deck level by 770 mm to account for the 1% AEP (including climate change) design storm event	Reduced impacts to Six Mile Creek and associated riparian vegetation.	Detailed Design

Location	Description	Benefit	Phase
	• Increased spacing between northbound and southbound bridge structures (to 1360 mm) to allow for increase natural light. • Consideration of specific construction methodologies such as pile structure, timing of construction program, use of a launching truss, use of scaffolding and use of steel casings.		
Curra Creek north diversion	A diversion of up to 100 m of Curra Creek north was considered due to the sinuous nature of the channel adjacent to the main alignment bridge. This diversion was avoided through careful placement of the bridge piers following a site inspection by the Design Team in August 2015.	Eliminated the requirement to permanently divert Curra Creek.	Business Case
Curra Creek bridges	There were four distinct crossings over Curra Creek proposed in the Business Case phase. This has been reduced to 3 crossings during the Detailed Design phase by re-positioning the southbound entry ramp bridge beside the highway bridges.	Reduced the amount of fill around Curra Creek embankment which will reduce the amount of earthworks required around the waterway.	Detailed Design
Banks Creek alternative diversion	An alternative diversion design was considered following a recommendation during a pre-lodgement meeting with the Department of Agriculture and Fisheries (DAF) and Department of Natural Resources and Mines (NRM) on 15 September 2015. The alternative design moved the bridge location approximately 100 m to the south and reduced the length of the diversion and associated impacts on this waterway. An assessment of the potential flooding impacts indicated that this alternative diversion design would introduce unacceptable afflux impacts on properties upstream of the proposed alignment and	Design consideration attempted to reduce impacts to Banks Creek.	Business Case

Location	Description	Benefit	Phase
	outside of the land acquisition required for the project. The original diversion design was retained in the final Business Case design.		
Moody Creek north alternative diversion design	An alternative diversion design was considered following a recommendation during the pre-lodgement meeting. The alternative design moved the proposed diversion location approximately 20 m north to reduce the length of the natural channel impacted by the diversion. A hydraulic assessment suggested that this change increased flow velocity upstream of the alternative diversion design by making the channel more efficient. This design increased the risk of scour adjacent to the North Coast Rail embankment and was excluded from the final Business Case design.	Design consideration attempted to reduce impacts to Moody Creek.	Business Case

2.3 Alternative locations, time frames or activities that form part of the referred action

If you have identified that the proposed action includes alternative time frames, locations or activities (in Section 1.10) you must complete this section. Describe any alternatives related to the physical location of the action, time frames within which the action is to be taken and alternative methods or activities for undertaking the action. For each alternative location, time frame or activity identified, you must also complete (where relevant) the details in Sections 1.2-1.9, 2.4-2.7, 3.3 and 4. Please note, if the action that you propose to take is determined to be a controlled action, any alternative locations, time frames or activities that are identified here may be subject to environmental assessment and a decision on whether to approve the alternative.

The project area that will contain the final project footprint is detailed in Appendix A. As of April 2017 construction funding is yet to be committed however, construction delivery for the project is anticipated to be undertaken by one of the following methods:

- One construction project undertaken by a single Construction Contractor
- Two separate contracts (Contract 1 and Contract 2) delivered simultaneously by two separate Construction Contractors
- Staged construction, Contract 1 delivered first followed by Contract 2

Although the project area has been defined, additional areas adjacent to the project area may be identified during the construction phase as being impacted to facilitate the construction of the project. The additional areas are proposed to be managed by implementing the provisions contained within the Additional Works Code of Compliance document developed for the project, discussed further in Section 4 of this referral. The Additional Works Code of Compliance document outlines the procedures required for managing any clearing of vegetation outside the project area. The aim of the Additional Works Code of Compliance document is twofold:

- To provide clarification to the Construction Contractor of the required procedures when undertaking vegetation clearing outside of the project area
- To manage the clearing of vegetation outside the project area in a manner consistent with the approved documentation developed for the project, including the EPBC Act Referral

2.4 Context planning framework and state/local government requirements

Explain the context in which the action is proposed, including any relevant planning framework at the state and/or local government level (e.g. within scope of a management plan, planning initiative or policy framework). Describe any Commonwealth or state legislation or policies under which approvals are required or will be considered against.

As a State-controlled road project, the project is exempt from assessment against a local government planning scheme under Schedule 4, Table 5, Item 7 of the *Sustainable Planning Regulation 2009*.

Planning and environmental approvals will be obtained in accordance with current Commonwealth and Queensland legislation and policy. State environmental permits, approvals and/or processes applicable to the project include the following:

- Development permit for operational works for constructing or raising waterway barrier works under the *Fisheries Act 1994*
- Water licence to take or interfere with water under the *Water Act 2000*
- Requirements under the *Environmental Offsets Act 2014* and Queensland offsets framework, in particular for State significant biodiversity values
- A Clearing Permit and Impact Management Plan for clearing conservation significant flora species under the *Nature Conservation Act 1992*
- Development of a ‘high risk’ Species Management Program (SMP) under the *Nature Conservation Act 1992*
- General environmental duty to minimise environmental harm under the *Environmental Protection Act 1994*
- Responsibilities to manage contaminated land under the *Environmental Protection Act 1994*
- Cultural heritage management requirements under the *Aboriginal Cultural Heritage Act 2003*
- Revocation of State Forests under the *Forestry Act 1959*

2.5 Environment impact assessments under Commonwealth, state or territory legislation

If you have identified that the proposed action will be or has been subject to a state or territory environmental impact statement (in Section 1.11) you must complete this section. Describe any environmental assessment of the relevant impacts of the project that has been, is being, or will be carried out under state or territory legislation. Specify the type and nature of the assessment, the relevant legislation and the current status of any assessments or approvals. Where possible, provide contact details for the state/territory assessment contact officer.

Describe or summarise any public consultation undertaken, or to be undertaken, during the assessment. Attach copies of relevant assessment documentation and outcomes of public consultations (if available).

Not applicable, the project does not trigger the need for an environmental impact statement under the *State Development and Public Works Organisation Act 1971*, as the Coordinator General has not declared this project a ‘coordinated project’.

The environmental assessment process for the project has followed TMR’s internal assessment process described in the *Technical Manual: Environmental Processes Manual August 2013* (TMR, 2013).

A description of all ecology studies undertaken for the project to date have been listed in Table 3 of this referral. Public consultation undertaken for the project is detailed in Section 2.6 of this referral.

2.6 Public consultation (including with Indigenous stakeholders)

Your referral must include a description of any public consultation that has been, or is being, undertaken. Where Indigenous stakeholders are likely to be affected by your proposed action, your referral should describe any consultations undertaken with Indigenous stakeholders. Identify the relevant stakeholders and the status of consultations at the time of the referral. Where appropriate include copies of documents recording the outcomes of any consultations.

Community consultation was undertaken during the Strategic Planning phase between 2004 and 2008 (ARUP, 2008). Meetings, newsletters, community consultative committees, focus groups and a number of public displays were used during this time to provide information to the community and encourage public comment on the proposed alignment for the highway. In July 2008, the Strategic Planning Study Recommended Corridor Report was released and in September of that year it was endorsed by the Australian Government.

Community consultation during the Strategic Planning phase was a key consideration in identifying the recommended highway alignment for the project.

Consultation during the Business Case phase focussed on directly impacted stakeholders and interested community groups such as Mary River Catchment Coordination Committee (MRCCC), Native Title Applicants, Gympie Regional Council, Queensland Rail, Energex, the Department of Natural Resources and Mines, developers with an interest in impacted land parcels and state and federal government environmental regulators. Feedback from the Department of Infrastructure and Regional Development (federal funding partner) was also a key consideration during the development of the Business Case.

Consultation during this phase, enabled TMR to determine the following:

- The extent of environmental risks and constraints
- Obtain agreement about standards required for local road connections (with consideration of future developments and traffic movements)
- Confirm current and future infrastructure requirements and locations with public utility providers and Queensland Rail
- Obtain an understanding of potential impacts on properties, business operations and cultural heritage
- Identify areas for further investigation as part of the Detailed Design phase of the project

Consultation with key stakeholders during the Business Case enabled detailed identification of risks and opportunities and improved confidence in the recommended option.

TMR officers have met with representatives from the MRCCC during the Detailed Design phase to discuss the Project and potential impacts. The MRCCC has been involved in all sections of the Bruce Highway (Cooroy to Curra) upgrade, including monitoring the water quality of the catchment of Section D and Section C projects during the Detailed Design phases and through the construction stages of Sections A and B.

Consultation with Indigenous stakeholders has commenced as part of the Cultural Heritage Assessment and will continue throughout the future project phases.

Public consultation will continue with key stakeholders (e.g. business and property owners, local environmental groups, government agencies, regional council, emergency services, elected representatives, transport operators, service authorities) throughout the Detailed Design phase, in accordance with TMR's Community Engagement Plan (June 2016). Stakeholder feedback and input will inform the final design, as well as risk management strategies to be adopted for the future construction phase.

2.7 A staged development or component of a larger project

If you have identified that the proposed action is a component of a larger action (in Section 1.12) you must complete this section. Provide information about the larger action and details of any interdependency between the stages/components and the larger action. You may also provide justification as to why you believe it is reasonable for the referred action to be considered separately from the larger proposal (e.g. the referred action is 'stand-alone' and viable in its own right, there are separate responsibilities for component actions or approvals have been split in a similar way at the state or local government levels).

The Cooroy to Curra program of the Bruce Highway upgrade is being delivered as four separate projects which are independent of each other, refer to Appendix C. The individual highway upgrade projects have been defined as follows:

- Section A: Cooroy Southern Interchange to Sankeys Road (EPBC Act Ref: 2011/6024) (currently under construction at the time of this referral) determined to be a controlled action on 8 August 2011.
- Section B: Sankeys Road to Traveston Road (construction complete)
- Section C: Traveston to Woondum (EPBC Act Ref: 2014/7394) (currently under construction) determined to be a controlled action on 6 January 2015
- Section D: Woondum to Curra (the subject of this EPBC Act referral)

Although this project is one of four sections to be upgraded along the Bruce Highway between Cooroy and Curra, the project is considered as an independent action, as the upgrade of each section of the Bruce Highway is not dependent on the other sections. The overall highway upgrade extends over 62 km and is anticipated to be constructed over a time period of potentially more than 20 years. Each section of the highway upgrade has been established individually so that they can be designed and constructed independently of each other, while maintaining a logical connection to the existing Bruce Highway at rationalised locations. Furthermore, each section has a logical connection, including the Cooroy Southern Interchange, Sankeys Road, Traveston Road, Keefton Road and Curra.

This project should be considered independent of the other sections for the following reasons (which have been determined using the Department's *Environment Protection and Biodiversity Conservation Act 1999 Policy Statement, Staged Developments – Split Referrals: Section 74A of the EPBC Act (2013)*):

- The overall Cooroy to Curra upgrade is being undertaken as four separate work packages, each with their own individually tailored environmental investigations, designers and Construction Contractors.
- Funding for the project is being delivered separately for all four sections of the highway upgrade.
- The environmental impacts for each section will be mitigated independently of any other future actions for the Bruce Highway or the previously constructed sections. This includes catchment related impacts, such as impacts to water quality, erosion and sediment control and impacts to aquatic fauna.
- Each section of the highway is not dependent on the other sections.
- Cumulative environmental impacts from the delivery of each section is not anticipated due to the linear nature of the whole upgrade alignment across the landscape. Therefore, the increased magnitude of environmental impacts, such as habitat connectivity, are not anticipated.

In 2012, the Queensland Government announced a commitment to allocate $1 billion in State funding over the next ten years to fast-track improvements to the Bruce Highway (Jacobs, 2016). The purpose for this funding was aimed at improving road safety and flood immunity, among other priorities identified in the Bruce Highway Action Plan (Queensland Government, 2012), including capacity. The division of this project into Contract 1 and Contract 2 is an administrative requirement to assist in the future management of contractual risks inherent with such a large project.

3. Description of environment and likely impacts

3.1 Matters of national environmental significance

Describe the affected area and the likely impacts of the proposal, emphasising the relevant matters protected by the EPBC Act. Refer to relevant maps as appropriate. The interactive map tool can help determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in your area of interest.

Your assessment of likely impacts should refer to the following resources (available from the Department's web site):

- Specific values of individual World Heritage properties and National Heritage places and the ecological character of Ramsar wetlands
- Profiles of relevant species/communities (where available), that will assist in the identification of whether there is likely to be a significant impact on them if the proposal proceeds
- Significant Impact Guidelines 1.1 – Matters of National Environmental Significance
- Associated sectoral and species policy statements available on the web site, as relevant.

Your assessment of likely impacts should consider whether a bioregional plan is relevant to your proposal. Note that even if your proposal will not be taken in a World Heritage area, Ramsar wetland, Commonwealth marine area, the Great Barrier Reef Marine Park or on Commonwealth land, it could still impact upon these areas (for example, through downstream impacts). Consideration of likely impacts should include both direct and indirect impacts.

3.1.1 World Heritage Properties

Description

A search of the EPBC Act Protected Matters Database (refer to Appendix D) identified that no World Heritage Properties are located within 5 km of the project.

The closest World Heritage Property to the project area is the Fraser Island world heritage area, located approximately 55 km (straight line distance) to the northeast.

Nature and extent of likely impact

The proposed action will not impact directly on the world heritage values of any World Heritage Property.

3.1.2 National Heritage Places

Description

A search of the EPBC Act Protected Matters Database (refer to Appendix D) identified that no National Heritage Places are located within 5 km of the project.

The closest National Heritage Place to the project area is Fraser Island world heritage area, located approximately 55 km (straight line distance) to the northeast.

Nature and extent of likely impact

The proposed action will not impact National Heritage Places.

3.1.3 Wetlands of International Importance (declared Ramsar wetlands)

Description

One wetland of international importance was identified on the EPBC Act Protected Matters Database within 5 km of the project (refer to Appendix D). DEE's interactive mapping shows the wetland is the Great Sandy Straight Ramsar site (Australian Ramsar site number 51) and is located approximately 30 km (straight line distance) east of the project.

Nature and extent of likely impact

The project may generate sediments or pollutants which have the potential to be transported into local drainage lines and waterways which ultimately flow into the Great Sandy Straight. However, impacts to the ecological character of the Ramsar wetland are considered to be highly unlikely due to the following:

- The significant upstream distance of the works from the wetland
- The implementation and establishment of erosion and sediment controls early during the construction phase of the project which will assist in minimising the volume of runoff and potential sediments from the works area
- The presence of large tracts of native vegetation such as swamps and coastal wetlands between the project area and the Ramsar site which may act as a filter
- The presence of multiple waterway barriers downstream of the project
- The linear nature of the project which may minimise downstream impacts, as runoff catchments from the project are small
- Implementation of permanent stormwater quality devices on major waterways to trap and treat stormwater runoff prior to entering receiving waterways

3.1.4 Listed threatened species and ecological communities

The threatened species and threatened ecological communities (TEC) that may potentially occur within the project area were identified through database searches and a series of targeted technical field surveys. Details of the field investigations have been presented below in Table 3. The following sections provide a description of the results of the below targeted surveys applicable to matters of national environmental significance (MNES).

Table 3 Ecology surveys undertaken for the project

Year	Author	Report title	Purpose
2015	BAAM	Baseline Ecological Assessment, Bruce Highway Upgrade Section D: Woondum Road to Curra (BAAM, 2015)	Capture baseline terrestrial ecology information to inform the Review of Environmental Factors
2015	FRC Environmental	Aquatic Ecology Assessment, Bruce Highway Upgrade Section D: Review of Environmental Factors (FRC Environmental, 2015 in Jacobs, 2016)	Capture baseline aquatic ecology information to inform the Review of Environmental Factors

Year	Author	Report title	Purpose
2016	ERM	Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D (ERM, 2016)	Targeted terrestrial fauna threatened species surveys to inform Commonwealth and State statutory approvals
2016	BAAM	Detailed Terrestrial Flora Survey Report Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (BAAM, 2016)	Targeted terrestrial flora threatened species surveys to inform Commonwealth and State statutory approvals
2016	GHD	Aquatic Ecology Technical Report Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (GHD, 2016a)	Targeted aquatic species surveys to inform Commonwealth and State statutory approvals
2016	GHD	Flora Survey Report for Survey Area Extents Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (GHD, 2016b)	Additional targeted terrestrial flora survey to provide greater survey area across the project to support Commonwealth and State statutory approvals
2016	GHD	Targeted Survey for the Greater Glider Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (GHD, 2016c)	Targeted greater glider survey due to listing of species as vulnerable under the EPBC Act on 25 May 2016
2016	USC	Koala Surveys (Final) Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project (USC, 2016)	Targeted koala surveys to provide additional information on koala presence across the project area to support the EPBC Act Referral

The following sections include a description and likelihood of occurrence for each listed threatened species and threatened ecological communities, followed by a description and analysis of the nature and likely extent of impact relevant to the MNES.

Description of MNES

Threatened ecological communities

The EPBC Act Protected Matters Database (refer to Appendix D) identified the Lowland Rainforest of Subtropical Australia TEC (listed as 'critically endangered') as likely to occur within 5 km of the project.

Field surveys undertaken to validate regional ecosystem (RE) mapping were undertaken by BAAM in 2015. The outcomes of these surveys confirmed the presence of RE within the survey area that are associated with the Lowland Rainforest of Subtropical Australia TEC (BAAM, 2015). Further field investigations confirmed that the Lowland Rainforest of Subtropical Australia TEC are present within the survey area along the banks of Six Mile Creek and a small patch south of Keefton Road within Woondum State Forest. These vegetation communities at these two locations conform to the key diagnostic characteristics and the condition threshold stated within the *Threatened Species Scientific Committee Guidelines for assessing the conservation status of native species according to the Environment Protection and Biodiversity Conservation*

Act 1999 and Environment Protection and Biodiversity Conservation Regulations 2000 (DEE, 2016b) (TEC listing advice).

A figure has been included in Appendix E which demonstrates the extent of the TEC within the project area.

Further details regarding the TEC at both locations, including an assessment of the key diagnostic characteristics and the condition threshold, is provided in the *Flora Survey Report for Survey Area Extents* (GHD, 2016b) (attached in Appendix F), including a description of the composition, structure and mapping of each TEC patch.

Threatened terrestrial fauna

A detailed assessment of the likelihood of occurrence of terrestrial fauna species within the project area and survey area was undertaken by ERM in 2016 and reported within the *Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D* (ERM, 2016) (refer to Section 2.1 of Appendix G). The likelihood of occurrence assessment undertaken by ERM built upon the likelihood of occurrence assessment reported in the REF by BAAM in 2015 (BAAM, 2015; Jacobs, 2016) and included a review of current legislative changes under the EPBC Act and outcomes of targeted field surveys undertaken in summer 2016.

Following the species' listing of the greater glider (*Petauroides Volans)* as vulnerable under the EPBC Act on 25 May 2016, an additional targeted survey for the greater glider was undertaken by GHD, with the results documented within the *Targeted Survey for the Greater Glider Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016c) (refer to Appendix H). The likelihood of occurrence assessment was based on the following:

- Baseline ecological assessments undertaken for the project (BAAM, 2015; Jacobs, 2016)
- Previous records reported on the Queensland government's Wildlife Online database, the Atlas of Living Australia and/or Birdata database
- Review of mapping products such as Queensland Globe to assess the suitability of habitat across the local region
- Outcomes of the targeted field surveys undertaken by ERM in 2016 (ERM, 2016) and GHD in 2016 (GHD, 2016c)

The terminology and definitions used in the likelihood of occurrence assessment are described in Table 4.

Table 4 Likelihood of occurrence definition for terrestrial fauna (ERM, 2016)

Likelihood rating	Definition
Known to occur	Species has been recorded (directly by TMR commissioned surveys or from database records) within the survey area in the past 10 years
Likely to occur	Species has been recorded within 10 km of the survey area in the past 10 years, **AND** The project area contains suitable habitat for the species
Potential to occur	The survey area is within the species current known distribution, but the species has not been recorded within 10 km of the survey area, **AND** The project area contains suitable habitat for the species
Unlikely to occur	The site is not within the species known distribution **AND/OR**

Likelihood rating	Definition
	Suitable habitat is not present within the project area

The outcomes of ERM's likelihood of occurrence assessment, combined with the additional targeted field survey for the greater glider (GHD, 2016c), for those species identified as either 'known to occur' or 'likely to occur', are provided in Table 5.

Table 5 Terrestrial fauna species likelihood of occurrence based on the outcomes of terrestrial fauna surveys

Scientific name	Common name	EPBC Act status
Known to occur		
Turnix melanogaster	black-breasted button-quail	vulnerable
Phascolarctos cinereus	koala	vulnerable
Petauroides volans	greater glider	vulnerable
Likely to occur		
Pteropus poliocephalus	grey-headed flying-fox	vulnerable
Potential to occur		
Cyclopsitta diophthalma coxeni	Coxen's fig parrot	endangered
Dasyurus maculatus maculatus	spotter-tailed quoll	endangered
Erythrotriorchis radiatus	red goshawk	vulnerable
Mixophyes iteratus	giant barred frog	endangered
Rostratula australis	Australian painted snipe	endangered
Unlikely to occur		
Dasyurus hallucatus	northern quoll	endangered

The species assessed by ERM as having either the 'potential to occur' or being 'unlikely to occur' within the survey area have a lower probability of being impacted by the proposed works, as the species has not been recorded within 10 km of the project (based on desktop assessments) or the project is not within the species distribution. In this regard, the impacts to these species are anticipated to be insignificant and no further assessment of the potential impacts to these species is provided in this referral.

Further information regarding the likelihood of occurrence assessment is provided in the *Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D* (ERM, 2016) (refer to Appendix G).

Additional information regarding the greater glider is provided in the *Targeted Survey for the Greater Glider Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016c) (refer to Appendix H).

To gain a more in-depth understanding of koala utilisation of the project area, TMR engaged the University of the Sunshine Coast (USC) to undertake targeted koala surveys using koala scat detection dogs. The survey involved selecting sites for koala surveys using a grid pattern based on a random start point projected inside the survey area. The surveys focused on koala habitat based on vegetation types (as defined in Jacobs, 2016); however, sites were added outside koala habitat to confirm koala utilisation outside previously mapped koala habitat. The USC koala surveys identified that of the 155 sites surveyed, 35 (23%) were found to be positive for koala presence based on the detection of koala scats (refer to Appendix I for a figure showing the survey locations). In addition, USC had eight opportunistic positive sightings for koala presence, including seven scats and one koala sighting (in Woondum State Forest) (refer to Appendix I). USC systematically searched 4,560 individual trees and koala scats were found under a total of 173 trees. The average utilisation rate for all surveys was 3.8% (± 9.4%). In positive sites, the number of trees with at least one scat present varied from 1 to 16, with an average of 4.9 trees with scats (± 3.9). The utilisation rate per site in this study ranged from 0 % (not utilised) to 53%.

The USC data identifies that koala presence was found within previously verified koala habitat, unverified koala habitat, as well as outside of koala habitat; with koalas utilising habitat in five regions located within the survey area (refer to Appendix I). Of the five habitats, the utilisation rate appears to be the highest at Mothar Mountain and within Woondum State Forest (refer to Appendix I). Refer to Appendix J for the USC koala survey report.

An *MNES Significant Impact Assessment Report* (GHD, 2016d) (refer to Appendix K of this referral) has been prepared for the threatened terrestrial fauna species identified in Table 5. This report documents all relevant information regarding each species including:

- General species descriptions
- Survey effort undertaken
- Records of MNES
- Location and suitability of habitat across the project area
- A determination of whether habitat represents habitat critical to the survival of the species
- Whether an important population is present
- An assessment against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) to confirm if the project is anticipated to have a significance impact on each MNES as a result of the project, and
- Proposed offset strategies for those species which were determined to have a significant impact.

Threatened aquatic fauna

The major waterways traversed by the project are classified as stream order 4 or greater and are major tributaries of the Mary River, while the remaining waterways that are intersected by the project are considered to be minor (i.e. stream order of 3 or less). A detailed assessment of the likelihood of occurrence of threatened aquatic fauna species within the project area and survey area was undertaken by GHD in 2016 and reported within the *Aquatic Ecology Technical Report Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016a) (refer to Section 5 of Appendix M). The following likelihood of occurrence assessment undertaken by GHD in 2016 built upon the likelihood of occurrence assessment reported in the REF in 2016 (FRC 2015 in Jacobs 2016).

- Baseline ecological assessments undertaken for the project (Jacobs, 2016)
- Outcomes of the aquatic habitat assessments and targeted aquatic fauna field surveys undertaken by GHD in 2016 (FRC 2015 in GHD, 2016a)

The terminology and definitions used in the likelihood of occurrence assessment by GHD (GHD, 2016a) are described in Table 6. Further information regarding the likelihood of occurrence assessment is provided in the *Aquatic Ecology Technical Report Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016a) (refer to Section 5 of Appendix M).

Table 6 Likelihood of occurrence definition for aquatic fauna (GHD, 2016a)

Likelihood rating	Definition
Known to occur	Species recorded during field surveys within waterways intersected by the project
Likely to occur	Species has been recorded in the waterway **AND** Suitable habitat is present (species determined to be 'likely to occur' are otherwise 'known to occur' within the waterway **AND** Has suitable habitat present; however, were not recorded during field surveys).
Potential to occur	Species has not been recorded in the waterway although species' distribution incorporates the waterway **AND** Potentially suitable habitat occurs in the waterway (but may not be particularly abundant or optimal habitat).
Unlikely to occur	Species has not been recorded within the waterway **AND/OR** Current known distribution does not encompass the waterway **AND/OR** Suitable habitat is generally lacking from the waterway.

The likelihood of occurrence assessment for aquatic fauna species is provided in Table 7. The three major waterways intersected by the project include Six Mile Creek, Deep Creek and Curra Creek.

The white-throated snapping turtle is 'known to occur' within Curra Creek, while the Mary River cod is 'known to occur' within Six Mile Creek. The Mary River turtle and white-throated snapping turtle were assessed as 'likely to occur' within the project at Six Mile Creek.

Additional information including, the significance of impact assessment for each species assessed as either 'known to occur' or 'likely to occur', has been documented in the *MNES Significant Impact Assessment Report* (GHD, 2016d) attached as Appendix K.

Table 7 Aquatic fauna species likelihood of occurrence based on the outcomes of GHD's *Aquatic Ecology Technical Report Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)*

Common name	Scientific name	EPBC Act status	Updated likelihood of occurrence			
			Six Mile Creek	Deep Creek	Curra Creek	Minor waterways
Mary River turtle	*Elusor macrurus*	Endangered	**Likely to occur** (foraging)	Potential to occur (foraging)	Potential to occur (foraging)	Unlikely to occur
White-throated	*Elseya albagula*	Critically endangered	**Likely to occur**	Potential to occur	**Known to occur**	Unlikely to occur

Common name	Scientific name	EPBC Act status	Updated likelihood of occurrence			
			Six Mile Creek	Deep Creek	Curra Creek	Minor waterways
snapping turtle			(foraging and low value breeding)	(foraging and low value breeding)	(foraging and low value breeding)	
Mary River cod	*Maccullochella mariensis*	Endangered	**Known to occur** (foraging and breeding)	Potential to occur (foraging and breeding)	Potential to occur (foraging and breeding)	Unlikely to occur
Australian lungfish	*Neoceratodus forsteri*	Vulnerable	Potential to occur (foraging)	Potential to occur (foraging)	Potential to occur (foraging and breeding)	Unlikely to occur

Threatened terrestrial flora

A detailed assessment of the likelihood of occurrence of threatened flora species within the project area and survey area was undertaken by BAAM in 2015 and reported within the REF (Jacobs, 2016). The likelihood of occurrence assessment updated by BAAM in 2016 (which built upon the likelihood of occurrence assessment reported in the REF), is presented in the *Detailed Terrestrial Flora Surveys Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (BAAM, 2016) (refer to Section 3.1 of Appendix F).

However, the likelihood of occurrence assessment undertaken by BAAM in 2015 and 2016 was assessed as being inconsistent with the terrestrial and aquatic fauna likelihood of occurrence assessments, due to the defining criteria used and the use of a 20 km search radius for the desktop searches. In this regard, and to achieve consistency between the likelihood of occurrence assessments, GHD updated BAAM's 2016 likelihood of occurrence assessment within the *Flora Survey Report for Survey Area Extents Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016b). The likelihood of occurrence definition criteria used to update the likelihood of occurrence assessment is provided in Table 8.

Table 8 Updated likelihood of occurrence definitions for terrestrial flora

Likelihood rating	Definition
Known to occur	Species has been recorded (directly by TMR commissioned surveys **OR** from database records) within the survey area
Likely to occur	Species has been recorded within 10 km of the survey area, **AND** The project area contains suitable habitat for the species
Potential to occur	The survey area is within the species current known distribution, but the species has not been recorded within 10 km of the survey area, **AND**

Likelihood rating	Definition
	The project area contains suitable habitat for the species
Unlikely to occur	The project area is not within the species known distribution **AND/OR** Suitable habitat is not present within the project area

The results of the updated likelihood of occurrence assessment resulted in three species which were previously assessed as having the ‘potential to occur’ being assessed as ‘likely to occur’. The outcomes of the updated likelihood of occurrence assessment, for those species identified as either ‘known to occur’ or ‘likely to occur’, are provided in Table 9.

Table 9 Updated threatened flora species likelihood of occurrence

Scientific name	Common name	EPBC Act status
Known to occur		
Macrozamia pauli-guilielmi	pineapple zamia	endangered
Likely to occur		
Cossinia australiana	cossinia	endangered
Fontainea rostrata	deep creek Fontainea	vulnerable
Floydia praealta	ball nut	vulnerable
Macadamia integrifolia	macadamia nut	vulnerable
Macadamia ternifolia	Maroochy nut	vulnerable
Samadera bidwillii	quassia	vulnerable

The likelihood of occurrence assessment was used in the development of the field surveys to target areas where flora species with a higher probability of occurrence may be present. Targeted flora surveys undertaken for the project (BAAM, 2015; BAAM, 2016; GHD, 2016b) have confirmed that *Macrozamia pauli-guilielmi* (pineapple zamia) is the only threatened flora species identified as present within the project area and survey area.

The flora species which were assessed as ‘known to occur’ and the majority of species assessed as ‘likely to occur’ are long-lived perennial species that can be confidently identified based on vegetative features. The BAAM surveys undertaken in 2015 and 2016, and the GHD survey July 2016, were deemed appropriate to maximise the likelihood of encountering all target species (i.e. those reassessed as ‘known to occur’ and ‘likely to occur’) and other species assessed as having a lower likelihood of being present (i.e. those species assessed as having the ‘potential to occur’).

Given that the project area has been extensively surveyed, those species assessed as being ‘likely to occur’, having the ‘potential to occur’ or being ‘unlikely to occur’ within the survey area are anticipated not to be significantly impacted by the project and therefore no further assessment of these species is provided in this referral. Further information regarding the likelihood of occurrence assessment is provided in the *Flora Survey Report for Survey Area Extents Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016b) (refer to Appendix F).

Nature and extent of likely impact

The nature and extent of likely impact for each MNES assessed as either 'known to occur' or being 'likely to occur' (fauna species only) is discussed in detail in the *MNES Significant Impact Assessment Report* (GHD, 2016d). This document (refer to Appendix K) has been prepared to summarise species specific information and provide the following for each threatened species identified as 'known to occur' and 'likely to occur':

- General information on the conservation status, distribution, habitat preferences and population estimates (where relevant)
- A summary of the survey effort undertaken for MNES over the course of the project
- Records of each MNES from either baseline ecological surveys (BAAM, 2015; FRC Environmental in Jacobs, 2016) or targeted 2016 surveys (ERM, 2016; BAAM, 2016; GHD, 2016a; GHD, 2016b; GHD, 2016c) and available online database records
- Suitability and extent of habitat within the project area and survey area for MNES
- A description of breeding, foraging and dispersal habitat for MNES fauna species
- Whether habitat within the project area has been assessed as 'habitat critical to the survival of the species' in accordance with the national recovery plan for the species (where available)
- Whether the survey area contains an 'important population' of a species in accordance with the national recovery plan for the species (where available)
- An assessment against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) to confirm if the project is anticipated to have a significant impact on each MNES as a result of the project
- Where a residual impact is determined likely to occur to a species, a description of offset strategies applicable to this species. As stated in the *EPBC Act Environmental Offsets Policy, 2012* a residual impact is the remaining impact following avoidance and mitigation measures (DSEWPC, 2012). Offsets are only required where the residual impact is significant (DSEWPC, 2012).

The following sections provide a summary of the significance of impact assessment for each MNES, including the threatened ecological community, threatened terrestrial fauna species and threatened aquatic fauna species as documented in the *MNES Significant Impact Assessment Report* (GHD, 2016d), refer to Appendix K.

Threatened Ecological Communities (TEC)

The Lowland Rainforest of Subtropical Australia TEC was confirmed present within the project area and survey area at Six Mile Creek. The extent of the TEC patch within the project area along Six Mile Creek is confined to the riparian vegetation associated with Six Mile Creek. The Lowland Rainforest of Subtropical Australia TEC was also confirmed present immediately adjacent to the project area (within the survey area) within Woondum State Forest. Refer to Appendix E for a figure showing the extent of TEC within the project area.

The full significance of impact assessment on the Lowland Rainforest of Subtropical Australia TEC is included in the relevant sections of Appendix K. The project has been assessed as likely to have a significant impact on the Lowland Rainforest of Subtropical Australia TEC due to the likelihood that the project will:

- Reduce the extent of an ecological community
- Fragment or increase fragmentation of an ecological community

- Adversely affect habitat critical to the survival of an ecological community
- Interfere with the recovery of an ecological community

The extent of impact on both confirmed patches of TEC is summarised in Table 10 and shown in Appendix E. Table 10 also identifies the extent of indirect impacts on the TEC as a result of remnant vegetation clearing within 50 m of each patch of TEC. The *Threatened Species Scientific Committee's listing advice for the Lowland Rainforest of Subtropical Australia TEC* (TSSC, 2011) states that a 50 m buffer zone is required to be placed around the outer edge of the TEC patch to preserve the communities' habitat. The TEC listing advice also identifies that impacts to vegetation within the 50 m buffer zone may constitute a significant impact (TSSC, 2011). Indirect impact to the TEC may also include:

- Importation and/or spread of weeds
- Habitat disturbance through introduction and/or degradation through dust, sedimentation, erosion and/or altered hydrology
- Reduction in patch size and isolation of two separate patches

Table 10 Extent of threatened ecological community

TEC Location	Extent of TEC patch surveyed	Extent of direct impact (i.e. clearing of the TEC patch within project area)	Extent of indirect impact (i.e. clearing within 50 m of the TEC patch within project area)	Relative proportion of direct impact
Six Mile Creek	14.23 ha	0.82 ha	4.67 ha	5.8% direct impact
Woondum State Forest	1.42 ha	Nil	0.52 ha	Nil

The extent of direct disturbance of the TEC at Six Mile Creek is required to facilitate the construction of the northbound and southbound bridges at this location. The project area at Six Mile Creek has been designed to allow for the construction of the bridges which includes access for piling pads, embankment works and construction of piers.

Threatened terrestrial fauna

The black-breasted button-quail, koala and greater glider are 'known to occur' within the project area. The grey-headed flying-fox and greater glider have been assessed as 'likely to occur' due to previous records within 10 km of the survey area and suitable habitat present.

In the absence of mitigation measures, the impacts to threatened fauna species anticipated as a result of the project may include the following:

- Direct vegetation clearing and loss of foraging and breeding habitat
- Fragmentation of habitats, loss of wildlife movement corridors
- Mortality and injury of individuals and disruption of movement during vegetation clearing and construction
- Disturbance to fauna during foraging or breeding activities
- Indirect impacts through importation and/or spread of weeds
- Introduction and/or proliferation of pest fauna
- Degradation of habitat through dust, sedimentation and/or erosion

- Degradation of aquatic environments through impacts to water quality
- Barrier effects due to reduced habitat connectivity and capacity for movement of individuals

The significance of impact assessment included in Appendix K identifies that the project is likely to have a significant impact on the black-breasted button-quail and the koala.

This assessment outcome for the black-breasted button-quail is attributed to the following two criteria of the significant impact assessment guidelines:

- The project will adversely affect habitat critical to the survival of the species
- The possibility that the project will modify, destroy, remove, isolate or decrease the availability and quality of habitat that the local population could potentially decline and contribute to the decline of the species

The location of habitat critical to the survival of the black-breasted button quail is shown on the figure included as Appendix N and the extent that will be directly impacted by clearing for the project is quantified in Table 11.

The significant impact assessment on the koala found the project is likely to have a significant impact on the species. An assessment of the koala habitat was undertaken in accordance with the koala habitat assessment tool provided by the *EPBC Act Referral Guidelines for the Vulnerable Koala* (DoE, 2014). Due to the linear nature of the project, the length over which the project occurs and the various vegetation communities and environmental features encountered, the habitat assessment tool has been applied for each of the four different koala habitat types identified. This approach has been taken to accurately identify habitat critical to the survival of the koala. The tool identified that the vegetation within the project area mapped by ERM (2016) as either 'remnant vegetation with less frequent detection of koala or signs' and 'remnant vegetation with more frequent detection of koala or signs' meets the criteria to be considered 'habitat critical to survival of koala,' with a score of 8. Scores greater than 5 are considered to be critical habitat for the species.

The assessment of habitat defined as either 'remnant vegetation with less frequent detection of koala or signs' and 'remnant vegetation with more frequent detection of koala or signs' is summarised as follows:

- High level of koala activity recorded in the vicinity: **score of 2** (evidence of one or more koalas within the last two years)
- High level of suitability of vegetation structure and composition: **score of 2** (has forest or woodland with 2 or more known koala food trees)
- High level of habitat connectivity: **score of 2** (area is part of a contiguous landscape >500 ha)
- Moderate level of existing threats: **score of 1** (evidence of infrequent or irregular koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence)
- Moderate level of recovery value: **score of 1** (uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context)

  Total score: 8

Those areas mapped as either 'generally unsuitable' or 'regrowth' score a lower habitat assessment score as follows:

- High level of koala activity recorded in the vicinity: **score of 1** (evidence of one or more koalas within 2 km of the edge of the impact area within the last 5 years)

- High level of suitability of vegetation structure and composition: **score of 0** (does not include forest or woodland)
- High level of habitat connectivity: **score of 0** (neither part of a contiguous landscape <500 ha or >300 ha)
- Moderate level of existing threats: **score of 1** (evidence of infrequent or irregular koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence)
- Moderate level of recovery value: **score of 1** (uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context)

  Total score 3

The project was assessed as likely to have a significant impact on the koala due to the associated impacts on habitat critical to the survival of the species and the possibility of the introduction of invasive species to the species habitat. The location of habitat critical to the survival of the koala is shown on the figure included as Appendix N, and the extent that will be directly impacted by clearing for the project is quantified in Table 11.

The significance of impact assessment identified that the project is anticipated not to have a significant impact on the greater glider and grey-headed flying-fox, as an important population of either species is not present within the project area. Furthermore the habitat present within the project area for the greater glider does not constitute habitat critical to the survival of the species due to the degraded nature of the habitats observed, coupled with the absence of historical records. Habitats within the project area are unlikely to be necessary for the long-term maintenance of the species or for maintaining genetic diversity and long-term evolutionary development of the greater glider, and are therefore not considered to constitute habitat critical to the survival of the species.

The *Draft Recovery Plan for the Grey-headed flying-fox Pteropus poliocephalus* (DEE, 2017) states that habitat and associated seasonal resources which are critical to the survival of the species are yet to be mapped. However, the loss of winter forage is considered a primary threat to the species, with the loss of spring forage unlikely to adequately provide resources for the species (DEE, 2017).

The project will impact upon vegetation communities which contain *Eucalyptus tereticornis*, *E. crebra*, *E. fibrosa*, *E. pilularis*, *E. robusta*, *E. siderophloia*, *Banksia integrifolia*, *Castanospermum australe*, *Corymbia citriodora citriodora*, *Grevillea robusta* and *Melaleuca quinquenervia*. Vegetation communities containing the aforementioned species are listed on the recovery plan as important winter and spring habitats (DEE, 2017). However, the recovery plan does not attribute an area value to what constitutes habitat critical to the survival of the species.

The project will result in the loss of 251.50 ha of suitable foraging habitat which is likely to contain the previously mentioned species. However, it is important to note the relative abundance of suitable foraging habitat which contains both winter and spring forage within the broader region and particularly to the east of Curra State Forest. The habitat within the project area is unlikely to be defined as dispersal habitat given the species' high mobility. Habitat within the project area is also unlikely to be necessary for the long-term maintenance of the species and to maintain genetic diversity and long-term evolutionary development of the species, given the species' high mobility and lack of high numbers of previous records within the project area (ERM, 2016). Reintroduction of the species is unlikely to be undertaken in the project area as the majority of the suitable habitat is present within the actively managed State Forests.

The extent of habitat critical to the survival of the species for each terrestrial fauna MNES is quantified in Table 11.

Table 11 Extent of threatened fauna species habitat within the project area

Threatened Species	EPBC Act status	Outcome of significance of impact assessment	Extent of habitat critical to the survival of the species		
			Contract 1	Contract 2	Total
Black-breasted button-quail (*Turnix melanogaster*)	Vulnerable	Likely to have a significant impact	8.14 ha	Nil	8.14 ha
Koala (*Phascolarctos cinereus*)	Vulnerable	Likely to have a significant impact	42.93 ha	95.51 ha	138.44 ha
Greater glider (*Petauroides volans*)	Vulnerable	Unlikely to have a significant impact	Nil	Nil	Nil
Grey-headed flying-fox (*Pteropus poliocephalus*)	Vulnerable	Unlikely to have a significant impact	Nil	Nil	Nil

Threatened aquatic fauna

Two threatened aquatic fauna species are ‘known to occur’ within the project area, the Mary River cod and the white-throated snapping turtle.

The Mary River cod was confirmed present within Six Mile Creek during the 2015 surveys and 2016 electrofishing surveys (FRC Environmental in Jacobs, 2016; GHD, 2016a). Six Mile Creek supports one of only three populations of the Mary River cod, this population is considered to be an important population for maintaining genetic diversity and for the long-term maintenance of the species (GHD, 2016a; GHD, 2016d). Six Mile Creek is also considered habitat critical to the survival of the Mary River cod, as the creek is necessary for critical activities such as foraging and breeding (GHD, 2016d). The Mary River cod has not been previously recorded within Deep Creek or Curra Creek; however, an anecdotal record of the species exists from the confluence of Curra Creek and the Mary River (recorded in 1989, Simpson and Jackson, 1996). Reaches of Deep Creek and Curra Creek that contain deep pools, high abundance of large woody debris, presence of overhanging vegetation and shaded habitat provide potentially suitable habitat conditions for the Mary River cod within the project area (GHD, 2016a). The likelihood of occurrence of the Mary River cod within these waterways, is reduced by the distance and connectivity of these creeks from the three main populations of the species. Notwithstanding, the Mary River cod has the potential to occur in Deep Creek and Curra Creek at low densities (GHD, 2016a).

The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek were identified as providing potentially suitable habitat conditions for the Mary River turtle and the white-throated snapping turtle. However, the Mary River turtle has not been previously recorded within waterways intersected by the project, while only one individual of the white-throated snapping turtle has been previously recorded (GHD, 2016a) from within these waterways. The low abundance of species recorded from the project area and the low suitability of turtle nesting habitat within these waterways, suggests aquatic habitats within the project area are unlikely to represent habitat critical to the survival of either the Mary River turtle or the white-throated snapping turtle.

In the absence of mitigation measures, the impacts to threatened aquatic fauna species as a result of the project may include the following:

- Alteration of aquatic habitat
- Disturbance to aquatic fauna within foraging habitat
- Degradation of downstream habitat quality due to changes in water quality
- Alteration of in-stream hydrological processes due to in-stream structures (e.g. culverts) on minor waterways
- Noise, vibration and light disturbance
- Injury and/or mortality during construction
- Introduction and/or proliferation of pest aquatic fauna
- Indirect impacts through importation and/or spread of weeds
- Barrier effects due to reduced habitat connectivity and capacity for movement of individuals

The significance of impact assessment included in Appendix K identified that the project is unlikely to have a significant impact on ‘known’ and ‘likely’ threatened aquatic fauna species where management and mitigation measures are incorporated in the design and construction phases of the project. Management and mitigation measures are detailed in Section 5 of this referral.

The project has been assessed as not resulting in a significant impact to aquatic species as the project has been assessed as unlikely to result in the criteria nominated in the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). Specifically, as the project has incorporated bridge structures over Six Mile Creek, Deep Creek and Curra Creek direct impacts will not result in the fragmentation of populations present or reduce the area of occupancy for the species. Furthermore, the implementation of mitigation and management measures will assist in reducing impacts within the project area and downstream of the project. Sediment transport is the primary potential impact to aquatic fauna species due to the potential for habitat degradation. Specific erosion and sediment control measures will assist in reducing the potential for sediment transport, which include:

- Implementation of MRTS52 – Erosion and Sediment Control and associated annexure. These documents are a recent addition to TMR's contract documentation suite, to enable TMR to have controlling provisions over the construction contract. MRTS52 – Erosion and Sediment Control includes specific requirements, including water quality performance indicators, monitoring, regular auditing (including independent auditors) and reporting.
- Requirement for an appropriately qualified person (in accordance with MRTS52 – Erosion and Sediment Control) to be nominated within Construction Contractors staff including a Certified Professional in Erosion and Sediment Control and demonstrated number of years' experience in erosion and sediment control.
- Requirement for sediment basins to be designed using appropriate modelling to ensure basins designs are correct for catchment intake and placed in the most appropriate location.
- Inclusion of lessons learnt from previous Cooroy to Curra projects, such as including staging of works to minimise vegetation clearing and provide for the establishment of pioneering works in relation to erosion and sediment control (i.e. establishment of temporary sediment basins and diversion drains prior to major earthworks). Including the use of passive flocculation of sediment basins during construction to provide for an increase in discharge rates while still meeting required discharge water quality objectives.
- Requirement for all temporary erosion and sediment control devices to be designed for a 5 day, 85th percentile storm event, rainfall events within this design requirement will be controlled by the Construction Contractor. Those storm events outside the design event are unable to be controlled by the Construction Contractor due to the intense nature of such storm events. It is likely that sediment laden runoff will exit the project area untreated during these storm events. It is important to note that these events are naturally occurring events and an additional amount of sediment laden runoff will occur from the upstream catchment which includes agricultural land uses, rural residential uses and large areas of bushland.

A summary of the assessment outcomes for the threatened aquatic species habitat, as a result of the project, is provided in Table 12.

Table 12 Outcomes of assessment for threatened aquatic species habitat within the project area

Threatened species	EPBC Act status	Outcome of significance impact assessment	Habitat critical to the survival of the species within the project area
Mary River cod (*Maccullochella mariensis*)	Endangered	Unlikely to have a significant impact	Six Mile Creek
Mary River turtle (*Elusor macrurus*)	Endangered	Unlikely to have a significant impact	Not present
White-throated snapping turtle (*Elseya albagula*)	Critically endangered	Unlikely to have a significant impact	Not present

Threatened terrestrial flora

A total of 48 adults and 167 seedlings of *Macrozamia pauli-guilielmi* were confirmed present within the project area and will be directly impacted by the project; refer to Table 13 (BAAM, 2016; GHD, 2016b). A further 44 adults and 27 seedlings of *Macrozamia pauli-guilielmi* are present adjacent to the project area (within the survey area) and are anticipated to be indirectly impacted by the project due to their close proximity to the construction works.

Appendix K identifies that remaining habitat where viable populations of *Macrozamia pauli-guilielmi* are present is likely to be habitat critical to the survival of the species. The *National Multi-species Recovery Plan for the Cycads* (Queensland Herbarium, 2007) identifies important populations of the species, none of which occur within the project area. The outcomes of the significance of impact assessment included in Appendix K indicates that with the implementation of the Translocation Management Plan developed for the *Macrozamia pauli-guilielmi*, the project is unlikely to have a significant impact on the species. The translocation of plants under threat is a mitigation measure endorsed in the *National Multi-species Recovery Plan for the Cycads* (Queensland Herbarium, 2007).

Due to the development and proposed implementation of the Translocation Management Plan, a residual impact on *M. pauli-guilielmi* is anticipated not to occur from the project. A number of adaptive management and contingency measures have been included in the Translocation Management Plan. One of these measures relates to the mortality or loss of adult plants. Where mortality occurs, a program to collect seeds from existing known populations (on a sustainable basis) is to be undertaken. This process will include propagating and planting the seedlings back into existing populations at a ratio of eight seedlings established per adult plant lost, to increase the size of existing populations. This adaptive measure has been developed to reduce a residual impact occurring later in the project. A five year monitoring program is proposed as part of the Translocation Management Monitoring Plan, to assist in assessing the long-term survival of the translocated individuals.

Table 13 Extent of threatened flora species impacted within the project area

Threatened species	EPBC Act status	Individuals within project area
Macrozamia pauli-guilielmi	Endangered	48 adults and 167 seedlings

No other threatened flora species were identified within the survey area despite numerous targeted flora surveys.

3.1.5 Listed migratory species

Description

A detailed assessment of the likelihood of occurrence of migratory species within the project area was undertaken by ERM in 2016 and reported within the *Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D* (ERM, 2016) (refer to Section 2.1 of Appendix G). The likelihood of occurrence assessment undertaken by ERM in 2016 built upon the likelihood of occurrence assessment reported in the REF by BAAM in 2015 (BAAM, 2015; Jacobs, 2016), and included a review of current legislative changes under the EPBC Act and outcomes of targeted field surveys undertaken in the summer of 2016. The terminology and definitions used in the likelihood of occurrence assessment by ERM 2016 are described in Table 4.

The outcomes of ERM's likelihood of occurrence assessment found that five migratory species are 'known to occur' while five additional migratory species are 'likely to occur', as shown in Table 14. The assessment identified that four listed migratory species were assessed as having the 'potential to occur', within the survey area. Given that these species were assessed as only having a potential to occur within the survey area, due to lack of previous records within 10 km of the project, a significant impact to these species are not anticipated as a result of the project and no further assessment of these species is provided in this referral.

Further information regarding the likelihood of occurrence assessment is provided in the *Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D* (refer to Appendix G).

Table 14 Migratory species 'known to occur' or 'likely to occur' based on the outcomes of ERM's *Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D*

Scientific name	Common name	EPBC Act status
Known to occur		
Ardea ibis	cattle egret	marine migratory
Ardea modesta	fork-tailed swift	marine migratory
Merops ornatus	rainbow bee-eater	marine migratory
Rhipidura ruficauda	rufous fantail	marine migratory
Symposiarchus trivirgatus	spectacled monarch	marine migratory
Likely to occur		
Apus pacificus	eastern great egret	marine migratory
Gallinago hardwickii	Lantham's snipe	marine migratory
Hirundapus caudacutus	white-throated needletail	marine migratory
Monarcha melanopsis	black-faced monarch	marine migratory

Nature and extent of likely impact

Given the ubiquitous nature of potential habitat and the unlikely occurrence of significant impacts on migratory species (refer to Appendix K), the habitat extent was not quantified. Impacts to migratory species that may occur as a result of the project include the following:

- Direct vegetation clearing including loss of foraging and breeding habitat
- Fragmentation of habitats
- Mortality and injury of individuals and disruption of movement during vegetation clearing and construction
- Disturbance to foraging or breeding habitat
- Indirect impacts through importation and/or spread of weeds
- Introduction and/or proliferation of pest species
- Degradation of habitat through dust, sedimentation and/or erosion

The *MNES Significant Impact Assessment Report* (GHD, 2016d), attached as Appendix K, concluded that although migratory species were confirmed present within the project area, the number of birds likely to occur within the project area would not represent a significant proportion of the international or national total population. This assessment was based on the small numbers of individuals observed during the field surveys and relatively small, localised areas of suitable habitat present. The project is not anticipated to have a significant impact on migratory bird species due to the lack of important habitat or breeding habitat within the project area.

Additional information regarding the listed migratory species identified in Table 14 has been documented in the *MNES Significant Impact Assessment Report* (GHD, 2016d), attached as Appendix K.

3.1.6 Commonwealth marine area

Description

A search of the EPBC Act Protected Matters Database (refer Appendix D) identified that no Commonwealth marine areas are located within 5 km of the project. The Commonwealth marine area closest to the project is located three nautical miles off the coast of Australia. Therefore, the Commonwealth marine area is located approximately 48 km (straight line distance) east of the referral area.

Nature and extent of likely impact

The project may potentially generate sediments or pollutants which may be transported into local drainage lines and waterways which ultimately flow into the ocean. However, it is highly unlikely that any impacts to the Commonwealth marine area or its ecological values will result from the project; this conclusion is attributed to:

- The significant distance upstream from the Commonwealth marine area
- The presence of large tracts of native vegetation and forestry between the project and the Commonwealth marine area, which may act as a filter
- The inclusion of sediment controls and impact mitigation measures implemented in the design and construction phases
- Implementation of permanent stormwater quality devices on major waterways to trap and treat stormwater runoff prior to entering receiving waterways

3.1.7 Commonwealth land

Description

A search of the EPBC Act Protected Matters Database (refer Appendix D) identified that one Commonwealth area is located within 5 km of the project, as described as 'Defence – Gympie Training Depot', however this facility is located approximately 35 km to the north-east of the project.

Nature and extent of likely impact

Given the separation distance between the project area and the Defence – Gympie Training Depot site, the proposed action will not impact on any Commonwealth areas.

3.1.8 The Great Barrier Reef Marine Park

Description

The project is not located within the Great Barrier Reef Marine Park, nor is it located within a catchment leading to the Great Barrier Reef.

Nature and extent of likely impact

The proposed action will not impact on the Great Barrier Reef Marine Park directly or indirectly.

3.1.9 A water resource, in relation to coal seam gas development and large coal mining development

Description

The proposed action is not a coal seam gas development or a large coal mining development.

Nature and extent of likely impact

The proposed action is not a coal seam gas development or a large coal mining development.

3.2 Nuclear actions, actions taken by the Commonwealth (or Commonwealth agency), actions taken in a Commonwealth marine area, actions taken on Commonwealth land, or actions taken in the Great Barrier Reef Marine Park

3.2.1 Is the proposed action a nuclear action?

No, the proposed action is not a nuclear action.

3.2.2 Is the proposed action to be taken by the Commonwealth or a Commonwealth agency?

No, the proposed action will be undertaken by TMR which is a State Government agency.

3.2.3 Is the proposed action to be taken in a Commonwealth marine area?

No, the project is not located within a Commonwealth marine area.

3.2.4 Is the proposed action to be taken on Commonwealth land?

No, the project is not located on Commonwealth land.

3.2.5 Is the proposed action to be taken in the Great Barrier Reef Marine Park?

No, the project is not located within the Great Barrier Reef Marine Park.

3.3 Other important features of the environment

Provide a description of the project area and the affected area, including information about the following features (where relevant to the project area and/or affected area, and to the extent not otherwise addressed above). If at Section 2.3 you identified any alternative locations, time frames or activities for your proposed action, you must complete each of the details below (where relevant) for each alternative identified.

3.3.1 Flora and fauna

Contract 1 traverses a landscape that has largely been subject to historic clearing, predominantly for agricultural, rural residential and industrial purposes

Contract 2 traverses rural residential properties, commercial properties and a large portion of contiguously vegetated land comprising Curra State Forest.

Fauna

The project area was categorised in four broad habitat categories in the REF (Jacobs, 2016) as follows:

- Open eucalypt forest (including RE 12.3.3d, RE 12.3.11, RE 12.9-10.4, RE 12.9-10.17b, RE 12.11.3, RE 12.11.5e, RE 12.11.14 and RE 12.11.16)
- Vine forest (including RE 12.3.1, regrowth of RE 12.11.10 and a small portion of RE 12.3.11)
- Wetlands (including dams, creeks and ephemeral waterways in non-remnant areas and within RE 12.3.1, RE 12.3.3d and RE 12.3.11)
- Open pasture (non-remnant)

ERM assessed the project area as being comprised of approximately 60% native habitat types (i.e. Open eucalypt forest, vine forest and wetlands), with the remaining 40% being comprised of cleared areas (i.e. open pasture (non-remnant)) (ERM, 2016). Much of the existing habitat has been subject to disturbance (largely by logging, cattle grazing and regular fire regime) and the conditions varies greatly across the survey area (Jacobs, 2016). Habitat within the majority of Curra State Forest was identified as having been historically subject to logging disturbance and active management. However some areas (where fire regime was not as common) displayed a high dominance of native ground cover, providing habitat of high potential value for ground-dwelling mammals and reptiles (Jacobs, 2016). Those areas of the State Forest subject to regular fire regimes are likely to have reduced the availability of fauna habitat values. Continued logging pressure in these areas has limited the availability of older hollow-bearing trees, which are important for arboreal mammals (Jacobs, 2016).

A detailed baseline terrestrial fauna survey was undertaken as part of the REF in 2015 by BAAM (Jacobs, 2016). A total of 164 fauna species (106 birds, 23 mammals, 22 reptiles and 13 amphibians) were observed within the survey area. A targeted fauna survey undertaken in 2016 by ERM (ERM, 2016) identified a total of 96 fauna species (67 birds, 13 amphibians, eight mammals, six reptiles and two invertebrates). In addition to MNES listed species, ERM recorded the presence of likely breeding places for the following fauna species listed under State legislation: *Adelotus brevis* (tusked frog), *Ninox strenua* (powerful owl) and *Tachyglossus aculeatus* (short-beaked echidna) (ERM, 2016). GHD (2016a) recorded the presence of *Ornithorhynchus anatinus* (platypus), another State listed fauna species.

Flora

The baseline terrestrial surveys undertaken by BAAM in 2015 (BAAM, 2015) field verified the presence of nine remnant vegetation across the survey area, including 'endangered', 'of concern' and 'least concern' REs under the Queensland *Vegetation Management Act 1999*, as summarised in Table 17. During these baseline surveys a total of 358 flora species were observed by BAAM within the survey area (BAAM 2015 in Jacobs 2016). Of these species 290 (81%) were native and 68 (19%) were exotic.

Further information regarding the flora and fauna values of the project area are detailed in the documentation prepared for the project, as summarised in Table 3 of this referral.

3.3.2 Hydrology, including water flows

The topography of the project area and its surrounds is hilly and undulating, with natural surface levels ranging between 50 – 150 metres AHD. The Mary River, the major river within the Mary River Catchment, is located to the west of the project area and flows in a northerly direction. The project does not intersect the Mary River, but intersects three sub-regional catchments of the Mary River catchment (i.e. Six Mile Creek, Deep Creek and Curra Creek). The project requires a total of 35 waterway crossings over mapped waterways (1012 bridges and 20 culverts). The major waterways traversed by the project (i.e. classified as stream order 4 or greater) include the waterways and associated tributaries shown in Table 15. The major waterways are all major tributaries of the Mary River, while the remaining waterways that are intersected by the project are considered to be minor. Stream order is a classification measurement relating to stream complexity. Those waterway classified as stream order 1 are located at the headwaters of a catchment, whereas a stream order of 3 and above usually provide some level of fish habitat value.

Table 15 Mapped waterways intersected by the project

Chainage (m)	Waterway name	Stream order	Minor / major	Flow direction	Diversion (Yes/No)
137500	Six Mile Creek	Fifth	Major	West	No
141800	Tannery Creek	Third	Minor	West	Yes
143200	Deep Creek	Fifth	Major	West	No
144000	Moody Creek (south)	Third	Minor	East	Yes
144900	Moody Creek (north)	Third	Minor	West	Yes
148000	Banks Creek	Third	Minor	East	Yes
149400	Tamaree Creek	Third	Minor	East	Yes
157100	Curra Creek	Fourth	Major	West	No
157750	Keliher Creek	Third	Minor	West	No
162200	Curra Creek	Fourth	Major	North	No

The construction of the project requires five minor waterways listed in Table 15 to be diverted to accommodate construction and operation of the highway: Tannery Creek, Moody Creek (north and south), Banks Creek and Tamaree Creek. Appropriate State statutory approvals will be sought for each waterway diversion.

For further information regarding waterways traversed by the project, refer to the *Aquatic Ecology Technical Report Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016a) (refer to Appendix M).

3.3.3 Soil and vegetation characteristics

The project is located within the Gympie block of the south-eastern Queensland bioregion. The surface and near-surface geology in the vicinity of the project area comprises quaternary alluvium, tertiary igeous intrusive rocks and Permian to Jurassic sedimentary and low grade metamorphic rocks (Jacobs, 2016). A review of the dominant soils was undertaken by Jacobs in 2016 as part of the REF (Jacobs, 2016). The three dominant soil types, their description and location across the project area are provided in Table 16.

Dispersive soils were determined as present (with a degree of certainty) within eight samples collected as part of the preliminary geotechnical investigations undertaken for the project (Jacobs, 2016). Jacobs (2016) concluded that due to the variability of soil structure across the project area, dispersive soils could potentially be encountered at various locations along the length of the alignment. Acid sulfate soils were discounted due to the location of the project being located above 20 m AHD.

Acid rock drainage (ARD) was identified during the Business Case phase of the project as potentially present across the project area (Jacobs, 2016). Geological mapping indicates that Myrtle Creek Sandstones (Geological Unit RJdm), which are known to support pyritic zones, are likely to be present in the general area between Gympie Connection Road and Sandy Creek Road (Ch 145000 m to Ch 146400m) and between Brady's Road and the southern extent of the Curra Interchange (Ch 156200 m – Ch 162000 m). Design measures, including the requirement for specific construction materials, have been incorporated within contract documentation during the Detailed Design phase to mitigate impacts from ARD during construction and operation.

Table 16 Dominant soil types across the project

Soil type	Generalised solid geology	Description	Location
Dermosols	Quaternary alluvium (sands and clayey/silty sands).	Typically, non-reactive Uniform soils with moderate to strongly structured B2 Horizons (subsoils). Soils may also have variable acidic or sodic profiles depending on geomorphology and the influence of landscape factors. These soils are more uniform and are loam to clay in texture.	Contract 1 – Woondum Interchange to Gympie Road Connection

Soil type	Generalised solid geology	Description	Location
Chromosol	Triassic metasediments (Arenite, Argillite, Phyllite).	Related to the harder meta sedimentary rocks (Kin Kin Beds) which form the higher ground to the west of the project.	Contract 1 - Gympie Connection Road to the North Coast Railway
Tenosol	Weak Permian sediments (sandstone, siltstone and mudstones).	Major soil type where the route crosses the weak sedimentary rocks of the Keefton Formation and Gympie Group.	Contract 1 -Keefton Road to Wood Road
Chromosol	Triassic metasediments (Arenite, Argillite, Phyllite).	Related to the harder meta sedimentary rocks (Kin Kin Beds) which form the higher ground to the west of the project.	Contract 2 - Wood Road to Bradys Road
Tenosol	Weak Permian sediments (sandstone, siltstone and mudstones).	Major soil type where the route crosses the weak sedimentary rocks of the Keefton Formation and Gympie Group.	Contract 2 - Bradys Road to Ashford Road
Sodosols	Weak Triassic sediment (labile feldspathic sandstone, siltstone and shales).	Derived from feldspathic sandstones of the Myrtle Creek Sandstone.	Contract 2 in the northern part of the project between Ashfords Road to the connection with the existing Bruce Highway (north of Curra)

3.3.4 Outstanding natural features

The closest outstanding natural feature to the project area is the Mary River. At its closest point, the Mary River is located 200 m from the project area in the southern extent. However, this distance extends to 10 km in the centre of the project area and 4 km in the north.

3.3.5 Remnant native vegetation

The baseline terrestrial surveys undertaken by BAAM in 2015 (BAAM, 2015) field verified the presence of remnant vegetation across the survey area, including ‘endangered’, ‘of concern’ and ‘least concern’ REs under the Queensland *Vegetation Management Act 1999*. A summary of REs confirmed present within the survey area are provided in Table 17.

Table 17 Regional Ecosystems within the survey area

RE	Status	Description
12.3.1	Endangered	Gallery rainforest (notophyll vine forest) on alluvial plains
12.3.3d	Endangered	Floodplain (other than floodplain wetlands). *Eucalyptus moluccana* woodland. Other frequently occurring species include *Eucalyptus tereticornis*, *E. crebra*, *E. siderophloia* and *Corymbia intermedia*. Occurs on margins of Quaternary alluvial plains usually adjacent sedimentary geologies.
12.3.11	Of concern	*Eucalyptus tereticornis* +/- *Eucalyptus siderophloia*, *Corymbia intermedia* open forest on alluvial plains usually near coast
12.9-10.4	Least concern	*Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks
12.9-10.17	Least concern	*Eucalyptus acmenoides*, *E. major*, *E. siderophloia* +/- *Corymbia citriodora* subsp. *variegata* woodland on sedimentary rocks
12.11.3	Least concern	*Eucalyptus siderophloia*, *E. propinqua* +/- *E. microcorys*, *Lophostemon confertus*, *Corymbia intermedia*, *E. acmenoides* open forest on metamorphics +/- interbedded volcanics
12.11.5e	Least concern	*Corymbia citriodora subsp. variegata* woodland usually including *Eucalyptus siderophloia* or *E. crebra* (sub coastal ranges), *E. propinqua* and *E. acmenoides* or *E. carnea*. Occurs on hills and ranges of Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.
12.11.10	Least concern	Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics
12.11.14	Of concern	*Eucalyptus crebra*, *E. tereticornis*, *Corymbia intermedia* woodland on metamorphics +/- interbedded volcanics
12.11.16	Endangered	*Eucalyptus cloeziana* open forest on metamorphics +/- interbedded volcanics

3.3.6 Gradient

The project is located within the Mary River valley with elevated ranges located to the east and west of the project (Jacobs, 2016). Elevation above sea level along the project alignment varies between 50 metres and 150 metres Australian Height Datum (AHD) (Jacobs 2016).

3.3.7 Current state of the environment

Include information about the extent of erosion, whether the area is infested with weeds or feral animals and whether the area is covered by native vegetation or crops.

The project area for construction extends through numerous landscapes with a variety of disturbances. The following dots points provide a summary of disturbances noted across the project area during technical studies undertaken for the project:

- Declared invasive weeds such as *Lantana camara* (lantana), *Macfadyena unguis-cati* (cats claw creeper) were noted as the two most prevalent weeds (ERM, 2016; GHD, 2016a). Cats claw creeper is most prevalent within the riparian vegetation of Six Mile Creek and Tannery Creek (GHD, 2016a). Both lantana and cats claw creeper are listed as Weeds of National Significance (WoNS) under the Australian Government's database (Australian Government, 2016). Additional WoNS noted in the project area included *Asparagus africanus* (climbing asparagus) and *Asparagus aethiopicus* (asparagus fern).
- Feral pig diggings were noted at Curra Creek (ERM, 2016) and Tamaree Creek, domestic (cows, horses and dogs) animals were noted across the project area and evidence of feral rabbits was observed (ERM, 2016). Minor erosion within waterways from cattle crossings was noted across the project area (ERM, 2016).
- Wild dogs are known to occur across the Gympie Region and evidence has been noted within the project area (ERM, 2016).
- Curra State Forest has been managed through regular fire management and active logging practises.
- Cleared areas such as pastures, agricultural or residential land parcels are present across approximately 50% of the project area.
- Naturally occurring bank erosion was noted within Six Mile Creek, Deep Creek, Curra Creek (upstream), Corella Creek, Keliher Creek, Tannery Creek, Moody Creek, Tamaree Creek and two unnamed waterways across the project area (GHD, 2016a).
- Two aquatic pest species were recorded during the 2015 (Jacobs, 2016) and 2016 (GHD, 2016a) aquatic fauna surveys. *Gambusia holbrooki* (mosquitofish) a noxious species known to occur in the Mary River catchment was recorded at Six Mile Creek, Curra Creek, Deep Creek, Tannery Creek, Moody Creek, Banks Creek, Tamaree Creek and Curra Creek north (Jacobs, 2016; GHD, 2016a). *Xiphophorus maculatus* (platy) was recorded at Six Mile Creek, Curra Creek, Deep Creek, Tannery Creek and Curra Creek north (Jacobs, 2016; GHD, 2016a).

3.3.8 Commonwealth heritage places or other places recognised as having heritage values

No Commonwealth Heritage Places were identified in the Protected Matters Search for the project (refer to Appendix D). No places of State or local European heritage are located within the project area.

3.3.9 Indigenous heritage values

A desktop assessment of the cultural heritage values of the site and surrounding area has been completed. Further site investigative works are currently in progress. No archaeological or cultural heritage sites have previously been recorded within the project area. Despite this, the desktop assessment has concluded that the project and surrounding area has the potential to contain as yet unrecorded archaeological and cultural heritage sites. It is expected that surface distributions of stone artefacts are the site type most likely to occur within the project area and are likely to be found in creeks and associated flood plains, as well as remnant woodland. Other site types likely to occur include scarred trees and/or carved trees, and earthen arrangements and features, including possibly bora grounds. Representatives of the Kabi Kabi First Nation

People have identified two potential bora grounds on a property located off Gympie Connection Road, referred to as Rocky Ridge. There is the potential for sites of cultural heritage to be identified at the Rocky Ridge location and this is currently being assessed in collaboration with the Kabi Kabi First Nation People.

3.3.10 Other important or unique values of the environment

Describe any other key features of the environment affected by, or in proximity to the proposed action (for example, any national parks, conservation reserves, wetlands of national significance etc.).

The project area intersects two State Forests including:

- Woondum State Forest (Lot 983 on FTY1488), located between approximate Ch 136800 m and Ch 137290 m
- Curra State Forest (Lot 700 on FTY1491), located between approximate Ch 151200 m and Ch 157700 m

Approximately 10 ha of Woondum State Forest will be revoked as part of Contract 1 and approximately 58 ha of Curra State Forest will be revoked as part of Contract 2.

The project does not intersect any additional forest reserves, national parks, regional parks or timber reserves.

3.3.11 Tenure of the action area (e.g. freehold, leasehold)

Real property descriptions of the properties impacted by the project are listed in Appendix B, with existing land tenure across the project area shown on a figure included as Appendix O. The entire project area will be transferred to road reserve prior to construction works commencing.

3.3.12 Existing land use of area

The project area extends for a length of 30 km and intersects a variety of land uses. The existing land uses intersected by the alignment include the following:

- Residential – including urban residential, rural residential and dwellings on rural properties. The majority of residential uses are generally located between the North Coast Railway and the southern boundary of the Curra State Forest (Jacobs, 2016).
- Commercial – including resource extraction, agricultural and livestock equipment sales and sporting clubs, such as the Mothar Mountain Speedway and Cooloola Kart Club
- Existing road infrastructure – including both State-controlled roads and local road networks
- State Forests – including Woondum State Forest and Curra State Forest

3.3.13 Any proposed land uses

No major changes to existing land use outside the project area planning is currently known. The project area is mapped on the existing *Gympie Regional Council Planning Scheme 2013* as a proposed State Government Road.

Within the project area, land use will be converted from its existing use to road uses.

4. Environmental outcomes

Provide descriptions of the proposed environmental outcomes that will be achieved for matters of national environmental significance as a result of the proposed action. Include details of the baseline data upon which the outcomes are based, and the confidence about the likely achievement of the proposed outcomes. Where outcomes cannot be identified or committed to, provide explanatory details including any commitments to identify outcomes through an assessment process.

If a proposed action is determined to be a controlled action, the Department may request further details to enable application of the draft Outcomes-based Conditions Policy 2015 and Outcomes-based Conditions Guidance 2015 (http://www.environment.gov.au/epbc/consultation/policy-guidance-outcomes-based-conditions), including about environmental outcomes to be achieved, details of baseline data, milestones, performance criteria, and monitoring and adaptive management to ensure the achievement of outcomes. If this information is available at the time of referral it should be included.

General commitments to achieving environmental outcomes, particularly relating to beneficial impacts of the proposed action, CANNOT be taken into account in making the initial decision about whether the proposal is likely to have a significant impact on a matter protected under the EPBC Act. (But those commitments may be relevant at the later assessment and approval stages, including the appropriate level of assessment, and conditions of approval, if your proposal proceeds to these stages).

This referral has been prepared using the documentation completed to date, including targeted surveys for flora species and vegetation communities and terrestrial and aquatic fauna (refer to Table 3). As described in Section 3.1 of this referral, the project is anticipated to have a significant residual impact on the following MNES:

- Black-breasted button quail
- Koala
- Lowland Rainforest of Subtropical Australia TEC

The project was assessed as unlikely to have a significant impact on the following MNES:

- *Macrozamia pauli-guilielmi* (pineapple zamia)
- The grey-headed flying-fox and greater glider
- Aquatic fauna including the Mary River turtle, Mary River cod and white-throated snapping-turtle

However, individuals of these species have the potential to occur within the project area and therefore mitigation measures have been included which are relevant to these species.

Proposed environmental outcomes

The following environmental outcomes are proposed for MNES significantly impacted by the project and those MNES not anticipated to be significantly impacted, however are either known or likely to occur:

- Clearing of no more than 138.44 ha, comprising 42.93 ha within Contract 1 and 95.51 in Contract 2 of habitat critical to the survival of the koala and foraging habitat for the grey-headed flying fox habitat
- Clearing of no more than 8.14 ha of black-breasted button quail habitat

- Clearing of no more than 45.63 ha of foraging habitat and 21.83 ha denning habitat of the greater glider within Curra State Forest
- Compliance with the water quality criteria nominated in the contract documentation (MRTS52 – Erosion and Sediment Control) for receiving water quality within major waterways providing habitat to the Mary River turtle, Mary River cod and white-throated snapping-turtle
- No permanent in-stream barriers to the movement of threatened aquatic species within major waterways
- Translocation of all known *Macrozamia pauli-guilielmi* (pineapple zamia) identified within the project area to the nominated translocation site outside the project area
- Clearing of no more than 0.82 ha of the Lowland Rainforest of Subtropical Australia TEC and 4.67 ha of the Lowland Rainforest of Subtropical Australia TEC 50 m buffer area at Six Mile Creek
- Clearing of no more than 0.52 ha of the Lowland Rainforest of Subtropical Australia TEC 50 m buffer area at Woondum State Forest

Environmental outcomes from the project for each of the above MNES will be achieved through the implementation of the mitigation measures proposed in Section 5 of this referral and through the implementation of the following documentation to be prepared for the project:

- TMR's current environmental specifications - Main Roads Technical Specification (MRTS) 51 – Environmental Management and associated annexure, and MRTS52 – Erosion and sediment control and associated annexure. These technical standards and annexures will be developed as part of the contract documentation for compliance by the awarded Construction Contractor. These documents outline requirements for environmental management plans and erosion and sediment control plans to be prepared by the Construction Contractor and detail required environmental monitoring, reporting and auditing processes to ensure environmental objectives and compliance throughout the construction of the project.
- An Environmental Management Plan (Construction) (EMP(C)) – to incorporate mitigation measures pertaining to fauna, flora and habitat, along with additional measures pertaining to timing of works, waste management, contaminant management, site personnel training, and air and noise management. The EMP(C) will be prepared by the Construction Contractor in accordance with MRTS51 – Environmental Management.
- An Erosion and Sediment and Erosion Control Plan (ESCP) – to manage sediment from construction works and minimise impacts on water quality. The ESCP and the proposed measures will be prepared in accordance with MRTS52 – Erosion and Sediment Control.
- Species Management Program (high risk) – is required to be developed for all endangered, vulnerable, near threatened or special least concern and colonial breeding fauna species listed under the State's NC Act, where an active breeding place has been confirmed
- A Dewatering Plan will be prepared as part of the SMP high risk to manage all dewatering activities to be undertaken during construction
- An EPBC Act Environmental Offsets Proposal for residual significant impacts to MNES, will be prepared in accordance with the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy, October 2012* (DSEWPaC, 2012). The offsets proposal will be developed using the a number of viable offset strategies which have been included in Appendix K of this referral.

- Translocation Management Plan prepared for *Macrozamia pauli-guilielmi* (pineapple zamia) identified within the project area. The Translocation Management Plan nominates potential suitable habitat areas for translocated individuals and management measures to maximize survival rates.
- Revegetation and landscaping plans to stabilise and rehabilitate areas following construction. These plans form part of the MRTS16 – Landscape and Revegetation Works and associated annexure.
- Additional Works Code of Compliance has been developed to enable vegetation clearing to support construction related activities outside the nominated project area, without resulting in significant impacts to MNES. This Code provides clear direction to the Construction Contractor of the required procedures to be undertaken when planning and undertaking vegetation clearing outside the nominated project area, refer to Appendix P.

Likelihood of achieving proposed environmental outcomes

It is considered likely that the proposed environmental outcomes nominated above will be achieved through the implementation of the above documentation and mitigation measures proposed in Section 5 of this referral. The proposed environmental outcomes will form part of TMR's contractual documentation by which the Construction Contractors must abide.

5. Measures to avoid or reduce impacts

Provide a description of measures that will be implemented to avoid, reduce, manage or offset any relevant impacts of the action. Include, if appropriate, any relevant reports or technical advice relating to the feasibility and effectiveness of the proposed measures.

For any measures intended to avoid or mitigate significant impacts on matters protected under the EPBC Act, specify:

- what the measure is;
- how the measure is expected to be effective, and
- the time frame or workplan for the measure.

Examples of relevant measures to avoid or reduce impacts may include the timing of works, avoidance of important habitat, specific design measures, or adoption of specific work practices.

Provide information about the level of commitment by the person proposing to take the action to achieve the proposed environmental outcomes and implement the proposed mitigation measures. For example, if the measures are preliminary suggestions only that have not been fully researched, or are dependent on a third party's agreement (e.g. council or landowner), you should state that, that is the case.

Note, the Australian Government Environment Minister may decide that a proposed action is not likely to have significant impacts on a protected matter, as long as the action is taken in a particular manner (section 77A of the EPBC Act). The particular manner of taking the action may avoid or reduce certain impacts, in such a way that those impacts will not be 'significant'. More detail is provided on the Department's web site.

For the Minister to make such a decision (under section 77A), the proposed measures to avoid or reduce impacts must:

- clearly form part of the referred action (eg be identified in the referral and fall within the responsibility of the person proposing to take the action),
- be must be clear, unambiguous, and provide certainty in relation to reducing or avoiding impacts on the matters protected, and
- must be realistic and practical in terms of reporting, auditing and enforcement.

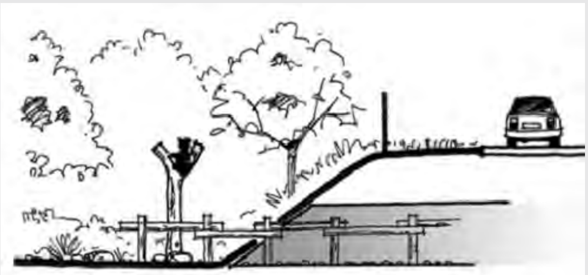
If a proposed action is determined to be a controlled action, the Department may request further details to enable application of the Outcomes-based Conditions Policy 2016 (http://www.environment.gov.au/epbc/publications/outcomes-based-conditions-policy-guidance), including information about the environmental outcomes to be achieved by proposed avoidance, mitigation, management or offset measures, details of baseline data, milestones, performance criteria, and monitoring and adaptive management to ensure the achievement of outcomes. If this information is available at the time of referral it should be included in the description of the proposed measures.

More general commitments (e.g. preparation of management plans or monitoring), commitments to achieving environmental outcomes and measures aimed at providing environmental offsets, compensation or off-site benefits CANNOT be taken into account in making the initial decision about whether the proposal is likely to have a significant impact on a matter protected under the EPBC Act. (But those commitments may be relevant at the later assessment and approval stages, including the appropriate level of assessment, if your proposal proceeds to these stages).

The project has incorporated a number of design alterations to avoid or reduce direct and/or indirect impacts to MNES. However, due to the range and broad extent of habitat suitable to MNES likely or known to occur within the project area, the complete avoidance to habitat suitable for MNES is unachievable due to road design constraints and safety considerations. Therefore offsets for residual significant impacts to MNES will be required in accordance with the *EPBC Act Environmental Offsets Policy 2012*.

The actions which have been incorporated into the project to avoid or reduce impacts to habitat suitable for MNES are summarised within the relevant chapters of the MNES Significant Impact Assessment Report, refer to Appendix K. A brief description of management measures included to mitigate impacts on those MNES where a significant residual impact is anticipated are provided in Table 18. A full description of these management measures and their effectiveness for each MNES is provided in the relevant sections of the MNES Significant Impact Assessment Report, refer to Appendix K.

Table 18 Mitigation measures to manage impacts to MNES

MNES	Management actions
Koalas	Targeted koala surveys completed during the Detailed Design phase Erection of fauna fencing (koala exclusion fencing) along retained bushland and on either side of nominated fauna connectivity structures, including both fauna underpasses and bridges Incorporation of 4 fauna connectivity structures and 10 bridge structures (8 over water, 2 over roads). Each fauna connectivity structure has been sized to accommodate for koalas (i.e. 3 m x 3 m) and will incorporate fauna furniture specific for koalas (refer to Plate 1) Incorporation of vegetation clearing limits, pre-clearing surveys, specific vegetation clearing requirements and methodologies within the contract documentation   **Plate 1 General details of fauna furniture specific for koalas**

MNES	Management actions
Black-breasted button-quail	Targeted black-breasted button-quail surveys completed during the Detailed Design phase Erection of fauna fencing along retained bushland and on either side of the nominated fauna connectivity structure Incorporation of a fauna connectivity structures within Woondum State Forest to maintain habitat connectivity on the eastern and western sides of the project Incorporation of vegetation clearing limits, pre-clearing surveys, specific vegetation clearing requirements and methodologies within the contract documentation Revegetation on both the entry and exit of the fauna connectivity structure to encourage use by the black-breasted button-quail
Macrozamia pauli-guilielmi	Targeted flora surveys to identify and confirm the extent of occurrence of *M. pauli-guilielmi* completed during the Detailed Design phase Development and implementation of a peer-reviewed Translocation Management Plan Post translocation monitoring of *M. pauli-guilielmi* and adaptive management measures
Lowland Rainforest of Subtropical Australia Threatened Ecological Community	A review of design and construction methodologies employed for the Six Mile Creek bridge structure to reduce impacts to the TEC. The review of the design and construction methodologies for bridge construction included: ○ Altering the bridge spans from 33 m span (Business Case phase) to a main span of 46.4 m in length made continuous using 38 m long super T-girders (Detailed Design phase) to reduce impacts to the waterway and associated riparian vegetation. ○ Individual span widths have been rationalised during the Detailed Design phase due to environmental concerns associated with Six Mile Creek and the TEC. ○ Raising the deck level by 770 mm during the Detailed Design phase to account of critical 1% AEP design storm event and climate change. ○ Increase in spacing between northbound and southbound bridge structures to 1360 mm to allow for increase in natural light. ○ Consideration of specific construction methodologies such as pile structure, timing of construction program, use of a launching truss, use of scaffolding, use of steel casings. Nomination of specific construction methodologies for the construction of the bridge in the contract documentation to reduce impacts to the area Nomination of timing requirements for the construction of the bridge structure Nomination of timing requirements for instream works and bank stability works Nomination of specific treatments for bank stability works on both banks of Six Mile Creek

MNES	Management actions
	Requirement for no temporary crossings to be constructed over Six Mile Creek Targeted flora surveys to identify the presence of the TEC Nomination of vegetation clearing limits, establishment on no-go zones within the contract documentation Ongoing weed control throughout the project duration

Additional general environmental mitigation measures included in the design or contract documentation to mitigate impacts to additional MNES includes the following:

- Incorporation of 8 bridge structures (comprising northbound and southbound bridges) over waterways including Six Mile Creek, Deep Creek and Curra Creek (rather than culverts) to allow for the movement of aquatic species upstream and downstream of the project area.
- Each bridge proposed over major waterways (i.e. Six Mile Creek, Deep Creek and Curra Creek) have been designed to span the low flow channel, with abutments also located outside the bed and banks of the waterway to avoid impacts to aquatic fauna species during operation of the bridge.
- Each bridge proposed over the major waterways has been separated to allow for natural light to filter between the two structures.
- Baseline water quality monitoring of major waterways intersected by the project has been undertaken for twelve months to gain an appreciation of baseline flow characteristics and response to rainfall events.
- Discharge and receiving water quality performance criteria will be developed and included in the contract documentation, with consideration of available data specific to the local catchment.
- Permanent water quality improvement devices (bio-retention systems) have been incorporated into the design at each major waterway crossing (i.e. Six Mile Creek, Deep Creek and Curra Creek) to reduce pollutant loads entering the receiving environment.
- Spill containment devices have been incorporated on structures over Six Mile Creek, Deep Creek and Curra Creek to trap oils and fuels from entering these waterways.
- Revegetation and landscaping plans have been developed in accordance with TMR’s MRTS16 – Landscape and Revegetation Works.
- Vegetation clearing limits will be defined under the contract documentation, to minimise the extent of vegetation clearing whilst allowing construction to occur taking into account erosion and sediment control devices. A plan of clearing limits will be prepared by the Construction Contractor and clearing shall not proceed on site until the limits of clearing have been deemed suitable by the Contract Administrator.
- The EMP(C) will include a requirement to restrict the use of herbicides and growth retardants to control vegetation, as well as fire retardants and insecticides over and adjacent to dams drainage lines and waterways within the project area, due to the potential indirect impacts on MNES and other threatened fauna.
- Additional workspace areas and haul routes will be placed in previously cleared areas, where possible.
- Suitable ESC measures will be installed in waterways prior to works commencing.

- Undertake instream, bank stability works and works within the bed and banks of Six Mile Creek during dry periods and periods of low flow.
- Undertake instream works within Deep Creek and Curra Creek during periods of low flow or the dry season.
- Where flow is present, maintain flow of waterways during construction of temporary diversions, temporary waterway crossings or appropriately sized bunds.
- Where appropriate, external catchment drainage lines shall be diverted around disturbed areas via cross drains and drainage channels.
- No-go zones will be nominated in the contract documentation. These will be clearly set out and marked prior to construction activities commencing. No works are to be undertaken in these areas, nor are these areas to be used as storage of materials/plant.
- The contract documentation will require the Construction Contractor to develop a clear staged approach to vegetation clearing prior to the commencement of works. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins). The staging of works will be required to be deemed suitable by the Contract Administrator prior to clearing works commencing.
- Environmental induction to all site personnel to outline responsibilities in relation to MNES.
- Weed species and pests will be required to be managed in accordance with the contract documentation.
  - Implement weed management strategies during construction, including weed monitoring and reporting during construction, washdown of vehicles prior to entering the project area, removal of invasive weeds and conducting weed inspection as part of the rehabilitation monitoring and reporting.
  - Hygiene declaration forms are to be prepared for all plant/vehicles working within the project area.
- Weed management will be required to be undertaken post-construction in accordance with the contract documentation and the Road Maintenance Performance Contract (RMPC) developed for the project.
- Terrestrial fauna specialists shall be appointed, prior to construction commencing, and approved by EHP for the handling, capture and release of native fauna (e.g. a licensed spotter catcher issued under the *Nature Conservation (Administration) Regulation 2006)*, for the assessment and/or removal of native fauna.
- Prior to vegetation clearing in each zone, the terrestrial fauna specialist will undertake a pre-clearing survey to identify and mark habitat features (i.e. hollow bearing logs, hollow bearing trees, areas of wetland vegetation, banks along waterways with burrows etc.). The terrestrial fauna specialist will also be required to identify the fauna species likely or known to be present within the stage to be cleared based on existing habitat and previous records as identified during the targeted surveys.
- Hollow timber, woody debris and bush rock which are suitable for fauna habitat will be relocated to retained habitat areas outside the clearing area adjacent to the project area, where possible.
- The terrestrial fauna specialist is required to undertake an immediate pre-clearance survey 24 hours ahead of vegetation clearing in each stage to search habitat features previously marked for fauna and/or breeding activity. A two stage approach to clearing

will be implemented where hollow bearing trees have been identified. Non-hollow bearing trees will be cleared before hollow bearing trees to allow fauna an opportunity to move away and allow time to concentrate rescue efforts on the trees that are most likely to be inhabited. Sequential vegetation clearing to be applied onsite. Vegetation clearing is to occur from disturbed areas and clear towards areas of vegetation to be retained. Hollow bearing trees will be felled after a minimum 24 hr delay after clearing of non-habitat trees. The terrestrial fauna specialist will be on site for all clearing works, including clearing of hollow bearing trees. Individual hollows of felled hollow bearing trees will be inspected using a torch or similar by the terrestrial fauna specialist and the relevant fauna contingency actions initiated. Once the trees are deemed clear by the terrestrial fauna specialist further processing can occur.

- Where possible, cleared native vegetation should be mulched and reused onsite during establishment of erosion and sediment control, rehabilitation and stabilisation activities. Should the mulch be required to be stockpiled, the material shall be stockpiled in a manner where endemic seeds remain viable and weeds are treated.
- All dewatering activities are to be supervised by an aquatic fauna specialist who must have demonstrated experience in the capture and relocation of aquatic MNES. The aquatic fauna specialist must hold all relevant permits including a current General Fisheries Permit, a Rehabilitation Permit and an Animal Ethics Permit.
- An aquatic fauna specialist is required to undertake pre-clearance surveys prior to any dewatering activities (including those relating to dams, waterway diversions etc.) to identify whether any burrows are present within the project area.
- Where possible, during construction, avoid positioning direct artificial lighting towards retained bushland.
- Strategic planting adjacent to targeted fauna connectivity structures will occur to improve and maintain habitat connectivity for MNES, where possible.
- Key aspects of the waterway revegetation actions will include stabilisation, replanting, weed control, and restriction of public access and grazing, where applicable.
- Permanent revegetation onsite shall occur progressively as soon as practicable once earthworks are complete in accordance with MRTS16 – General Requirements Landscape and Revegetation Works and associated annexure.

6. Conclusion on the likelihood of significant impacts

Identify whether or not you believe the action is a controlled action (i.e. whether you think that significant impacts on the matters protected under Part 3 of the EPBC Act are likely) and the reasons why.

6.1 Do you think your proposed action is a controlled action?

No, complete section 6.2

Yes, complete section 6.3

Yes

6.2 Proposed action IS NOT a controlled action

Specify the key reasons why you think the proposed action is NOT LIKELY to have significant impacts on a matter protected under the EPBC Act.

Not applicable.

6.3 Proposed action IS a controlled action

Type 'x' in the box for the matter(s) protected under the EPBC Act that you think are likely to be significantly impacted. (The 'sections' identified below are the relevant sections of the EPBC Act.)

	Matters likely to be impacted
	World Heritage values (sections 12 and 15A)
	National Heritage places (sections 15B and 15C)
	Wetlands of international importance (sections 16 and 17B)
X	Listed threatened species and communities (sections 18 and 18A)
	Listed migratory species (sections 20 and 20A)
	Protection of the environment from nuclear actions (sections 21 and 22A)
	Commonwealth marine environment (sections 23 and 24A)
	Great Barrier Reef Marine Park (sections 24B and 24C)
	A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E)
	Protection of the environment from actions involving Commonwealth land (sections 26 and 27A)
	Protection of the environment from Commonwealth actions (section 28)
	Commonwealth Heritage places overseas (sections 27B and 27C)

Specify the key reasons why you think the proposed action is likely to have a significant adverse impact on the matters identified above.

A *MNES Significant Impact Assessment Report* (GHD, 2016d) has been prepared for all MNES known or likely to occur within the project area, which includes a significant impact assessment for each MNES (refer Appendix K). The outcomes of this report conclude that although the project has incorporated a number of avoidance and mitigation measures the project is likely to have a significant impact on the black-breasted button-quail, koala and the lowland sub-tropical rainforest of lowland south-eastern Australia TEC. A significant impact has been avoided for the following MNES: grey-headed flying-fox, greater glider, Mary River cod, Mary River turtle and the white-throated snapping turtle, through either the incorporation of design avoidance or mitigation measures which are known or likely to occur in the project area.

On the basis of this assessment, the project should be controlled through the commitments of environmental outcomes as defined in Section 4, the avoidance measures and mitigation measures included in Section 5 and the offset strategies included as Appendix K of this referral.

7. Environmental record of the responsible party

NOTE: If a decision is made that a proposal needs approval under the EPBC Act, the Environment Minister will also decide the assessment approach. The EPBC Regulations provide for the environmental history of the party proposing to take the action to be taken into account when deciding the assessment approach.

7.1 Does the party taking the action have a satisfactory record of responsible environmental management?

Yes, TMR has implemented a strategic environmental planning, assessment and implementation process for its major projects. To date, TMR has successfully implemented its 'duty of care' to the environment, as per Section 319 of the Queensland *Environmental Protection Act 1994*. Environmental impact minimisation and mitigation measures are implemented for all projects and these requirements are communicated to relevant parties through a number of processes and documents, including: Environmental Management Plans (Planning, Design, Construction and in some cases Operation), contract documentation (Main Roads Standard Specification MRTS51 - Environmental Management and MRTS52 - Erosion and Sediment Control). All of these documents are also utilised during internal and external environmental audits to ensure documented processes are implemented on the ground. TMR and its contractors are responsible for understanding any non-conformances or improvements and implementing rectification measures as required. In addition, if unforeseen circumstances do arise and unexpected environmental impacts are experienced, TMR and its contractors have, and are willing, to rectify such situations to ensure minimal impact occurs, as well as restoration of the environment in accordance with TMR procedural instructions or direction given by the responsible environmental agency (e.g. Commonwealth DEE or Queensland EHP). In developing mitigation measures and certain design related aspects for the current Section D project, liaison with the environmental representative of the Contract Administration team on the previous Cooroy to Curra projects has been undertaken to build upon previous learnings in regards to environmental management.

7.2 Has either (a) the party proposing to take the action, or (b) if a permit has been applied for in relation to the action, the person making the application - ever been subject to any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources?

No.

7.3 If the party taking the action is a corporation, will the action be taken in accordance with the corporation's environmental policy and planning framework?

If yes, provide details of environmental policy and planning framework.

Yes. TMR has recognised a need for environmental compliance as part of its core business, having established an Environmental Management System.

The TMR's environmental policy and planning framework forms a functional role in the environmental assessment of TMR's projects and business. This framework flows down from the Department's Strategic Plan which requires TMR's business to undertake "environmental management to support environmental conservation" through corporate policies, strategies and documents. The overall strategic environmental outcome is implemented during TMR's business through the Environmental Processes Manual (August 2013). The environmental assessment processes (undertaken in accordance with the Environmental Processes Manual) are then implemented during construction through Main Roads Specification MRTS51 Environmental Management and MRTS52 Erosion and Sediment Control, which forms part of all Main Roads construction tender documentation. The Road Maintenance Performance Contracts also require environmental management to be implemented as part of any maintenance work contractors undertake on TMR's behalf. There are a variety of other environmental policies and documents which TMR has developed to address some of the more specific environmental issues, such as cultural heritage and noise, with all of these specialist policies providing support to the broader environmental assessment process undertaken by TMR.

7.4 Has the party taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?

Provide name of proposal and EPBC reference number (if known).

Yes, TMR have previously referred a variety of actions from across Queensland. Some Wide Bay Burnett Region and South East Queensland Region examples include:

- EPBC 2008/4452 Bruce Highway, Cooroy to Curra, Section B
- EPBC 2011/6024 Bruce Highway, Cooroy to Curra, Section A
- EPBC 2013/6815 for Bruce Highway Realignment – Cabbage Tree Creek and Carman Road
- EPBC 2014/7394 Bruce Highway, Cooroy to Curra, Section C
- EPBC 2015/7464 Bruce Highway Upgrade Caloundra Road to Sunshine Motorway
- EPBC 2015/7558 Bruce Highway Overtaking Lane Adjustment near Bauple-Woolooga Road Intersection
- EPBC 2015/7552 Eton Range Realignment Project, Peak Downs Highway

8. Information sources and attachments

8.1 References

List the references used in preparing the referral.

Australian Cultural Heritage Management (ACHM) (2015) *Desktop Cultural Heritage Assessment Bruce Highway Upgrade: Cooroy to Curra Section D*. Prepared for the Department of Transport and Main Roads.

Australian Government (2016) *Weed in Australia*. Available from: http://www.environment.gov.au/biodiversity/invasive/weeds/index.html. Accessed: August 2016.

ARUP (2008) *Bruce Highway (Cooroy to Curra) Strategic Planning Study - Recommended Corridor Report*. Prepared for the Department of Transport and Main Roads (formally Department of Main Roads).

Biodiversity Assessment And Management (BAAM) (2015) *Bruce Highway Upgrade Section D: Baseline Ecological Assessment Woondum Road to Curra*. Prepared for the Department for Transport and Main Roads.

Biodiversity Assessment And Management (BAAM) (2016) *Detailed Terrestrial Flora Surveys Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)*. Prepared for the Department for Transport and Main Roads.

Department of the Environment and Energy (DEE) (2016a) Species Profile and Threats (SPRAT) Database species descriptions.

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8.2 Reliability and date of information

For information in Section 3 specify:

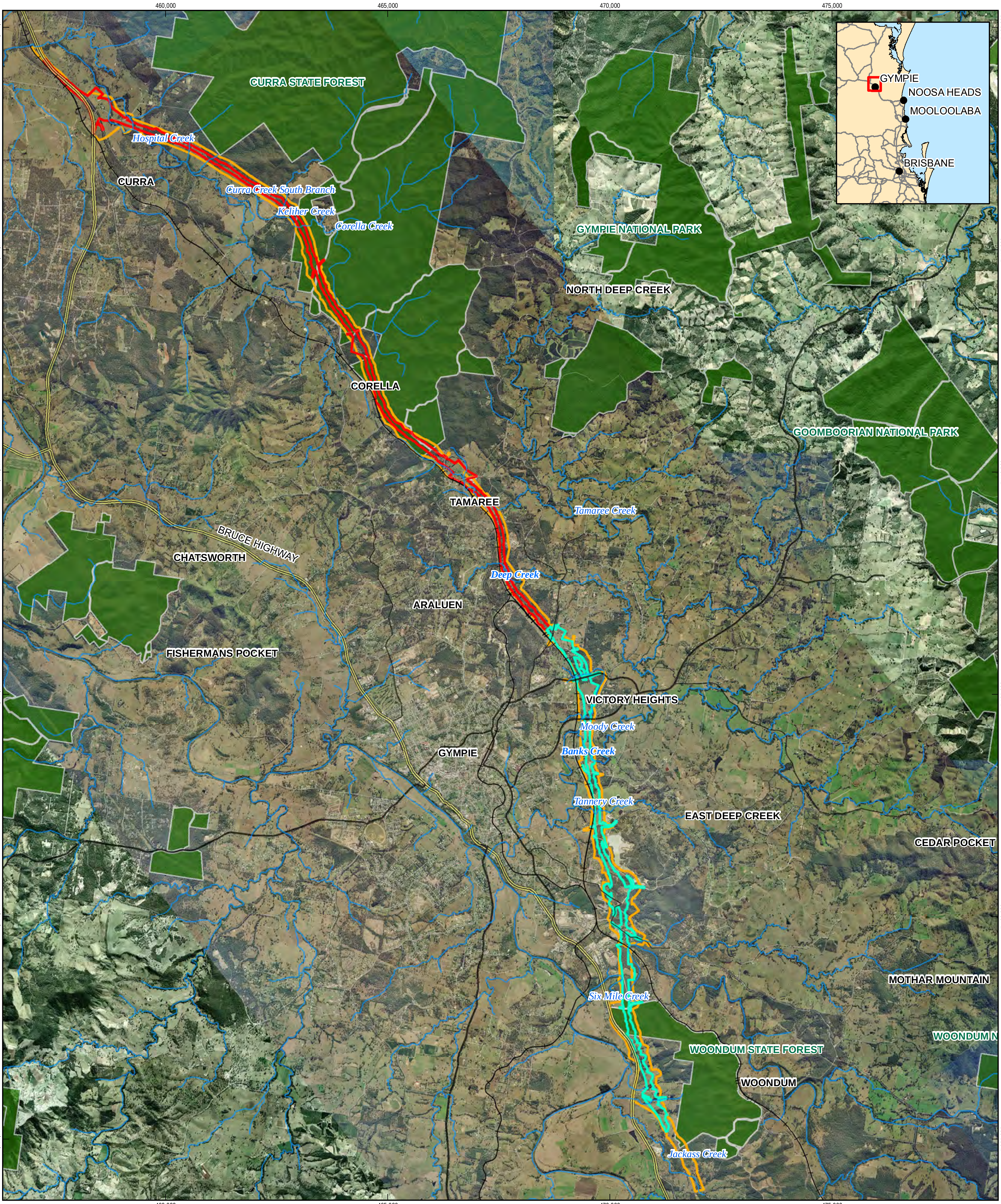
- source of the information
- how recent the information is
- how the reliability of the information was tested
- any uncertainties in the information

Information used in the preparation of this referral is based on a number of reports and studies previously developed to inform compliance with Commonwealth, Queensland and local government approval processes. These studies have been undertaken by professional consultants who are qualified ecologists with practical experience in surveying and monitoring the local environment. Methods followed during field surveys were in accordance with relevant guidelines published by State and Commonwealth departments.

References that have been cited in preparation of this referral and supporting documentation (include databases and documents) that have been produced and maintained by State and Commonwealth departments, and as such are considered highly reliable. Other documents included manuscripts in scientific journals that have been subject to peer-review prior to publication, and are therefore also considered reliable sources of information.

Appendices

Appendix A – Locality Plan



LEGEND

- Town
- Watercourse
- Railway
- Highway
- Secondary Road
- Local Connector Road
- Street/Local Road

Project Area

- Contract 1
- Contract 2
- Survey Area

- Protected Areas

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:80,000 @ A3

0 0.5 1 2 3

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	24 Mar 2017

Locality Plan

Appendix A

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3030_EPBC_Fig01_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: GA: Town (2014); TMR: Aerial Imagery (2016), Survey Area (2016); DNRM: Railway, Watercourse (2014), Road (2016). GHD: Project Area (March 2017). Created by: SC

Appendix B – Real Property Descriptions

Appendix B - Lot on plan and land tenure

Lot on Plan	Tenure
21USL37366	State Land
3SP157903	State Land
13AP15872	State Land
57SP269736	State Land
983FTY1488	State Forest
983FTY1488	State Forest
700FTY1491	State Forest
700FTY1491	State Forest
700FTY1491	State Forest
700FTY1491	State Forest
491MCH4825	Reserve
410MCH4680	Reserve
351SP121982	Lands Lease
20CP907156	Lands Lease
351SP121982	Lands Lease
392SP121981	Lands Lease
715MCH5272	Lands Lease
733MCH5308	Lands Lease
18RP226325	Lands Lease
764MCH5342	Lands Lease
12SP121977	Lands Lease
100CP907156	Lands Lease
684MCH5452	Lands Lease
676SP121978	Lands Lease
401MCH5139	Lands Lease
412MCH5139	Lands Lease
414MCH804760	Lands Lease
0491MCH4825	Lands Lease
565MCH4992	Lands Lease
392SP121981	Lands Lease
724SP121979	Lands Lease
308CP827215	Lands Lease
2RP223609	Freehold
889CP864404	Freehold
833CP850502	Freehold
833CP850502	Freehold
1SP219428	Freehold
14MPH40540	Freehold
1MPH23906	Freehold
15MPH40639	Freehold
4MPH23906	Freehold
4MPH23816	Freehold
1SP233315	Freehold
2SP181040	Freehold
688MCH5456	Freehold

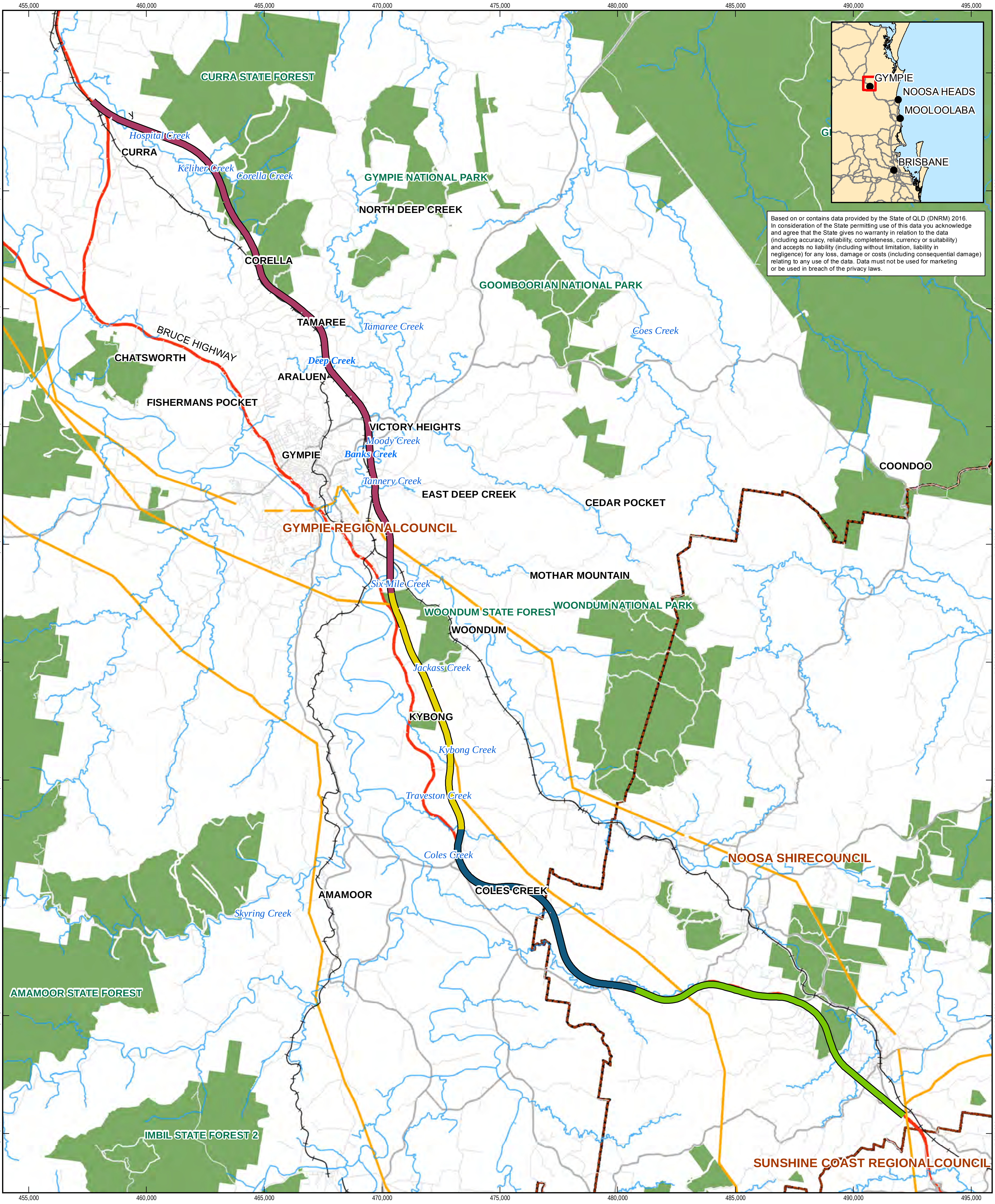
Lot on Plan	Tenure
1RP35055	Freehold
689MCH5456	Freehold
13MCH5356	Freehold
751MCH5339	Freehold
677MCH5338	Freehold
723MCH5306	Freehold
11MCH5356	Freehold
683MCH5338	Freehold
681MCH5338	Freehold
725MCH5306	Freehold
2MCH5360	Freehold
4MCH806660	Freehold
4MCH806659	Freehold
749MCH5343	Freehold
211MCH660	Freehold
7MCH806657	Freehold
4MCH806656	Freehold
4MPH40286	Freehold
3MPH40286	Freehold
1MPH30794	Freehold
2MPH23816	Freehold
644MCH5513	Freehold
6MCH806660	Freehold
10MCH806657	Freehold
8MCH806660	Freehold
6MCH806659	Freehold
1SP185929	Freehold
2RP163559	Freehold
3SP185929	Freehold
4SP185929	Freehold
2RP903717	Freehold
1MPH6461	Freehold
1MPH5877	Freehold
1MPH6211	Freehold
16MPH40639	Freehold
1MPH6094	Freehold
5MPH5013	Freehold
1RP903717	Freehold
1MPH7001	Freehold
1MPH30197	Freehold
1MPH35291	Freehold
1MPH40428	Freehold
2MPH40286	Freehold
1MPH40286	Freehold
3MPH23816	Freehold
1MPH6275	Freehold

Lot on Plan	Tenure
1MPH23816	Freehold
1MPH23450	Freehold
687MCH5456	Freehold
1MCH5360	Freehold
750MCH5339	Freehold
1MCH840256	Freehold
732MCH5308	Freehold
4MPH14224	Freehold
731MCH5309	Freehold
730MCH5309	Freehold
10MCH806659	Freehold
3RP213686	Freehold
2RP891751	Freehold
3RP845243	Freehold
3RP888053	Freehold
2RP888053	Freehold
1RP888053	Freehold
2RP157499	Freehold
4RP888053	Freehold
1RP891751	Freehold
5SP159637	Freehold
4RP212322	Freehold
1RP213686	Freehold
3RP158303	Freehold
1RP158303	Freehold
2RP158303	Freehold
250M37161	Freehold
1MPH14102	Freehold
1MPH14224	Freehold
926MCH5512	Freehold
690MCH5456	Freehold
19RP226325	Freehold
3MCH5360	Freehold
742MCH5342	Freehold
673MCH5303	Freehold
2SP145636	Freehold
3SP145636	Freehold
3RP802526	Freehold
1RP848424	Freehold
3RP165151	Freehold
5SP109084	Freehold
4SP109084	Freehold
60SP124228	Freehold
14RP802525	Freehold
2RP802526	Freehold
15RP802525	Freehold

Lot on Plan	Tenure
10RP802525	Freehold
11RP802525	Freehold
13RP802525	Freehold
2SP138757	Freehold
2SP138757	Freehold
2SP138757	Freehold
2SP138757	Freehold
1MPH11890	Freehold
729MCH5381	Freehold
878MCH1061	Freehold
878MCH1061	Freehold
1RP36941	Freehold
12MCH5356	Freehold
1RP228930	Freehold
3CP864821	Freehold
21SP277895	Freehold
22SP277895	Freehold
1MPH23745	Freehold
1MPH23906	Freehold
1MPH5226	Freehold
752SP233315	Freehold
16MPH40540	Freehold
3RP903717	Freehold
1MPH5105	Freehold
17MPH40639	Freehold
8MCH806659	Freehold
15MPH40540	Freehold
3RP199250	Freehold
1MPH6454	Freehold
1MPH5393	Freehold
2MPH23745	Freehold
1MPH5979	Freehold
14SP197847	Freehold
2SP185929	Freehold
685RP894546	Freehold
5MPH23815	Freehold
307SP103099	Freehold
1RP172559	Freehold
2MPH14224	Freehold
12RP802525	Freehold
4RP802526	Freehold
1SP109084	Freehold
1717M37818	Freehold
80CP882519	Freehold
2RP153981	Freehold
21SP277895	Freehold

Lot on Plan	Tenure
11SP197847	Freehold
BMPH40540	Easement
NMPH35430	Easement
DMCH5549	Easement
AMCH5544	Easement
ARP888053	Easement
BRP888053	Easement
ARP227832	Easement
EMCH5581	Easement
ARP882423	Easement
BRP882423	Easement
FMCH5548	Easement
BRP167032	Easement
ARP141972	Easement
ARP141973	Easement
ARP800302	Easement
ARP141974	Easement
AMPH40639	Easement

Appendix C – Bruce Highway Upgrade Cooroy to Curra Key Plan



LEGEND

- Town
- Waterways
- Railway
- Powerline 250kV
- Highway
- Secondary Road
- Local Connector Road
- Street/Local Road
- Section A: Cooroy Southern Interchange to Sankeys Rd
- Section B: Sankeys Rd to Traveston Rd
- Section C: Traveston to Woondum
- Section D: Woondum to Curra
- Protected Areas
- Local Government Boundaries

1:150,000 @ A3

0 1 2 4 6 8

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	21 Mar 2017

Key Plan

Appendix C

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3030_EPBC_Fig02_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: Cooroy to Curra Sections (2012). DNRM: Town (2014); Railway (2014), Waterways (2014), Road Network (2016), Local Government Boundaries (2014), Powerlines (2012). Created by: SC

Appendix D – EPBC Act Protected Matters Report

Australian Government
Department of the Environment

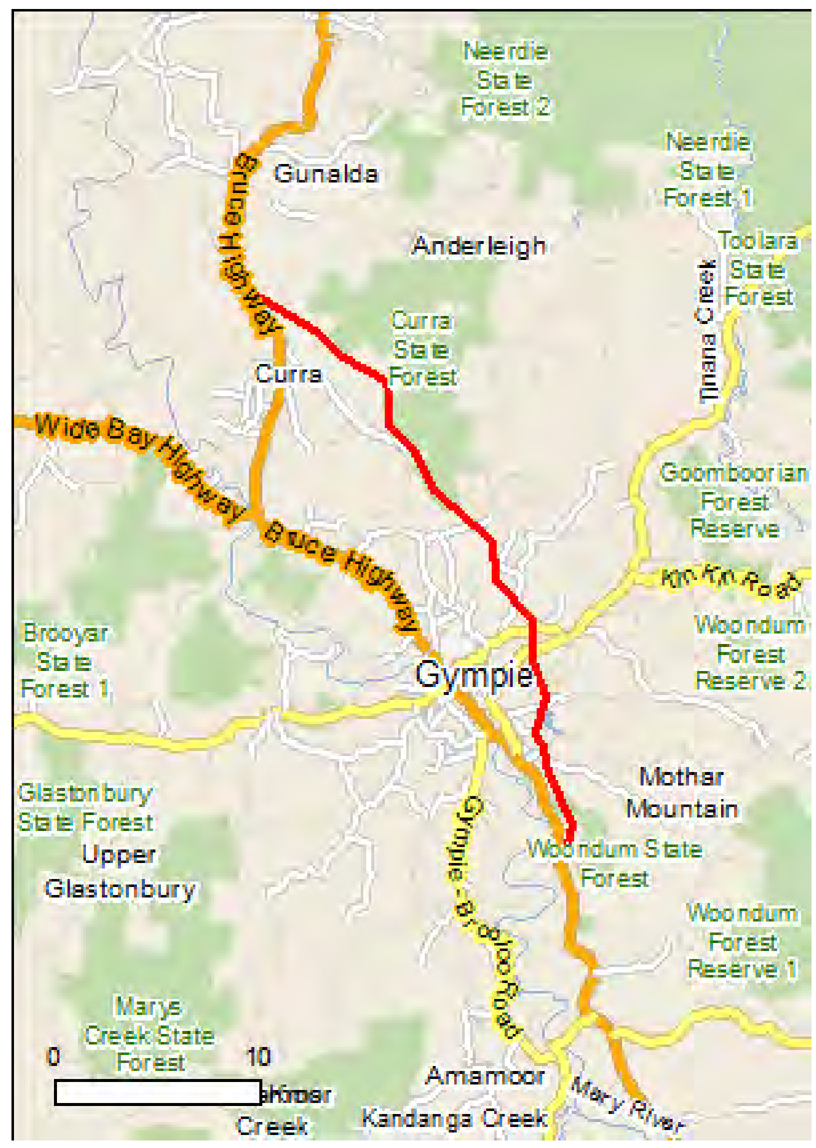
EPBC Act Protected Matters Report

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.

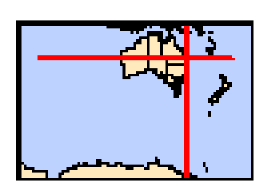
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 11/07/16 15:10:32



Coordinates
Buffer: 5.0Km



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:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	45
Listed Migratory Species:	10

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:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	17
Whales and Other Cetaceans:	None
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:	1
Regional Forest Agreements:	None
Invasive Species:	40
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Great sandy strait (including great sandy strait, tin can bay and tin can	30 - 40km upstream

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
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Cyclopsitta diophthalma coxeni Coxen's Fig-Parrot [59714]	Endangered	Species or species habitat may occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Fish		
Maccullochella mariensis		
Mary River Cod [83806]	Endangered	Species or species habitat known to occur within area
Neoceratodus forsteri		
Australian Lungfish, Queensland Lungfish [67620]	Vulnerable	Species or species habitat known to occur within area
Frogs		
Mixophyes iteratus		
Giant Barred Frog, Southern Barred Frog [1944]	Endangered	Species or species habitat known to occur within area
Insects		
Phyllodes imperialis smithersi		
Pink Underwing Moth [86084]	Endangered	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus		
Northern Quoll, Digul [331]	Endangered	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
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
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Other		
Macrozamia pauli-guilielmi		
Pineapple Zamia [5712]	Endangered	Species or species habitat likely to occur within area
Plants		
Archidendron lovelliae		
Bacon Wood, Tulip Siris [13451]	Vulnerable	Species or species habitat likely to occur within area
Arthraxon hispidus		
Hairy-joint Grass [9338]	Vulnerable	Species or species habitat may occur within area
Baloghia marmorata		
Marbled Balogia, Jointed Baloghia [8463]	Vulnerable	Species or species habitat may occur within area
Bosistoa transversa		
Three-leaved Bosistoa, Yellow Satinheart [16091]	Vulnerable	Species or species habitat likely to occur within area
Cossinia australiana		
Cossinia [3066]	Endangered	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Cryptocarya foetida Stinking Cryptocarya, Stinking Laurel [11976]	Vulnerable	Species or species habitat likely to occur within area
Cupaniopsis shirleyana Wedge-leaf Tuckeroo [3205]	Vulnerable	Species or species habitat likely to occur within area
Floydia praealta Ball Nut, Possum Nut, Big Nut, Beefwood [15762]	Vulnerable	Species or species habitat likely to occur within area
Fontainea rostrata [24039]	Vulnerable	Species or species habitat likely to occur within area
Fontainea venosa [24040]	Vulnerable	Species or species habitat likely to occur within area
Macadamia ternifolia Small-fruited Queensland Nut, Gympie Nut [7214]	Vulnerable	Species or species habitat likely to occur within area
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat likely to occur within area
Phebalium distans Mt Berryman Phebalium [81869]	Critically Endangered	Species or species habitat may occur within area
Samadera bidwillii [29708]	Vulnerable	Species or species habitat likely to occur within area
Sophora fraseri [8836]	Vulnerable	Species or species habitat likely to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area
Triunia robusta [14747]	Endangered	Species or species habitat likely to occur within area
Xanthostemon oppositifolius Penda, Southern Penda, Luya's Hardwood [8738]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Delma torquata Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Elusor macrurus Mary River Turtle, Mary River Tortoise [64389]	Endangered	Species or species habitat known to occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species

Name	Status	Type of Presence
		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		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
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 likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may 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
Defence - GYMPIE TRAINING DEPOT

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		
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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]		Breeding likely to occur within area
Cuculus saturatus Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat 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 likely to 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 likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Gympie	QLD

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
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
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
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
Equus caballus Horse [5]		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

Name	Status	Type of Presence
		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
Sus scrofa Pig [6]		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		
Annona glabra Pond Apple, Pond-apple Tree, Alligator Apple, Bullock's Heart, Cherimoya, Monkey Apple, Bobwood, Corkwood [6311]		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, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus africanus Climbing Asparagus, Climbing Asparagus Fern [66907]		Species or species habitat likely to occur within area
Asparagus plumosus 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]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Dolichandra unguis-cati Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana,		Species or species

Name	Status	Type of Presence
Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to 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
Sagittaria platyphylla		
Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii		
Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		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
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area

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.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

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

-26.039269 152.572429,-26.05357 152.59927,-26.063945 152.611755,-26.073757 152.630793,-26.077402 152.632042,-26.090296 152.632042,-26.099827 152.642654,-26.116642 152.651393,-26.136258 152.676986,-26.150827 152.678234,-26.167636 152.694776,-26.184162 152.694464,-26.197325 152.700394,-26.212167 152.696025,-26.216927 152.69977,-26.227847 152.701331,-26.247723 152.711942,-26.261159 152.709133,-26.261159 152.709133

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
-Parks and Wildlife Commission NT, Northern Territory Government
-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, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-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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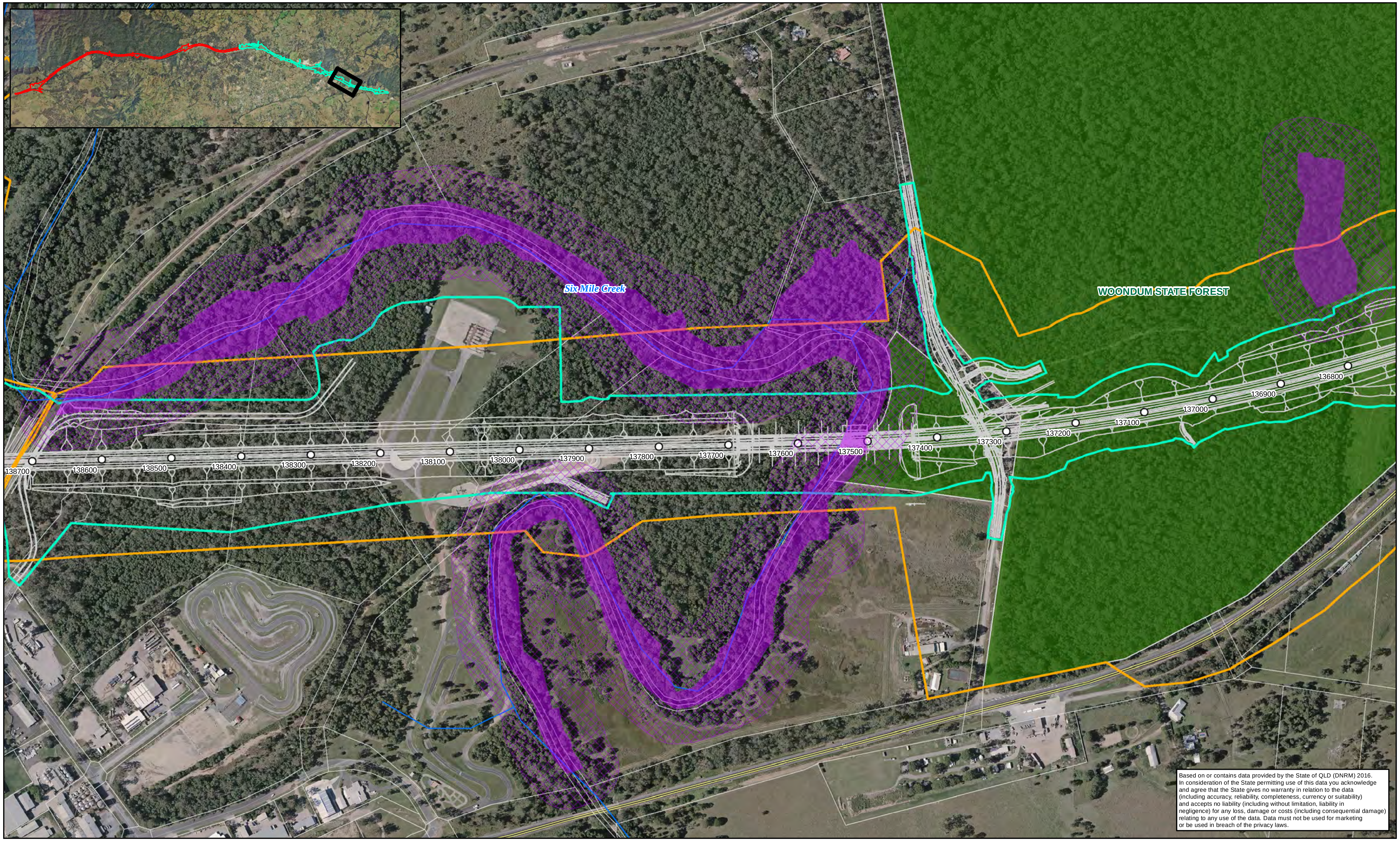
Appendix E – Lowland Rainforest of Subtropical Australia TEC



Paper Size A3

0 25 50 100 150 200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- 100m Chainage
- Highway
- Local Connector Road
- Street/Local Road
- Watercourse
- Survey Area
- Cadastral Boundary
- TEC (GHD 2016)
- TEC 50 m Buffer
- Protected Areas
- Contract 2

Project Area

- Contract 1

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Lowland Rainforest of Subtropical Australia TEC

Job Number	41-29914
Revision	0
Date	04 Apr 2017

Appendix E

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6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: GHD: TEC, TEC 50m Buffer (2016); TMR: Imagery (2014). DNRM: Cadastre (2016), Watercourses (2010), Road Network (2016), Protected Areas (2014). GHD: Project Area (March 2017), Road Design (November 2016). Created by: sc

Appendix F – Flora Survey Report for Survey Area Extents, *Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD 2016b)

Department of Transport and Main Roads

Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Detailed Design Job No. 232/10A/7, Invitation No. WBYD-1335

Flora Survey Report for Survey Area Extents

December 2016

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Appendices

1. Introduction

1.1 Project description

The Department of Transport and Main Roads (TMR) proposes to upgrade and realign 26 km of the existing Bruce Highway, including a bypass to the east of Gympie. This package of works is termed the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (herein referred to as 'the project'). The new highway will have a posted speed limit of 110 km/hr and directional separation from Woondum Road to Curra. The project construction area extends for approximately 30 km and will include the acquisition of a project corridor to ultimately accommodate a six lane divided carriageway. Due to the length of the project, the construction phase is likely to be procured under two contracts.

A Southern Contract will extend from the northern tie in to the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project, at Woondum Interchange, to approximately 200 m north of Sandy Creek Road. At approximately 12 km in length, the Southern Contract is termed Contract 1. A Northern Contract of approximately 18 km in length will extend from just north of Sandy Creek Road to Curra termed Contract 2. A locality plan identifying the project area and the separation of the two contracts is provided as Figure 1.

Areas of the proposed works are located within two High Risk Areas identified on the Department of Environment and Heritage Protection's (EHP) Protected Plants Flora Survey Trigger Map, as shown on Figure 1. Section 250 of the *Nature Conservation (Wildlife Management) Regulation 2006* requires a protected plant assessment to be undertaken prior to disturbance of protected plants within a High Risk Area.

1.2 Background

This Flora Survey Report provides updated information and builds upon the works previously completed by Biodiversity Assessment and Management Pty Ltd (BAAM) in 2015 and 2016. In 2015, BAAM completed the *Bruce Highway Upgrade Section D: Baseline Ecological Assessment Woondum Road to Curra* (BAAM, 2015 in Jacobs, 2016) report which provided baseline data on flora species and vegetation communities as well as ground-truthed regional ecosystem (RE) mapping. In 2016, BAAM completed the *Detailed Terrestrial Flora Surveys* report (BAAM, 2016) which provided details of targeted flora surveys for 'endangered', 'vulnerable' or 'near threatened' (EVNT) flora species. Following delivery of BAAM's 2016 report, TMR commissioned GHD to undertake targeted flora surveys for EVNT species in areas not previously surveyed.

1.3 Terminology

For the purposes of this report, the project area is referred to as the extent of disturbance required for the construction of the project. A survey area for the project was established for the purposes of conducting terrestrial flora, terrestrial fauna and aquatic ecology surveys and was defined as the project alignment (as of January 2015) which includes the extent of the cut/fill batters, plus a buffer of approximately 50 m to 100 m around the project area, with some broader areas on surrounding properties, upstream and downstream extents within waterways, or within adjacent habitats. The survey area was selected to gain an appreciation of ecological values that are present within and immediately adjacent to the project area. A locality plan identifying the project area and survey area is provided as Figure 1.

1.4 Purpose of this report

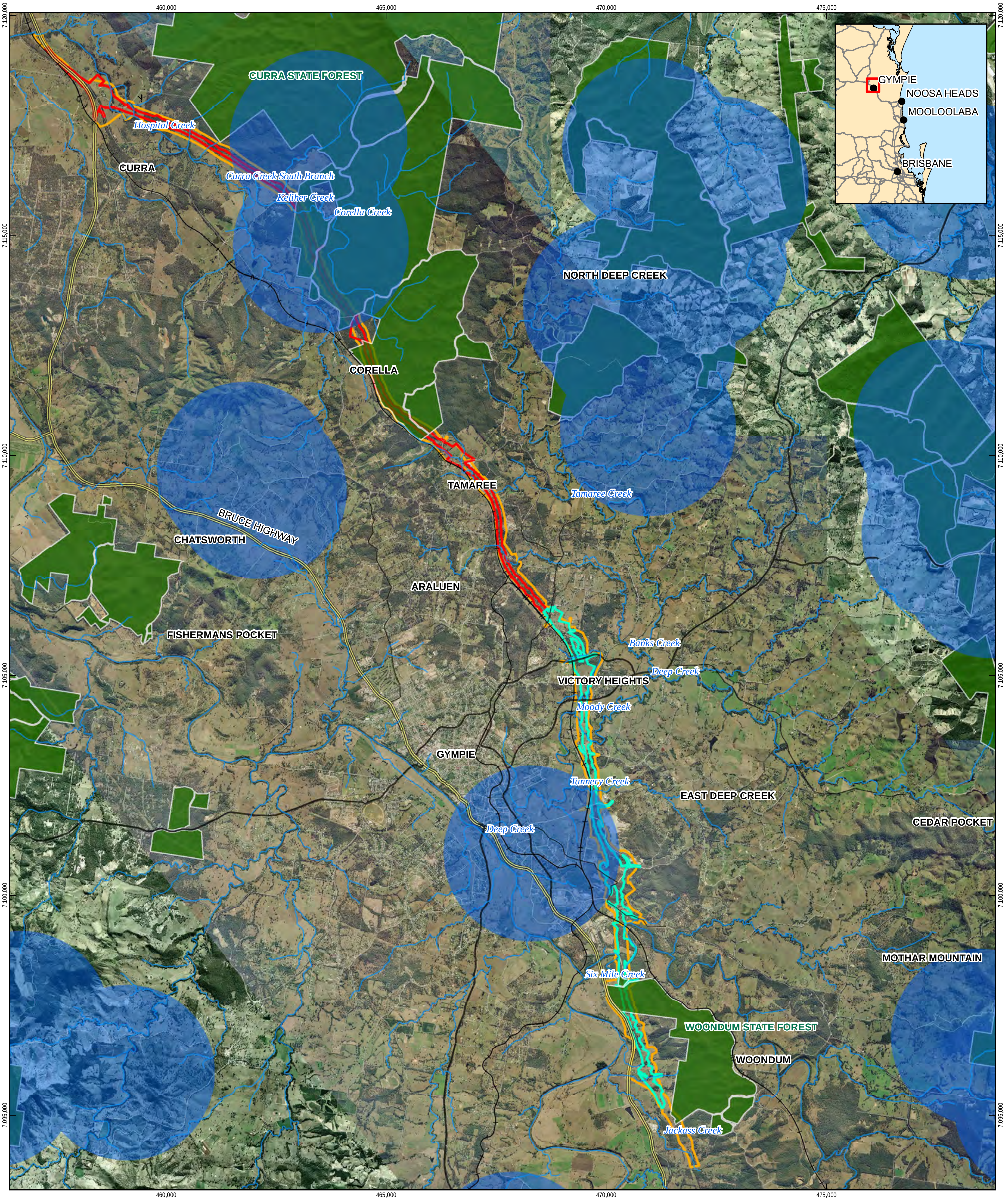
This Flora Survey Report provides the outcomes of the flora surveys undertaken by GHD from 25 to 29 July 2016 and builds upon BAAM's previous works. This Flora Survey Report addresses two flora related components of the project; being the protected plants assessment required under the *Nature Conservation Act 1992* (NC Act) and an assessment of two areas previously identified as closed forest vegetation communities with characteristics of the Lowland Rainforest of Subtropical Australia Threatened Ecological Community (TEC) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The protected plants assessment addresses Section 250 of the *Nature Conservation (Wildlife Management) Regulation 2006* which requires that a flora survey is undertaken within an area identified as a High Risk Area on a Protected Plants Flora Survey Trigger Map or where EVNT flora species are known to occur and appropriate reporting is provided to EHP documenting the outcomes of the survey. In this regard, this report aims to:

- Demonstrate that the flora surveys undertaken for the project meet the principles of the *Flora Survey Guidelines – Protected Plants* ('the Guidelines')
- Present the results of the GHD 2016 flora survey in compilation with BAAM's 2016 *Detailed Terrestrial Flora Surveys* report
- Delineate the extent of EVNT flora species and their area of occupancy within the project area
- Recommend appropriate mitigation measures to minimise impacts to protected plants for the clearing required to accommodate the project.

The protected plants assessment focuses on conservation significant protected plants, i.e. plants listed as EVNT under the *Nature Conservation (Wildlife) Regulation 2006* (NC Wildlife Regulation). Therefore, no detailed discussion on species listed as 'least concern' is provided.

The TEC assessment aims to confirm the presence and extent of the Lowland Rainforest of Subtropical Australia TEC within the project area and survey area.



LEGEND

Town	Secondary Road	**Project Area**	Protected Plants High Risk Area
Watercourse	Local Connector Road	Contract 1	
Railway	Street/Local Road	Contract 2	
Highway	Survey Area	Protected Areas	

1:80,000 @ A3

0 0.5 1 2 3

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	14 Oct 2016

Locality Plan

Figure 1

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3019_Overview_A3_Rev0.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GA: Town (2014); TMR: Aerial Imagery (2016), Survey Area (2016); DNRM: Railway, Watercourse (2014), Road (2016). DEHP: Protected Plants High Risk Area (2015). GHD: Project Area (2016) Created by: sc

1.5 Proposed works

Vegetation clearing will be required to facilitate the project. The key elements of the project include:

- 26 km of four lane highway with a posted speed limit of 110 km/hr and directional separation from Woondum Road to Curra
- Acquisition of a project corridor to ultimately accommodate a six lane divided carriageway
- Integration with the Woondum Interchange at the northern extent of Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project
- Integration with major interchanges at Penny Road, Gympie Connection Road and the township of Curra
- Construction of multi-span bridges over major waterways including Six Mile Creek, Tannery Creek, Deep Creek, Moody Creek (north and south), Banks Creek, Tamaree Creek, Upper Curra Creek, Keliher Creek, Curra Creek overflow and Curra Creek north
- Construction of a new bridge over the existing North Coast Rail Line
- Construction of new multi-span bridges over existing local road infrastructure, several connections and alteration to the existing local road network
- Acquisition of areas of Woondum State Forest and Curra State Forest for conversion to road reserve or on sale to relevant State government departments
- Waterway diversions of Tannery Creek, Moody Creek (north and south), Banks Creek, Tamaree Creek, Tamaree Creek tributary and Curra Creek anabranch

During the Construction phase of the project, vegetation within the boundaries of the project area (as delineated in Figure 1) may be subject to clearing by the construction contractor. Areas not to be cleared will be delineated as 'no go zones' to retain adjacent vegetation.

1.6 TMR exemption

TMR have a Compliance Management Plan (CMP) in place with EHP for road infrastructure works identified in the TMR document entitled '*Queensland Transport and Road Investment Program 2015-16 to 2018-19*' which details how the clearing of non-remnant vegetation is to be managed with regard to impacts to EVNT flora species. The project is currently listed on the QTRIP for planning purposes only at this stage. The CMP commenced on 22 April 2016 and is able to be used by TMR, its contractors and agents for the taking of EVNT wildlife by clearing under the NC Act. Appendix 2 of the CMP contains the compliance matters and states that the purpose of the CMP is satisfied in relation to the taking of protected plants when carrying out works as follows:

- No clearing of protected plants within a forestry reserve or protected area as defined under the NC Act
- Protected plants comprising EVNT wildlife may only be taken
  - In areas where vegetation has been previously cleared; and
  - The vegetation has not regrown to a state that has reached remnant vegetation status under the *Vegetation Management Act 1999*

As the CMP implies an exemption for clearing EVNT wildlife in non-remnant vegetation outside of a forestry reserve or protected area, there is a requirement to carry out surveys for clearing in High Risk Areas, or obtain clearing permits to take protected plants in non-remnant vegetation.

Nevertheless, while the primary focus of the assessment was on remnant vegetation, the July 2016 flora survey encompassed areas of non-remnant vegetation where there was a reasonable likelihood that habitat for an EVNT species or other protected vegetation association may be present. Additionally, the CMP is for the planning phase of a TMR road project and there is no guarantee the CMP will remain current during project delivery.

1.7 Previous permits

TMR have previously undertaken minor clearing works to support geotechnical investigations and currently hold the following clearing permits issued under the *Nature Conservation Act 1992*:

- Protected Plant Authority: Protected Plant Clearing Permit (permit number WIPA15933015) for the P2 geotechnical investigations was granted on the 26 May 2015
- An amendment to the clearing permit relating to the inclusion of the P3 geotechnical investigations was granted on the 29 May 2015
- A second addendum to the clearing permit relating to the inclusion of the D1 and D2 geotechnical investigations was granted on the 4 April 2016.
- Protected plant authority – amendment for the D3 and D4 geotechnical investigations (permit number WIPA17630516). This permit was supported by an impact management plan which included provisions for an ecologist to be present during clearing works, that no EVNT flora species were to be cleared and that exclusion zones surrounding EVNT flora species were to be in place prior to clearing activities.

A clearing permit has been applied for by TMR to support the D3 and D4 geotechnical investigations.

1.8 Disclaimer

This report has been prepared by GHD for TMR and may only be used and relied on by TMR and EHP and the Commonwealth Department of the Environment and Energy for the purpose agreed between GHD and the TMR as set out in this report. GHD otherwise disclaims responsibility to any person other than TMR arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by TMR and others who provided information to GHD (including government authorities and consultants engaged by TMR), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points. Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the presence of large areas of recently burned vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of conservation significant species and/or their supporting habitat) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Flora survey assessment method

2.1 General

2.1.1 Assessment methodologies

This section of the report is presented in two parts to distinguish between the assessment methodology undertaken for the protected plants assessment under the NC Act and the TEC assessments undertaken for the EPBC Act. While there is considerable overlap in the assessment methodologies for the two assessments, the protected plants assessment requires certain information is provided and site survey is progressed in accordance with the Guideline requirements.

2.1.2 Protected plants assessment

The protected plant assessment included a desktop assessment of existing information (which relies on the previous works and reporting undertaken for the project, including searches of relevant government databases) and a targeted field survey for EVNT species and their extent of occurrence within the project area and survey area.

Details of the people responsible for the flora survey and the methods employed for addressing the requirements of the Guidelines have been included in Sections 2.2 through to 2.4 of this Flora Survey Report.

2.1.3 TEC assessment

An assessment of two polygons of a closed forest vegetation community at Six Mile Creek and Woondum State Forest was undertaken to confirm whether the vegetation communities conform with the key diagnostic criteria and condition thresholds of the Lowland Rainforest of Subtropical Australia TEC. Further details on the methodology adopted have been provided in Section 2.5 of this Flora Survey Report.

2.2 Assessment personnel

This assessment was undertaken by Dr Megan Ward, Peter Moonie and Colin Vaughan with support from Nick Willis, all of whom are professional flora ecologists deemed suitably qualified in accordance with the following requirements identified by the Guidelines:

- A professional qualification or formal training in plant identification and the taxonomy of Queensland flora
- A minimum of five years' experience in undertaking surveys for EVNT species

Megan, Peter, Colin and Nick have previously submitted their *Curricula vitae* to EHP.

Personnel and their relevant experience from BAAM who previously undertook an assessment in 2016 are detailed within the *Detailed Terrestrial Flora Surveys* report (BAAM, 2016) (refer to Appendix A).

No departures from the requirements of the Guidelines were identified with regard to the suitability of the people who undertook the assessment.

2.3 Desktop assessment

A desktop assessment was undertaken to facilitate an informed approach to the field survey. The desktop assessment reviewed existing information for the purposes of identifying target EVNT species for the field assessment and to determine areas with higher potential to encounter EVNT species. The desktop assessment involved a review of the following information sources:

- **Protected Plants Flora Survey Trigger Map:** EHP's Flora Survey Trigger Map was viewed to determine the extent of High Risk Areas within the project area.
- **Previous reporting:** Flora surveys of the project area and survey area have previously been undertaken in 2011, 2015 and 2016 and are reported in the following:
  - The *Review of Environmental Factors* (Jacobs, 2016)
  - The *Detailed Terrestrial Flora Surveys* report (BAAM, 2016) (refer to Appendix A).

2.4 Protected plants field assessment

2.4.1 Survey timing

The following conservation significant flora species have been assessed by BAAM (2016) as being 'known to occur', 'likely to occur' or having the 'potential to occur' within the survey area:

Known to occur:

- *Macrozamia pauli-guilielmi* (pineapple zamia)

Likely to occur:

- *Marsdenia coronata* (slender milkvine)

Potential to occur:

- *Aponogeton elongatus* subsp. *elongatus*
- *Archidendron lovelliae* (bacon wood)
- *Arthraxon hispidus* (hairy-joint grass)
- *Baloghia marmorata* (jointed baloghia)
- *Floydia praealta* (ball nut)
- *Fontainea rostrata* (deep creek Fontainea)
- *Macadamia integrifolia* (macadamia nut)
- *Macadamia ternifolia* (Maroochy nut)
- *Picris conyzoides* (fleabane hawkweed)
- *Pterostylis chaetophora*
- *Ricinocarpos speciosus*
- *Samadera bidwillii* (quassia)
- *Sophora fraseri* (brush sophora)
- *Symplocos harroldii* (hairy hazelwood)
- *Triunia robusta* (glossy spicebush)
- *Xanthostemon oppositifolius* (southern penda)

The terminology and definitions used in the likelihood of occurrence assessment by BAAM (BAAM, 2016) are described in Table 1.

Table 1 Likelihood of occurrence definition for terrestrial flora (BAAM, 2016)

Likelihood rating	Definition
Known to occur	The species was detected during field assessment, or is known from past surveys in the survey area and is not now considered locally extinct.
Likely to occur	A medium to high probability that the species: • Occurs in the survey area because suitable habitat occurs

Likelihood rating	Definition
	• The survey area is within the known distribution of the species • There are records of the species in the vicinity of the survey area; and • The species is not now considered locally extinct
Potential to occur	Either: (a) there are no past records of the species in the vicinity of the survey area but suitable habitat occurs and there is insufficient information on the distribution of the species (e.g. it is naturally rare and difficult to detect, or there has been insufficient survey effort) to categorise the species as likely or unlikely to occur; or (b) there are past records of the species in the vicinity of the survey area but habitat in the survey area is marginal or spatially limited meaning that the species' presence on the survey area would be transitory at best.
Unlikely to occur	A low probability that the species occurs in the survey area because: • Suitable habitat does not occur • The survey area is outside the known distribution of the species • There are no records of the species in the local region despite adequate survey effort • The species is considered locally extinct; or • The species has not been observed despite sufficient spatial and temporal survey effort for detecting the species

Given that the July 2016 flora surveys were undertaken to target EVNT flora species, a revised likelihood of occurrence assessment was undertaken with a focus on flora species previously recorded within a 10 km search radius of the alignment. In this regard, the defining criteria used for the updated likelihood of occurrence assessment is provided in Table 2.

Table 2 Updated likelihood of occurrence definitions for terrestrial flora

Likelihood rating	Definition
Known to occur	Species has been recorded (directly by TMR commissioned surveys or from database records) within the survey area
Likely to occur	Species has been recorded within 10 km of the survey area and the survey area contains suitable habitat for the species
Potential to occur	The survey area is within the species' current known distribution, but the species has not been recorded within 10 km of the survey area and the survey area contains suitable habitat for the species
Unlikely to occur	The survey area is not within the species' known distribution and/or suitable habitat is not present within the survey area

The results of the updated likelihood of occurrence assessment identified the following species as ‘known to occur’ and ‘likely to occur’:

Known to occur:

- *Macrozamia pauli-guilielmi* (pineapple zamia)
- *Marsdenia coronata* (slender milkvine)

Likely to occur:

- *Cossinia australiana* (cossinia)
- *Fontainea rostrata* (deep creek Fontainea)
- *Floydia praealta* (ball nut)
- *Macadamia integrifolia* (macadamia nut)
- *Macadamia ternifolia* (Maroochy nut)
- *Picris conyzoides* (fleabane hawkweed)
- *Samadera bidwillii* (quassia)
- *Symplocos harroldii* (hairy hazelwood)

All of the species assessed as ‘known to occur’ and the majority of species assessed as ‘likely to occur’ are long-lived perennial species that can be confidently identified based on vegetative features. BAAM (2016) identified that *Picris conyzoides* is most likely associated with RE 12.3.3 which is described as *Eucalyptus tereticornis* woodland on Quaternary alluvium and is restricted to a small area of land within the northern extent of the project area. No observation of this species was made by BAAM who completed their survey work of RE 12.3.3 over summer months.

BAAM (2016) also identified *Pterostylis chaetophora,* which is a cryptic ground orchid flowering from August to September, as having the ‘potential to occur’. Revised desktop searches have indicated that previous records for this species have been located approximately 20 km from the project area and therefore this species is not ‘known to occur’ or considered to be ‘likely to occur’ within the survey area.

On the basis of the above, a flora survey at the end of July 2016 was deemed appropriate to maximise the likelihood of encountering all target species (i.e. those reassessed as ‘known to occur’ and ‘likely to occur’) and other species assessed as having a lower likelihood of being present (i.e. those species assessed as having the ‘potential to occur’ including *Pterostylis chaetophora*).

With regard to the timing of the flora survey, no departures from the requirements of the Guidelines were identified.

2.4.2 Flora survey area

The survey area is defined in Section 1.3 of this Flora Survey Report, with the extents of the project area and survey area shown in Figure 1.

Within mapped High Risk Areas, the clearing impact area for the flora surveys was deemed to encompass the area of vegetation within the project area as well as a 100 m buffer area surrounding the project area. The clearing impact area includes areas of both remnant and non-remnant vegetation.

The flora surveys also encompassed vegetation external to mapped High Risk Areas. Section 259, Clause (1) of the *Nature Conservation (Wildlife Management) Regulation 2006* states that a protected plant clearing permit is required for an area other than a High Risk Area if, before a person starts clearing in an area other than a High Risk Area, the person is, or becomes, aware of the following:

- There are plants that are EVNT wildlife within the area to be cleared
- The plants would be taken by the clearing or there would be clearing within 100 m of the plants.

BAAM (2016) provided mapping of areas of ‘known habitat’ and ‘potential habitat’ for EVNT flora species in locations external to High Risk Areas. As these areas had not been previously assessed, survey of these habitats was undertaken in July 2016. Surveyed areas external to High Risk Areas encompassed both remnant vegetation and non-remnant vegetation communities.

It is acknowledged that areas of Curra State Forest had been burnt relatively recently prior to the field survey. However, this limitation was overcome by implementing a habitat suitability approach to the assessment.

No departures from the requirements of the Guidelines were identified as representative meanders across all habitat types present within the clearing impact area were undertaken.

2.4.3 Protected plants survey

The design for the July 2016 survey involved targeted surveys for individuals of *Macrozamia pauli-guilielmi* (pineapple zamia) and *Marsdenia coronata* (slender milkvine) in areas previously identified by BAAM in 2016 as either ‘potential habitat’ or ‘known habitat’ for either species. Surveys occurred only in those areas not previously surveyed as part of BAAM’s flora survey in 2016. The location of individual plants, or clusters of plants, was recorded with a global positioning system (GPS) unit. The extent of occurrence in the survey area was delineated to allow an estimate of the number of individuals within the localised extent of occurrence to be quantified and extrapolated across that habitat type where the targeted species are present.

As the project area lies within two High Risk Areas and in other areas where EVNT species are ‘known to occur’ and have ‘potential to occur’, two survey methodologies were employed. The two flora survey methodologies are discussed in the following sections.

High Risk Areas

Timed meander

The protected plants survey within mapped High Risk Areas was consistent with the timed meander method that is described in the Guidelines. In brief, the timed meander method involves the following steps:

1. Select a starting point within the particular habitat of interest and record the time.
2. Record the identities of the protected plant species observed, and collect specimens for any unknown species (specimens only collected in State forest or protected areas where appropriate permits are held).
3. Traverse the particular habitat in a random manner so as to maximise the coverage of habitat and the encounter rate of different species.
4. Record a list of flora species encountered and note the time every 2 to 5 minutes. If the survey needs to be interrupted, do not include this time in the results.
5. Continue searching until no new species have been recorded for 30 minutes or when the entire area of habitat type is surveyed, whichever happens sooner.

A figure showing the survey effort is included as Appendix B. With regard to the methods of the timed meander, no departures from the requirements of the Guidelines were identified.

Protected plant population survey

In accordance with the Guidelines, when an EVNT plant species has been recorded during a timed meander search, there is a requirement for a more comprehensive assessment to be undertaken. This is required in order to determine the species abundance, distribution and habitat associations, as well as to inform impact management measures. The preferred approach to collect additional data is plot-based assessment.

Following the Queensland Herbarium's methodology (Neldner *et al*., 2012), plots measuring 50 m by 10 m were used to assess identified EVNT plant species. This is the preferred standard quadrat size for determining vegetation structure and composition for the majority of plant communities found in Queensland. With respect to the survey, a plot was established at the location of the *M. coronatas* identified within a High Risk Area and the following information was recorded and described:

- The GPS location of each plot or plots
- The number of individuals of the EVNT species, as well as any other observations such as the age structure (if possible), reproductive state and health
- A description of the vegetation structure, including noting the RE type
- The identities of all flora taxa found in each of the strata comprising the vegetation community
- The landscape attributes including the landform type, soil type, geology, slope, aspect and altitude
- Any specific habitat or micro-habitat features associated with the EVNT species
- The nature and degree of any disturbance to the habitat

No *Macrozamia pauli-guilielmi* (pineapple zamia) additional to those identified by BAAM in 2016 were identified. As BAAM had previously identified *Macrozamia pauli-guilielmi* (pineapple zamia) within a High Risk Area, the information required by the Guidelines was collected by BAAM in 2016 and is presented in their *Detailed Terrestrial Flora Surveys* report (2016).

Areas outside of High Risk Areas

Areas outside of High Risk Areas are not required to be surveyed in accordance with the Guidelines, except where species of conservation significance are known to be present. Nevertheless, the survey methodology employed for areas outside of the mapped High Risk Areas was generally consistent with the timed meander technique described above. Where EVNT flora species were identified outside of High Risk Areas, their location was recorded using handheld GPS units. The field verified RE mapping was relied upon to provide vegetation descriptions of EVNT habitat.

2.4.4 Identification of plant species

All plant species encountered were identified in the field. As a general practice, where field identification is not possible, specimen material is typically collected and later identified with the assistance of diagnostic keys and references. No specimen material was collected from State forests or protected areas during this survey.

BAAM have previously collected specimen material of *M. coronata* from the project area and submitted the collected specimen to the Queensland Herbarium for confirmation, the results of which are presented in their 2016 report.

2.5 Threatened ecological community field assessment

All vegetation communities previously identified by BAAM in 2016 with the potential to conform to the floristic attributes of a TEC were assessed against the key diagnostic characteristics and condition thresholds relevant to the EPBC Act, including the Lowland Rainforest of Subtropical Australia TEC potentially at Six Mile Creek and the area within Woondum State Forest as identified by BAAM in 2016). The extent of any TEC was delineated via an ecologist walking the boundary of the TEC with a handheld GPS unit to confirm the edge of the vegetation community.

2.6 Protected plants assessment data analysis

During the flora surveys, data was captured using the Collector application on iPads to allow for the rapid collection and analysis of information in the field. Following the completion of the flora surveys, the data was analysed in ArcGIS to assist in interpretation.

The extent of occurrence of *M. pauli-guilielmi* and *M. coronata* was calculated based on the methodology provided by the *Threatened Species Scientific Committee Guidelines for assessing the conservation status of native species according to the Environment Protection and Biodiversity Conservation Act 1999 and Environment Protection and Biodiversity Conservation Regulations 2000* (DEE, 2016). The extent of occurrence provided by the Threatened Species Scientific Committee Guidelines is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure of the extent of occurrence excludes discontinuities or disjunctions within the overall distributions of taxa. In order to capture the extent of EVNT flora species' supporting habitat in the extent of occurrence calculations (to align with the Guidelines), a 100 m buffer area was included in the extent of occurrence calculations.

In this regard, the outer boundaries of clusters of *M. pauli-guilielmi* and *M. coronata* individuals were identified and a 100 m buffer area was applied. The outer edge of the buffer area was then used to create the shortest continuous boundary around the clusters of *M. pauli-guilielmi* and *M. coronata.*

3. Protected Plants Assessment Results

3.1 Desktop assessment

3.1.1 Protected Plants Flora Survey Trigger Map

The Protected Plants Flora Survey Trigger Mapping identifies that the project area intersects two High Risk Areas.

3.1.2 Previous field surveys and reporting

BAAM's 2015 *Bruce Highway Upgrade Section D: Baseline Ecological Assessment Woondum Road to Curra* report (BAAM, 2015 in Jacobs, 2016) provides the location and extent of REs within the project area and survey area, as well as baseline information on flora species encountered during the flora survey.

BAAM's 2016 *Detailed Terrestrial Flora Surveys* report (BAAM, 2016) provides the outcomes of the targeted EVNT flora surveys undertaken for the project and identifies that *M. pauli-guilielmi* and *M. coronata* were the only two EVNT flora species encountered during the flora surveys. A detailed discussion on these two species and their supporting habitat is provided in BAAM's *Detailed Terrestrial Flora Surveys* report (BAAM, 2016) included as Appendix A.

3.2 Protected plants assessment flora survey results

3.2.1 General

The July 2016 flora survey confirmed that *M. coronata* and *M. pauli-guilielmi* are present within the survey area. No additional EVNT flora species were identified during the field investigations.

3.2.2 *Macrozamia pauli-guilielmi* (pineapple zamia)

The July 2016 flora survey did not identify any additional *M. pauli-guilielmi* individuals in areas not previously surveyed by BAAM in 2016 (BAAM, 2016). The *M. pauli-guilielmi* previously identified by BAAM are located within a High Risk Area. Refer to BAAM's *Detailed Terrestrial Flora Surveys* (2016) report for a full discussion on the habitat present at the location of each sub-population identified within the survey area.

A total of approximately 48 adults and 167 seedlings of *M. pauli-guilielmi* with an extent of occurrence of 8.31 ha were identified within the project area.

3.2.3 *Marsdenia coronata* (slender milkvine)

The July 2016 flora survey confirmed that *M. coronata* is present in areas previously surveyed by BAAM as well as in areas not previously surveyed. A total of approximately 334 adults and 531 seedlings of *M. coronata* with an extent of occurrence of 69.87 ha were identified within the project area based on the BAAM 2016 and GHD 2016 flora surveys.

The *M. coronata* individuals identified in areas not previously surveyed were identified in a variety of habitat types across the same mapped landform and in areas mapped by BAAM as 'known habitat' and 'potential habitat'. *M. coronata* was associated with habitat types characterised by the following attributes (refer to Plate 1):

- Open forests or woodlands dominated by *Eucalyptus* species
- A low shrub layer was present or juvenile woody species

- Sparse ground cover with bare soil present
- Typically identified on mid to upper slopes

Plate 1 *Marsdenia coronata* habitat within the project area

Table 3 provides the locations of the *M. coronata* individuals identified during the July 2016 flora surveys.

Table 3 *Marsdenia coronata* (slender milkvine) locations with survey area

Location	Habitat type	Number of individuals identified in High Risk Area	Total number of individuals identified
Curra State Forest Lot 700 on FTY1491	12.11.5e	37 adults 4 seedlings*	84 adults 19 seedlings
Lot 3 on MPH23816	12.11.3	4 adults 7 seedlings	4 adults 7 seedlings
Lot 2 on MPH14224	12.11.3	-	23 adults 2 seedlings
Lot 4 on MPH14224	12.11.3	-	3 adults 14 seedlings
	12.11.16	-	10 adults 8 seedlings
Lot 1 on MPH11890	12.11.3	-	10 adults 9 seedlings
Woondum State Forest Lot 983 on FTY1488	12.11.3/12.11.14	-	23 adults
	Total	**41 adult** **11 seedlings**	**157 adults** **59 seedlings**

*Note - For the purposes of this assessment, a seedling is defined as a plant with four leaves or less

A total of 157 adult *M. coronata* individuals and 59 seedlings were identified during the July 2016 flora surveys across six allotments within four different vegetation communities. The vegetation communities within which *M. coronata* were identified are described as follows:

- **RE 12.11.3** (least concern) – *Eucalyptus siderophloia* and *E. propinqua* open forest +/- *E. microcorys*, *Lophostemon confertus*, *Corymbia intermedia*, *E. biturbinata*, *E. acmenoides*, *E. tereticornis*, *E. moluccana*, *Angophora leiocarpa*, *Syncarpia verecunda* with vine forest species and *E. grandis* or *E. saligna* in gullies. *Eucalyptus pilularis* and *E. tindaliae* sometimes present e.g. mid D'Aguilar Range, Conondale Range. Occurs predominantly on hills and ranges of Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.
- **RE 12.11.5e** (least concern) – *Corymbia citriodora* subsp. *variegata* woodland usually including *Eucalyptus siderophloia* or *E. crebra* (sub coastal ranges), *E. propinqua* and *E. acmenoides* or *E. carnea*. Other species that may be present and abundant locally include *Corymbia intermedia*, *C. trachyphloia* subsp. *trachyphloia*, *Eucalyptus tereticornis*, *E. microcorys*, *E. portuensis*, *E. helidonica*, *E. major*, *E. longirostrata*, *E. biturbinata*, *E. moluccana* and *Angophora leiocarpa*. *Lophostemon confertus* often present in gullies and as a sub-canopy or understorey tree. Mixed understorey of grasses, shrubs and ferns. Occurs on hills and ranges of Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.
- **RE 12.11.14** (of concern) – *Eucalyptus crebra, E. tereticornis, Corymbia intermedia* grassy woodland. Other species including *Eucalyptus melanophloia*, *Corymbia clarksoniana*, *C. erythrophloia*, *C. tessellaris, E. siderophloia*, *Angophora* spp. May be present in low densities or in patches. Mid-layer generally sparse but can include low trees such as *Vachellia bidwillii*, *Capparis* spp., *Dodonaea triquetra*, *Alphitonia excelsa* and *Xanthorrhoea* spp. Occurs on mid and lower slopes on Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.
- **RE 12.11.16** (endangered) – *Eucalyptus cloeziana* +/- *E. propinqua*, *E. acmenoides*, *E. microcorys* and *E. grandis* open forest. Understory is generally shrubby +/- vine forest species. Occurs on Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics, especially phyllite of the Kin Kin Beds.

M. coronata was identified during a timed random meander within High Risk Areas mapped over Lot 700 on FTY1491 (Curra State Forest) and Lot 3 on MPH23816. High Risk Areas are not mapped over the other allotments upon which *M. coronata* was identified. In accordance with the Guidelines, plot based assessments were undertaken to quantify the population extent and density in order to quantify the potential impact of the project. Table 4 details the outcomes of the plot based assessments.

Table 4 Outcomes of plot based assessments for *Marsdenia coronata* (slender milkvine) identified within a High Risk Area

Assessment criteria	Outcomes
The GPS location.	The plot based assessments were undertaken where EVNT plant species were identified in each habitat type. The locations of EVNT flora species are provided in Appendix B.
The number of individuals of the EVNT species, as well as any	A total of 65 adult and 51 seedling *M. coronata* individuals were identified within mapped High Risk Areas during the flora surveys undertaken in early 2016 (BAAM) and July 2016. The majority of

Assessment criteria	Outcomes
other observations such as the age structure (if possible), reproductive state and health.	the individuals appeared to be in good health with no obvious signs of stress. One individual appeared unhealthy with wilting leaves and chlorosis evident (i.e. leaf yellowing). No flowers or seed pods were observed during the July 2016 flora surveys. Refer to BAAM's reporting included as Appendix A for a discussion on the individuals identified during the early 2016 flora surveys.
A description of the vegetation structure, noting the RE.	The *M. coronata* individuals were identified in the following habitats: • RE 12.11.3 • RE 12.11.5e These vegetation communities have previously been field verified and conform to the descriptions provided above. BAAM identified *M. coronata* within RE 12.9-10.4, which was field verified as consistent with a *Eucalyptus racemosa* woodland on sedimentary rocks.
The identities of all flora taxa found in each of the strata comprising the vegetation community.	A comprehensive flora species list is provided in BAAM's 2015 *Bruce Highway Upgrade Section D: Baseline Ecological Assessment Woondum Road to Curra* and BAAM's 2016 *Detailed Terrestrial Flora Surveys* (2016) report.
The landscape attributes including the landform type, soil type, geology, slope, aspect and altitude.	*M. coronata* was generally identified on the mid to upper slopes on gently undulating land. All *M. coronata* within the plots were identified on land zone 11. The land zone is described as follows: Metamorphosed rocks, forming ranges, hills and lowlands. Primarily lower Permian and older sedimentary formations which are generally moderately to strongly deformed. Includes low- to high-grade and contact metamorphics such as phyllites, slates, gneisses of indeterminate origin and serpentinite, and interbedded volcanics. Soils are mainly shallow, gravelly Rudosols and Tenosols, with Sodosols and Chromosols on lower slopes and gently undulating areas. Soils are typically of low to moderate fertility.
Any specific habitat or micro-habitat features associated with the EVNT species. Notes must also be included on the nature and degree of any disturbance to the habitat.	*M. coronata* was associated with habitat types characterised by the following attributes: • Open forests or woodlands dominated by *Eucalyptus* species • A low shrub layer was present or juvenile woody species • Sparse ground cover with bare soil present • Typically identified on mid to upper slopes

3.2.4 Extent of occurrence

Extent of occurrence calculations

The extent of occurrence for *M. pauli-guilielmi* and *M. coronata* is shown in Appendix C, with calculations differentiating the extent of occurrence within the survey area and the extent of occurrence within the project area. The clearing impact area defined in Section 2.4.2 of this report was generally the same area as the survey area, comprising the project area plus a 50 m to 100 m buffer. This approach was adopted to minimise the potential of excluding habitat from the extent of occurrence calculations and to accurately quantify the extent of direct impact.

Macrozamia pauli-guilielmi (pineapple zamia)

As identified in BAAM's *Detailed Terrestrial Flora Surveys* (2016) report, *M. pauli-guilielmi* occurs as three distinct sub-populations along approximately 2.8 km of the project area from Chainage (Ch) 159700 m to Ch 156900 m (BAAM, 2016, in Appendix A). No additional *M. pauli-guilielmi* were identified within the survey area during the July 2016 flora surveys.

In this regard, the extent of occurrence provided in Table 5 has been based on the *M. pauli-guilielmi* data provided in BAAM's *Detailed Terrestrial Flora Surveys* (2016) report.

Table 5 Extent of occurrence of *Macrozamia pauli-guilielmi* (pineapple zamia) within the survey area and project area

Sub-population	Map ID (refer to Appendix C)	Location	Extent of occurrence (ha)	
			Survey area	Project area
1	1	Lot 889 on CP864404	3.07	-
2	2	Lot 4 on MPH23906	13.33	6.01
		Lot 1 on MPH23906		
3	3	Lot 700 on FTY1491 Curra State Forest	4.26	2.30
		Total	**20.66**	**8.31**

Based on the results of the survey effort undertaken by BAAM in early 2016, *M. pauli-guilielmi* was identified as having a total extent of occurrence of 8.31 ha within the project area.

Marsdenia coronata (slender milkvine)

The results of the recently completed flora surveys have been combined with data provided by BAAM (2016) to determine the total extent of occurrence of *M. coronata* within the survey area and project area, with the results presented in Table 6.

Table 6 Extent of occurrence of *Marsdenia coronata* (slender milkvine) within the survey area and project area

Site ID (refer to Appendix C)	Location	Extent of occurrence (ha)	
		Survey area	Project area
4	Curra State Forest	33.32	14.78
5	Lot 700 on FTY1491	39.23	20.21

Site ID (refer to Appendix C)	Location	Extent of occurrence (ha)	
		Survey area	Project area
8		3.12	1.71
9		3.56	2.17
7	Lot 3 on MPH23816	42.98	26.69
	Lot 2 on MPH23816		
	Lot 1 on MPH23816		
	Lot 1 on MPH30794		
	Lot 4 on MPH23816		
	Lot 10 on RP212322		
	Lot 4 on MPH23906		
	Lot 2 on MPH14224		
	Lot 4 on MPH14224		
	Lot 1 on MPH11890		
	Lot 5 on MPH14224		
	Lot 1 on MPH7001		
6	Woondum State Forest Lot 983 on FTY1488	11.23	4.31
	Total	**133.44**	**69.87**

Based on the results of the survey effort undertaken by BAAM in early 2016 and the GHD surveys in July 2016, *M. coronata* was identified as having a total extent of occurrence of 69.87 ha within the project area.

4. Threatened ecological community field assessment results

4.1 General

The previous flora surveys identified two locations where the vegetation communities were similar to the Lowlands Rainforest of Subtropical Australia TEC. The vegetation communities are located at Six Mile Creek and within Woondum State Forest.

4.2 Six Mile Creek

The riparian vegetation within the survey area along Six Mile Creek was assessed in 2011 and the results are presented in Addendum 1 of BAAM's *Detailed Terrestrial Flora Surveys* (2016) report. The outcomes of the assessment provided in Table A1.2 of BAAM's *Detailed Terrestrial Flora Surveys* (2016) report identified that although the vegetation community meets the key diagnostic characteristics of the Lowland Rainforest of Subtropical Australia TEC, the vegetation community fails to meet the condition thresholds of the Lowland Rainforest of Subtropical Australia TEC due to low species richness (only 20 woody species from Appendix A of the listing advice were identified).

A more extensive survey of the riparian vegetation along Six Mile Creek was undertaken by GHD in July 2016. The assessment was undertaken along Six Mile Creek from the North Coast railway line in the north to where Six Mile Creek intersects the existing Bruce Highway (refer to Appendix E) and comprises an area of approximately 10 ha. During the flora survey, a total of 45 species from Appendix A of the TEC listing advice were identified as present. Appendix E contains a list of species identified during the assessment of the riparian vegetation along Six Mile Creek that are listed in Appendix A of the TEC listing advice.

At intermittent locations within the TEC, the vegetation along Six Mile Creek was observed to be highly impacted by the declared pest species *Macfadyena unguis-cati* (cats claw creeper), while the balance of the TEC within the area surveyed is also impacted by *M. unguis-cati* but to a lesser extent (refer to Plate 2).


Plate 2 TEC impacted by *Macfadyena unguis-cati* (cats claw creeper) along Six Mile Creek

The TEC along Six Mile Creek also contains areas with low density weeds and presents as a closed forest community in good condition (refer to Plate 3).

Plate 3 Closed forest community in good condition along Six Mile Creek

The amount of closed forest identified along Six Mile Creek from the existing Bruce Highway to the North Coast railway line has been calculated and is presented in Table 7.

Table 7 Extent of TEC along Six Mile Creek

	Six Mile Creek from Bruce Highway to North Coast railway line (ha)	Within Survey Area (ha)	Within Project Area (ha)
TEC	14.23	4.60	0.82
50 m buffer	29.77	9.14	4.67

An assessment against the key diagnostic characteristics is provided in Table 8 and assessment against the condition thresholds is provided in Table 9.

Table 8 Key diagnostic characteristics of the riparian vegetation along Six Mile Creek

Key diagnostic characteristics	Riparian vegetation along Six Mile Creek	Conformance with characteristics
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions.	The vegetation community occurs in the South Eastern Queensland bioregion	Conforms
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments	The vegetation community occurs on alluvial soils.	Conforms
The ecological community generally occurs at an altitude less than 300 m above sea level.	Occurs at an altitude of 100 m	Conforms
The ecological community typically occurs in areas with high annual rainfall (>1,300 mm).	Occurs in an area with a mean annual rainfall of 1,126.9 mm (Gympie weather station (40093)).	Conforms – although an average rainfall of less than the key diagnostic characteristic, numerous years have rainfall higher

Key diagnostic characteristics	Riparian vegetation along Six Mile Creek	Conformance with characteristics
		than 1,300 mm.
The ecological community is typically more than 2 km inland from the coast.	Vegetation community occurs approximately 36 km inland from the coast.	Conforms
The structure of the ecological community is typically a tall (20 m – 30 m) closed forest, often with multiple canopy layers.	Vegetation community occurs as a tall closed forest with multiple tree layers.	Conforms
Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A).	The vegetation community has patches with high species richness, including > 30 woody species from Appendix A of the listing advice.	Conforms

As shown in Table 8, the riparian vegetation along Six Mile Creek conforms to the key diagnostic characteristics of the Lowland Rainforest of Subtropical Australia TEC.

Table 9 Condition thresholds of the riparian vegetation along Six Mile Creek

Condition thresholds		Conformance with condition threshold
Patch type (evidence of remnant vegetation and regeneration status)	Natural remnant evident by the persistence of mature residual trees from Appendix B of the listing advice. AND	Conforms – vegetation is remnant vegetation with persistent mature trees from Appendix B
Patch size (excludes buffer zone)	≥ 0.1 ha AND	Conforms – vegetation community is approximately 10 ha
Canopy cover (over entire patch)	Emergent/canopy/subcanopy cover is ≥ 70% AND	Conforms – projective foliage cover was assessed as greater than 70%
Species richness (over entire patch)	Contains ≥ 40 native woody species from Appendix A AND	Conforms – contains > 40 woody species from Appendix A
Percent of total vegetation cover that is native (use sample plot)	≥ 70% of vegetation is native	Conforms – although the vegetation community contains high density *M. unguis-cati*, total native vegetation cover is greater than 70%

As demonstrated in Table 9, although some areas of the riparian vegetation present within the area surveyed along Six Mile Creek contain high density *M. unguis-cati,* the overall vegetation polygon conforms to the condition thresholds of the Lowland Rainforest of Subtropical Australia TEC.

4.3 Woondum State Forest

An area of rainforest vegetation west of the project area at approximately Ch 136800 m within Woondum State Forest was previously identified as conforming to the key diagnostic characteristics of the Lowland Rainforest of Subtropical Australia TEC; however, upon assessment against the condition thresholds, the vegetation polygon did not conform to the condition thresholds as only 38 woody species from Appendix A of the listing criteria were identified (refer to BAAM's *Detailed Terrestrial Flora Surveys* (2016) report contained in Appendix A for the assessment).

Given that the entirety of the closed forest community polygon was not surveyed and the possibility of an additional two species being present (which would elevate the vegetation community to a TEC and therefore a matter of national environmental significance), a more extensive survey was undertaken in July 2016. The outcome of this assessment identified that a total of 45 species from Appendix A (with greater than 40 woody species) of the listing advice are present within this closed forest vegetation polygon. The location of the closed forest vegetation polygon is shown in Appendix E and comprises an area of approximately 1 ha. Appendix F contains a list of species identified during the assessment of the closed forest vegetation polygon within Woondum State Forest that are listed on Appendix A of the TEC listing advice.

The area of closed forest community identified in Woondum State Forest comprises 1.42 hectares. The areas of the Lowland Rainforest of Subtropical Australia TEC at Woondum State Forest have been calculated with respect to the survey area and project area and are presented in Table 10.

Table 10 Extent of TEC in Woondum State Forest

	Total Extent of TEC in Woondum State Forest	Within Survey Area (ha)	Within Project Area (ha)
TEC	1.42	0.64	0
50 m buffer	3.56	2.27	0.52

As additional species were identified during the July 2016 flora survey, an updated assessment against the key diagnostic characteristics is provided in Table 11 and assessment against the condition thresholds is provided in Table 12.

Table 11 Key diagnostic characteristics of the vegetation polygon within Woondum State Forest

Key diagnostic characteristics	Riparian vegetation along Six Mile Creek	Conformance with characteristics
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions.	The vegetation community occurs in the South Eastern Queensland bioregion	Conforms
The ecological community	The vegetation community	Conforms

Key diagnostic characteristics	Riparian vegetation along Six Mile Creek	Conformance with characteristics
occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments	occurs on alluvial soils.	
The ecological community generally occurs at an altitude less than 300 m above sea level.	Occurs at an altitude of 100 m	Conforms
The ecological community typically occurs in areas with high annual rainfall (>1,300 mm).	Occurs in an area with a mean annual rainfall of 1,126.9 mm (Gympie weather station 40093).	Conforms
The ecological community is typically more than 2 km inland from the coast.	Vegetation community occurs approximately 36 km inland from the coast.	Conforms
The structure of the ecological community is typically a tall (20 m – 30 m) closed forest, often with multiple canopy layers.	Vegetation community occurs as a tall closed forest with multiple tree layers.	Conforms
Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A).	The vegetation community has patches with high species richness, including > 30 woody species from Appendix A of the listing advice.	Conforms

As detailed in Table 11, the rainforest community vegetation within Woondum State Forest conforms to the key diagnostic characteristics of the Lowland Rainforest of Subtropical Australia TEC.

Table 12 Condition thresholds of the vegetation polygon within Woondum State Forest

Condition thresholds		Conformance with condition threshold
Patch type (evidence of remnant vegetation and regeneration status)	Natural remnant evident by the persistence of mature residual trees from Appendix B of the listing advice. AND	Conforms – vegetation is remnant vegetation with persistent mature trees from Appendix B
Patch size (excludes buffer	≥ 0.1 ha	Conforms – vegetation community is approximately

Condition thresholds		Conformance with condition threshold
zone)	AND	1 ha
Canopy cover (over entire patch)	Emergent/canopy/subcanopy cover is ≥ 70% AND	Conforms – projective foliage cover was assessed as greater than 70%
Species richness (over entire patch)	Contains ≥ 40 native woody species from Appendix A AND	Conforms – contains > 40 woody species from Appendix A
Percent of total vegetation cover that is native (use sample plot)	≥ 70% of vegetation is native	Conforms – weeds were present only in low densities

As demonstrated in Table 12, the closed forest vegetation present within Woondum State Forest conforms to the key diagnostic characteristics and condition thresholds of the Lowland Rainforest of Subtropical Australia TEC.

The Lowland Rainforest of Subtropical Australia TECs at Six Mile Creek and Woondum State Forest are considered to be matters of national environmental significance and are to be included in the referral documentation submitted to the Commonwealth government under the EPBC Act.

5. Impacts and mitigation

5.1 General

Construction dates for the project are currently unknown as funding for the project has not been formally secured. During the Construction phase of the project, the project area will be made available to the construction contractor to be cleared. In the absence of mitigation measures, this will result in direct impacts to *M. pauli-guilielmi* and *M. coronata*. The anticipated impacts and proposed mitigation measures to these two species are discussed in the following sections. In addition to the species specific mitigation measures developed for the project, the following general management measures will be implemented during the Construction phase of works to minimise impacts to native flora and potential habitat for EVNT flora species:

- Clearing of vegetation will be minimised, as far as practicable by designating a works area which avoids encroachment into adjoining areas of remnant vegetation
- Weed management activities will be undertaken to avoid the spread of weeds in the project area or the introduction of new weed species
- Any existing cleared areas are to be utilised to the greatest extent possible for ancillary activities (e.g. site buildings and stockpiles) and potential impacts managed using appropriate dust, erosion and sediment control
- A project-specific erosion and sediment control plan shall be prepared by the construction contractor for the Construction phase of the project
- Appropriate management of dust and emissions will occur in accordance with strategies identified by the Environmental Management Plan (Construction) to be prepared by the construction contractor
- Rehabilitation and revegetation of exposed surfaces is to be undertaken sequentially during the Construction phase

5.2 Impacts

5.2.1 Protected plants

The Construction phase of the project will require vegetation clearing within the project area which has the potential to result in direct impacts to all *M. pauli-guilielmi* and *M. coronata* identified within this report. Based on the outcomes of the flora surveys undertaken by BAAM in 2016 and GHD in 2016, this would result in a loss of approximately 48 adults and 167 seedlings of *M. pauli-guilielmi* with an extent of occurrence of 8.31 ha within the project area and 334 adults and 531 seedlings of *M. coronata* with an extent of occurrence of 69.87 ha within the project area.

5.2.2 Threatened ecological community

A bridge is proposed over Six Mile Creek which will require the removal of 0.82 ha of the TEC present along the northern bank of Six Mile Creek at this location. A total of 4.67 ha of the TEC 50 m buffer area will be impacted on the southern bank of Six Mile Creek at the location of the bridge crossing.

The highway upgrade works will impact upon the Roadcraft driver training facility currently operating north of Six Mile Creek on Lot 412 on MCH5139, Lot 410 on MCH4680 and Lot 401 on MCH5139. As part of the resumption process, the driver training facility will be relocated within Lot 412 on MCH5139 and Lot 410 on MCH4680.

5.3 Mitigation measures

A number of general mitigation measures have been adopted at the Detailed Design phase of the project to minimise clearing requirements (as detailed in Section 5.1). Mitigation measures to assist in conserving *M. pauli-guilielmi* and *M. coronata* and maximise the potential of these species' survival in the wild involve limiting the extent of clearing and offsetting any residual impact.

In order to achieve a no net-loss of *M. pauli-guilielmi*, all individuals within the project area and individuals whose sub-populations will be fragmented are proposed to be translocated to suitable habitat. This will be completed in accordance with a Translocation Management Plan developed for the project and includes provisions for weed management, replacement of failed treatments, seed dispersal and securing the offset site from future clearing.

In order to achieve a no net-loss of *M. coronata*, a land based offset is being proposed to secure suitable *M. coronata* habitat. A propagation program will be developed in conjunction with a local native plant nursery, with preference given to nurseries that have previously had success in propagating *M. coronata,* and the propagated individuals will be planted at an offset site to be secured from future clearing. Local nurseries have previously had success in propagating *M. coronata* from salvaged individuals and success in planting these individuals in offset sites. The mitigation measures proposed for *M. coronata* will be included in the Impact Management Plan developed for the project which will include provisions for offsetting.

6. Conclusion

Flora assessments of the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) survey area have been undertaken over a number of surveys to determine the presence of conservation significant flora species that may potentially be impacted by the project. The results of the various flora surveys are presented in this report and in BAAM's *Detailed Terrestrial Flora Surveys* (2016) report included as Appendix A.

This report presents the combined survey effort and results of the flora surveys as well as documenting how the flora surveys achieve compliance with the Guidelines. Table 13 provides a summary of how the flora surveys meet the requirements of the Guidelines.

Table 13 Comparison of flora survey with requirements of the *Flora Survey Guidelines – Protected Plants 2014*

Key requirements of the *Flora Survey Guidelines – Protected Plants*	Limitations of this assessment	Justification
Flora surveys to be co-ordinated and led by a suitably qualified person.	No limitations or deviations were identified with regard to the use of suitably qualified personnel.	The flora survey was co-ordinated and led by suitably qualified persons who all have appropriate qualifications and training together with a minimum of five years' experience in undertaking EVNT flora surveys. For further details of technical lead refer to Section 2.2 of this report and Section 3.2 of Appendix A.
The survey must be conducted at the most appropriate time of year to maximise the chance of detecting the EVNT species.	No limitations with regard to the timing of the flora survey were identified.	The majority of the target species are long-lived perennial species that can be confidently identified based on vegetative features. One species identified by BAAM (2016) as potentially present within the survey area, *Pterostylis chaetophora,* is a cryptic ground orchid which flowers from August to September. A flora survey at the end of July was deemed appropriate to maximise the likelihood of encountering all target species, even though this species was not considered to be likely to occur within the survey area.
The flora survey needs to assess the area to be cleared as well as a buffer area of 100 m around the clearing.	No limitations with regard to the 100 m buffer were identified.	Meanders were completed across all habitat types within the area proposed for clearing together with the surrounding buffer.
The timed meander survey method is the preferred approach for detection of EVNT species.	No limitations with regard to the method of the flora survey were identified.	Timed random meander surveys were undertaken in accordance with the Guidelines in High Risk Areas as well as in areas mapped as 'known habitat' and 'potential habitat'.
If an EVNT plant species is recorded during the survey, a more comprehensive survey is required in order to collect data concerning the EVNT population and its habitat.	Not applicable.	One EVNT species (*M. coronata*) was recorded during the July 2016 flora survey in a High Risk Area while the *M. pauli-guilielmi* was identified by BAAM in a High Risk Area. A plot based assessment was undertaken for the *M. coronata*; with the results presented in Section 3.2.3. The habitat within which the *M. pauli-guilielmi* was identified is presented in BAAM's 2016 report.

7. Works cited

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Appendices

Appendix A – BAAM's Detailed Terrestrial Flora Surveys (2016)

DETAILED TERRESTRIAL FLORA SURVEYS

BRUCE HIGHWAY COOROY TO CURRA (SECTION D: WOONDUM TO CURRA)

Prepared for
Advisian on behalf of Department of Transport and Main Roads

Biodiversity Assessment and Management Pty Ltd
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BAAM ECOLOGICAL CONSULTANTS

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Document Control Sheet

File Number: 0402-001

Project Manager/s: Dr Penn Lloyd

Client: Advisian on behalf of Department of Transport and Main Roads

Project Title: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Project Author/s: Dr Penn Lloyd

Project Summary: Detailed targeted surveys for threatened and near threatened flora species along the proposed alignment of the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra).

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Biodiversity Assessment and Management Pty Ltd has produced this report in its capacity as {consultants} for and on the request of Advisian on behalf of Department of Transport and Main Roads (the "Client") for the sole purpose of providing the results of detailed targeted surveys for threatened and near threatened flora species along the proposed alignment of the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (the "Specified Purpose"). This information and any recommendations in this report are particular to the Specified Purpose and are based on facts, matters and circumstances particular to the subject matter of the report and the Specified Purpose at the time of production. This report is not to be used, nor is it suitable, for any purpose other than the Specified Purpose. Biodiversity Assessment and Management Pty Ltd disclaims all liability for any loss and/or damage whatsoever arising either directly or indirectly as a result of any application, use or reliance upon the report for any purpose other than the Specified Purpose.

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Signed on behalf of
Biodiversity Assessment and Management Pty Ltd

Date: 24/06/2016

Managing Director

EXECUTIVE SUMMARY

PURPOSE OF THE REPORT

This report has been prepared to document the results of targeted terrestrial flora surveys undertaken to establish an accepted standard of information regarding the presence or absence of plant species listed as threatened or near threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or Queensland *Nature Conservation Act 1992* (NC Act), as well as the distribution, quality and significance of habitat for these species within the study area of the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project (the Project), including Stage D1 (Woondum Interchange to Sandy Creek Road) and Stage D2 (Sandy Creek Road to Curra Interchange).

APPROACH

The study involved two stages, a desktop assessment followed by a targeted field survey. The desktop component reviewed online databases and previous ecological studies undertaken in the study area to compile a list of endangered, vulnerable and near-threatened (EVNT) flora species that are known to occur or could potentially occur in the study area, identify the preferred habitat requirements, and confirm the survey requirements in accordance with established survey guidelines for these species to be targeted in the field survey. The field survey was undertaken over four days 22-25 February 2016 by a team of two experienced ecologists. The survey included timed random meanders searching for EVNT flora species at 26 locations with the study area that were selected to provide a spatially replicated stratified random survey of the range of habitat types present. Wherever an EVNT flora species was encountered, detailed information on the population size or density and supporting habitat characteristics was recorded.

KEY RESULTS

The desktop assessment identified one flora species known to occur, Zamia Palm (*Macrozamia pauli-guilielmi*: EPBC Act: endangered; NC Act: endangered), one species as likely to occur, Slender Milkvine (*Marsdenia coronata*: NC Act: vulnerable), and a further 17 species that may occur in the study area. Two threatened flora species were detected during the field survey: Zamia Palm and Slender Milkvine.

The field assessment identified three distinct and highly localized sub-populations of Zamia Palm in the Stage D2 portion of the study area, with a fourth sub-population confirmed 1.3 km east of the study area. The three sub-populations in the study area were growing in remnant eucalypt forest in soft, sandy soils derived from sandstone (Land Zone 10) and ranged in size from 15 to 61 adult plants, with between two and 109 seedlings present, confirming successful reproduction. The fourth sub-population was growing in remnant eucalypt forest in gravelly soils derived from metasediments (Land Zone 11) and included at least 98 adult plants and numerous seedlings. Due to the extensive coverage of the previous and present surveys, there is a low probability of undetected Zamia Palm sub-populations occurring on un-surveyed portions of the study area.

Slender Milkvine was encountered in a variety of eucalypt forest types during nearly half of the random meanders. At some locations it was widely distributed and relatively common, particularly on Land Zone 11 in Curra State Forest. Estimated Slender Milkvine densities ranged between two and 88 adult plants per hectare, with between 11 and 148 seedlings per hectare.

Despite extensive survey effort in suitable habitats over several surveys, no other EVNT flora species have been encountered; therefore it is concluded that there is a low probability that any of the 17 species assessed as having potential to occur in the study area may actually occur.

POTENTIAL IMPACTS ON EVNT FLORA SPECIES

Based on the proposed Project footprint, a total of 48 adult and 167 seedling Zamia Palms will be directly impacted by Stage D2 of the Project. A further 44 adults and 27 seedlings will be indirectly impacted due to their close proximity to the proposed Project footprint and/or population fragmentation and isolation by the Project.

Based on the proposed Project footprint, a total of 78.18 ha of known habitat (12.56 ha in Stage D1 and 65.62 ha in Stage D2) and 38.37 ha of potential habitat for Slender Milkvine (19.74 ha in Stage D1 and 18.63 ha in Stage D2) will be directly impacted by the Project.

RECOMMENDATIONS

The residual impact of the Project on Zamia Palm will likely require mitigation and offsetting in accordance with the Commonwealth EPBC Act Environmental Offsets Policy and the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. A suitable mitigation and offset action for Zamia Palm would be to salvage and translocate plants proposed to be impacted by the project to suitable habitat(s) in the local region. Different options for such translocation are presented. Translocation should be undertaken in accordance with a translocation management plan prepared for the Project.

The residual impact of the Project on Slender Milkvine will likely require mitigation and offsetting in accordance with the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. Due to the relatively high abundance of Slender Milkvine in known habitat areas within the proposed Project footprint, the translocation of plants is unlikely to be cost-effective as a mitigation and offsetting action. Instead, a habitat offset should be considered, based on the area of known habitat to be impacted by the Project. Given the apparent success of seedling establishment in proximity to parent plant locations from the previous season, the collection of seed from plants within the proposed Project footprint for subsequent manual dispersal to establish plants in habitat offset areas could be an effective mitigation and offsetting action.

DETAILED TERRESTRIAL FLORA SURVEYS

BRUCE HIGHWAY COOROY TO CURRA (SECTION D: WOONDUM TO CURRA)

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Table of Terms and Abbreviations

ALA	Atlas of Living Australia
BAAM	Biodiversity Assessment and Management Pty Ltd
DTMR	Queensland Department of Transport and Main Roads
EHP	Queensland Department of Environment and Heritage Protection
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	Endangered, Vulnerable or Near Threatened
NC Act	Queensland *Nature Conservation Act 1992*
RE	Regional Ecosystem

1.0 INTRODUCTION

1.1 BACKGROUND

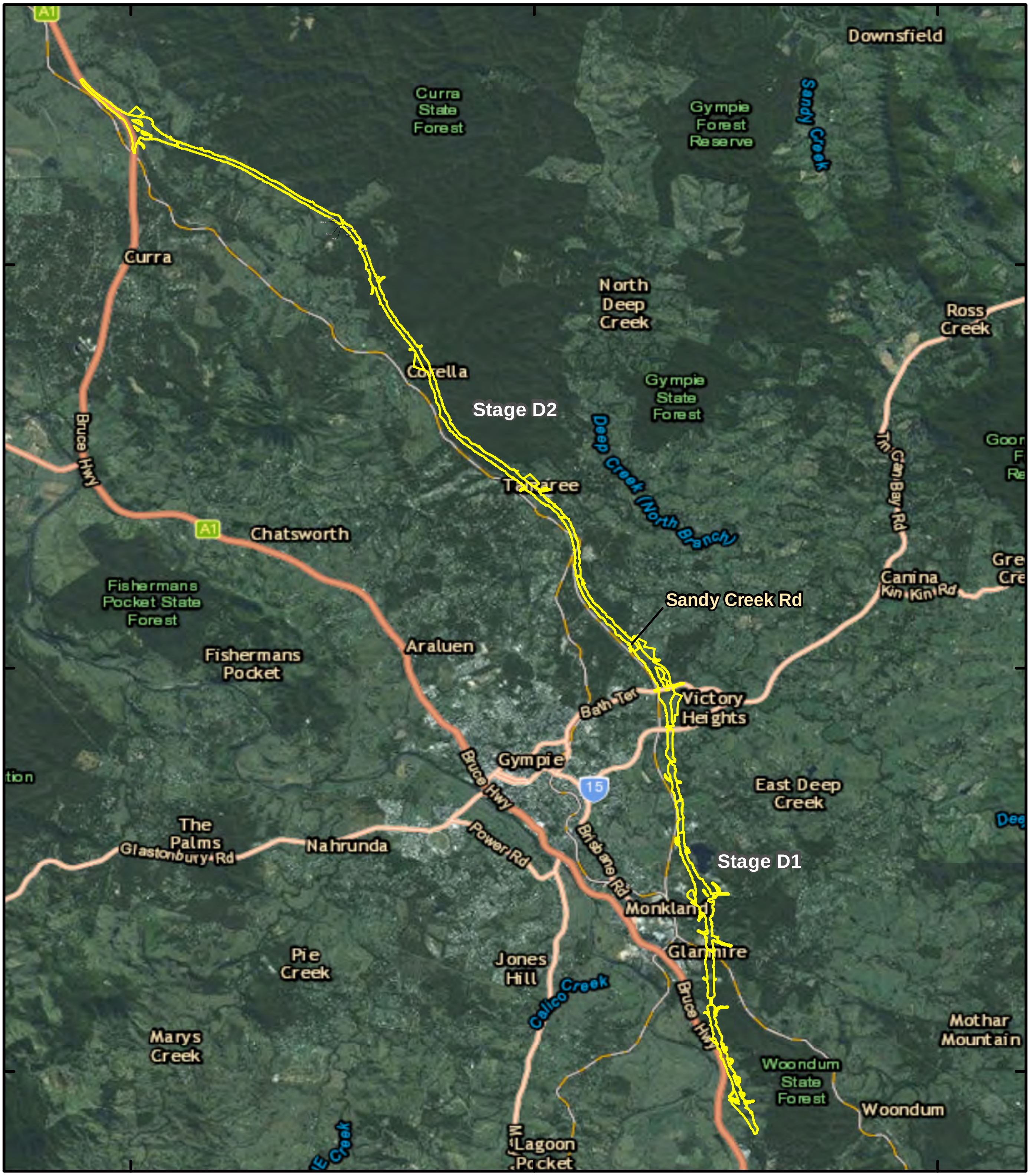
The Bruce Highway (Cooroy to Curra) project involves a 62 km upgrade and realignment of the Bruce Highway between Cooroy and Curra, including a bypass of Gympie township. One of Queensland's highest priority road projects, it is designed to meet strategic transport needs of the Sunshine Coast and Gympie regions well into the future. Section D of the project comprises 30 km of predominantly green-field, four-lane dual carriageway from Woondum Road to Curra, including a bypass of the Gympie township and side roads (see **Figure 1.1**). Section D of the project (the Project) comprises two stages, namely Stage D1 (Woondum Interchange to Sandy Creek Road) and Stage D2 (Sandy Creek Road to Curra Interchange). A Review of Environmental Factors (REF) and Environmental Management Plan (Planning) for the Section D Project identified a number of environmental factors requiring additional investigations and approvals prior to the commencement of construction. These included specific investigations of flora species listed as threatened or near threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or Queensland *Nature Conservation Act 1992* (NC Act), as well as the distribution, quality and significance of habitat for these species within the proposed Project footprint and surrounding landscape. A flora survey conducted in the Section D study area to inform the REF (reported in Jacobs 2015) conducted plot-based flora surveys as a component of Regional Ecosystem (RE) ground-truthing, assessed habitat suitability for threatened and near threatened flora species, and searched for threatened and near threatened flora species during these activities. As this survey was primarily focused on ground-truthing vegetation communities, it did not include extensive, targeted surveys for threatened and near threatened flora species.

The study area for the Project is the area selected for the purposes of conducting flora and fauna surveys, and includes the extent of the cut and fill batters provided in the concept design for the highway as at January 2015, plus a buffer of approximately 200 metres on either side. The study area was not moved following slight modifications to the design after January 2015. Consequently, the width of the buffer varies and may be 50 metres or less in some places. The Project footprint is the likely impact area associated with the construction of the Project and takes into account the potential areas for site offices, drainage structures, access tracks, erosion and sediment control devices, and borrow/spoil areas. The Project footprint is based on the final Business Case design at November 2015, with the following assumptions:

- The toe of embankments plus 25 metres will be cleared of vegetation to provide adequate room for haul routes, light vehicle access and drainage structures, stockpiles and temporary sediment basins.
- The top of cuttings plus 15 metres will be cleared of vegetation to provide adequate room for drainage structures and light vehicle access tracks.
- Where cuttings may be laid back to win more material, or spoil areas required to dispose of material, to balance earthworks, an additional footprint area has been provided.
- Proposed site office locations as identified in the constructability review.

1.2 AIMS AND OBJECTIVES

The primary aim of the detailed terrestrial flora surveys is to complement earlier flora surveys and undertake sufficient survey effort by experienced flora ecologists to establish an accepted standard of information regarding the presence or absence of threatened and near threatened plant species, as well as the distribution, quality and significance of habitat for these species within the study area. The surveys are required to be undertaken in accordance with established threatened flora species survey guidelines, or other relevant sources where no guidelines currently exist.



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:129,000 at A4

0 0.5 1 2 3 4 Kilometers

LEGEND

Cooroy to Curra Section D - Project Footprint

Figure:	**1-1**
Title:	Location of the project
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

BAAM ECOLOGICAL CONSULTANTS

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Document Location: D:\GIS\Jobs\0402-001 C2C Secion D FloraSurvey\GIS\MXDs\ReportMaps\Figure1-1 Location of the study area.mxdDate: 3/04/2016 3:28:43 PM

2.0 APPROACH TO THE STUDY

The study involved two stages, a desktop assessment followed by a detailed and targeted field survey.

2.1 DESKTOP ASSESSMENT

The objectives of the desktop assessment were to:

- compile a list of endangered, vulnerable and near-threatened (EVNT) flora species that are known to occur or could potentially occur in the study area based on database records in the vicinity of the study area; these species are to be targeted in the detailed flora surveys;
- identify the preferred habitat requirements for each of the EVNT flora species to be targeted, particularly with respect to the Regional Ecosystem (RE) vegetation communities that occur within the study area; and
- confirm the survey requirements in accordance with established survey guidelines for each of the EVNT flora species to be targeted in the field surveys.

The list of EVNT flora species was compiled through a review of the following:

- the Flora and Fauna chapter of the Review of Environmental Factors (Business Case) for the project, which identified EVNT flora species that are known to occur or could potentially occur in the study area based on database searches (dated February 2015) and field surveys undertaken over six days from the 5th to the 10th of December 2011 (BAAM 2012) and nine days over the periods 2-7 March and 5-7 May 2015 (Jacobs 2015);
- the EPBC Act Protected Matters Search Tool database;
- the Wildlife Online database; and
- the Atlas of Living Australia (ALA) database.

The preferred habitat requirements for each of the EVNT flora species to be targeted were identified from review of:

- online species profiles, including the Species Profile and Threats (SPRAT) database (DoE 2015), WetlandInfo database (EHP 2016) and the Plant Information Network System database of the National Herbarium of NSW (PlantNET 2016);
- published literature, e.g. Leiper *et al*. (2008) and species recovery plans (Queensland Herbarium 2007); and
- essential habitat factors derived from the Queensland Essential Habitat database.

2.2 FIELD SURVEY

The primary objectives of the targeted field survey were to:

- search for EVNT flora species during a structured survey program aimed at stratified sampling of the different RE vegetation communities within the study area that are known to provide preferred habitat for the targeted EVNT species to ensure that the full range of potential habitats are systematically sampled;
- collect a range of information on the population area and size (or extent), reproductive state, age structure and supporting habitat of any EVNT flora species found during the survey;

- census the total sub-population sizes of known locations of the endangered Zamia Palm (*Macrozamia pauli-guilielmi*) that have been previously found in the study area;
- survey for sub-populations of Zamia Palm in potentially suitable habitat (adjacent to known sub-populations) that will be fragmented and isolated by the proposed Project footprint;
- survey for sub-populations of Zamia Palm in potentially suitable core contiguous habitat in Curra State Forest (i.e. to the east of the Project footprint) that could potentially be supplemented by plants translocated from the proposed Project footprint; and
- opportunistically record the locations of key habitat features such as hollow bearing trees.

No species-specific survey guidelines are available in Queensland or nationally for most threatened plant species (DotE 2016a). Therefore, a combination of methods from DEC (2004) and EHP (2014) threatened species survey guidelines was implemented. The most effective method of searching a wide area for threatened flora species that are naturally rare is through the implementation of a random meander survey technique through potentially suitable habitat, rather than undertaking transect or plot-based surveys (DEC 2004). This technique allows for substantially greater coverage than a plot-based survey and is less time consuming. As the name suggests, the random meander technique involves traversing areas of suitable habitat in no set pattern, but roughly back and forth, whilst searching for particular plant species, usually threatened species.

The locations of random meanders were selected using a stratified random survey design to obtain spatially replicated, representative surveys of each of the different REs present within the study area for the Project, and focussed particularly on the proposed Project footprint and on REs known to provide preferred habitat for the targeted species.

3.0 RESULTS AND DISCUSSION

3.1 DESKTOP ASSESSMENT

The Review of Environmental Factors (Business Case) for the project found one EVNT flora species, *Macrozamia pauli-guilielmi*, occurring within the study area, and assessed that a further one species, *Marsdenia coronata*, is likely to occur and 15 species have potential to occur (**Table 3.1**). The updated database searches identified a further two species as having potential to occur based on database records in the study area, namely *Aponogeton elongatus* subsp*. elongatus* and *Ricinocarpos speciosus* (**Table 3.1**). The preferred habitat characteristics of these species and recommended survey approach and timing are summarized in **Table 3.1**. An analysis of the optimal survey timing for each of these species, summarized in **Table 3.2**, identified the period November to February as optimal for all species except *Pterostylis chaetophora*. The optimal survey timing for the latter species is during its flowering season in late August to early September; however the species can still be detected and identified on the basis of its leaves outside of this period.

Table 3.1. Species known, likely or with the potential to occur in the Section D project study area, proposed survey methodology consistent with survey guidelines and recommended survey times.

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
Macrozamia pauli-guilielmi	Zamia Palm	E	E	Known	Essential habitat REs 12.3.11, 12.9-10.4, 12.9-10.17, 12.11.14; within study area, refined on the basis of field surveys to include REs 12.9-10.4 and 12.9-10.17.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round.** A low-growing perennial with 1 m tall leaf fronds.
Marsdenia coronata	Slender Milkvine		V	Likely	Essential habitat REs 12.11.3, 12.11.5e, 12.11.16, 12.9-10.4, 12.9-10.17b; in sclerophyll forest, particularly on slopes with small, rocky outcrops and where *Lophostemon confertus* is present in the understorey.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**November to April** - when flowering/ fruiting.
Aponogeton elongatus subsp. *elongatus*			NT	Potential	Aquatic, in rivers and streams with thick sediments or in floodplain billabongs. Essential habitat RE 12.3.11.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – An aquatic herb, flowers and fruits from October to March.
Archidendron lovelliae	Bacon Wood	V	V	Potential	Wetter forest on sandy loam, including riparian areas; REs 12.3.1 and 12.3.11.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – A small tree (flowers December to February, fruits March to May).
Arthraxon hispidus	Hairy-Joint Grass	V	V	Potential	Highest potential in non-remnant, swampy grassland within the study area.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Spring to autumn**. An inconspicuous grass that grows spring-summer and dies off in winter.

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
Baloghia marmorata	Jointed Baloghia	V	V	Potential	Rainforest, including regrowth RE 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub or small tree that flowers during winter (Leiper *et al*. 2008).
Bosistoa transversa (includes B. selwynii)	Three Leaved Bosistoa, Heart-leaved Bosistoa	V		Potential	Rainforest, including regrowth RE 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a tree that flowers between January and May (DotE 2016h).
Floydia praealta	Ball Nut	V	V	Potential	Rainforest, including RE 12.3.1.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a small tree that flowers and fruits from January to June (DotE 2016f).
Fontainea rostrata	Deep Creek Fontainea	V	V	Potential	REs 12.3.1, 12.11.10; rainforest and riparian forest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – A tree or shrub. Flowers in spring, fruits in summer (ALA 2016).
Macadamia integrifolia	Macadamia Nut	V	V	Potential	Dry rainforest; REs 12.3.1 regrowth 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a small tree that flowers and fruits from January to June (DotE 2016g).
Macadamia ternifolia	Maroochy Nut	V	V	Potential	Rainforest, including RE 12.3.1 and regrowth 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A	**Year round** - flowers winter to spring and fruits between December and March (DotE

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
						combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	2016d).
Picris conyzoides	Fleabane Hawkweed		V	Potential	RE 12.3.3; open eucalypt forest and woodland in lower rainfall areas.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Spring to summer** - no flowering information available. Two other *Picrus* spp. in SEQ known to flower in Spring (Stanley & Ross 1986).
Pterostylis chaetophora	-		E	Potential	Sclerophyll forest; REs 12.9-10.4; 12.9-10.17b.	This is a cryptic ground orchid with a persistent underground tuber, so detection is problematic and can only be detected with the appearance of leaf rosettes and flowers. No species-specific survey guidelines for Queensland. Draft Survey Guidelines for Australia's Threatened Orchids (Commonwealth of Australia 2013) to be applied.	**August to September** – an inconspicuous, small terrestrial orchid. Two records of flowering from Gympie Region are from late August and early September (ALA 2016).
Ricinocarpos speciosus	-		V	Unlikely	Wet montane eucalypt forest.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub that flowers in spring (Leiper *et al*. 2008).
Samadera bidwillii	Quassia	E	E	Potential	REs 12.3.1, 12.3.11, 12.11.10; rainforest and open forest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub or small tree that flowers in November–March ((DotE 2016e).

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
Sophora fraseri	Brush Sophora	V	V	Potential	Vine thickets and dry rainforests; REs 12.3.1 and regrowth 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub that flowers from spring to autumn (Leiper *et al*. 2008).
Symplocos harroldii	Hairy Hazelwood		NT	Potential	Dry rainforests; RE 12.11.10.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a small tree that flowers during summer (Leiper *et al*. 2008).
Triunia robusta	Glossy Spicebush	E	E	Potential	REs 12.3.1, 12.11.16; wet rainforest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub or small tree that flowers during spring (Leiper *et al.* 2008).
Xanthostemon oppositifolius	Southern Penda	V	V	Potential	REs 12.3.1, 12.11.16; wet rainforest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a tree that flowers and fruits from winter to spring.

* Regional Ecosystems (REs) present in the study area (see **Figure 3.1** for mapped distribution) comprise the following:
RE 12.3.1: Gallery rainforest (notophyll vine forest) on alluvial plains.
RE 12.3.3d: *Eucalyptus moluccana* woodland on alluvial plains.
RE 12.3.11: *Eucalyptus tereticornis* +/- *E. siderophloia*, *Corymbia intermedia* open forest on alluvial plains.
RE 12.9-10.4: *Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks.
RE 12.9-10.17b: *Corymbia citriodora* subsp. *variegata* mixed open forest to woodland on sedimentary rocks.
RE 12.11.3: *Eucalyptus siderophloia*, *E. propinqua* +/- *E. microcorys*, *Lophostemon confertus, Corymbia intermedia, E. acmenoides* open forest on metamorphics +/- interbedded volcanics.
RE 12.11.5e: *Corymbia citriodora* subsp. *variegata* open forest on metamorphics +/- interbedded volcanics, usually including *Eucalyptus siderophloia*, *E. propinqua* and *E. acmenoides*.
RE 12.11.10: Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics.
RE 12.11.14: *Eucalyptus crebra, E. tereticornis, Corymbia intermedia* woodland on metamorphics +/- interbedded volcanics.
RE 12.11.16: *Eucalyptus cloeziana* open forest on metamorphics +/- interbedded volcanics.

Table 3.2 Optimum survey times (represented by blue shading) for target species.

Target species	Optimum survey times											
	summer			autumn			winter			spring		
	D	J	F	M	A	M	J	J	A	S	O	N
Known species												
Macrozamia pauli-guilielmi												
Likely species												
Marsdenia coronata												
Potential species												
Aponogeton elongatus subsp. *elongatus*												
Archidendron lovelliae												
Arthraxon hispidus												
Baloghia marmorata												
Bosistoa transversa												
Floydia praealta												
Fontainea rostrata												
Macadamia integrifolia												
Macadamia ternifolia												
Pterostylis chaetophora												
Picris conyzoides												
Ricinocarpos speciosus												
Samadera bidwillii												
Sophora fraseri												
Symplocos harroldii												
Triunia robusta												
Xanthostemon oppositifolius												

The Atlas of Living Australia database search identified four specimen records for *Macrozamia pauli-guilielmi* in the vicinity of the study area, collected from two sites in Curra State Forest, as follows:

- October 1997 (D. Halford). Curra State Forest (S.F.700), Keliher Logging Area, 14 km NNW of Gympie. Eucalypt open forest with shrubby understorey, hilly terrain, simple slope, southerly aspect, stony dark brown light clay. Female plant, frond 70 cm long erect, dark green. Occasional.
- October 1997 (D. Halford). Curra State Forest (S.F.700), Keliher Logging Area, 14 km NNW of Gympie. Eucalypt open forest with shrubby understorey, hilly terrain, simple slope, southerly aspect, stony dark brown light clay. Frond 80 cm long, erect male. Occasional.
- April 2011 (P.I. Forster). Curra State Forest (S.F.700), Keliher Logging Area; 14 km NNW of Gympie. Open forest of *Corymbia intermedia*, *C. citriodora*, *Eucalyptus acmenoides*, *E. propinqua*, *Lophostemon confertus*, dense shrubby understorey, south facing ridge; gravelly clay soil from metasediments. Small cycad, subterranean caudex; leaves 2-6, 70-80 cm long, leaflets dark green with whitish-yellow petiolules; male cones green (aseasonal). Very common at locality.
- October 1997 (D Halford). Curra State Forest (S.F.700), Tamaree Logging Area, 12 km NNW of Gympie. Eucalypt open forest, hilly terrain, crest, stony dark reddish brown loam. Frond 70 cm high, female plant. Only one male and one female plant seen.

The first three specimens correspond to the same location (1.3 km east of the study area) and sub-population, whereas the fourth specimen was collected from an occurrence of the species approximately 2 km south of the other collecting site and located at the edge of the study area. The localities of these records, which also correspond to the locations of essential habitat mapping for the species, were targeted during the field survey as a component of the search for sub-populations in core habitat for the species in Curra State Forest.

3.2 Field Survey

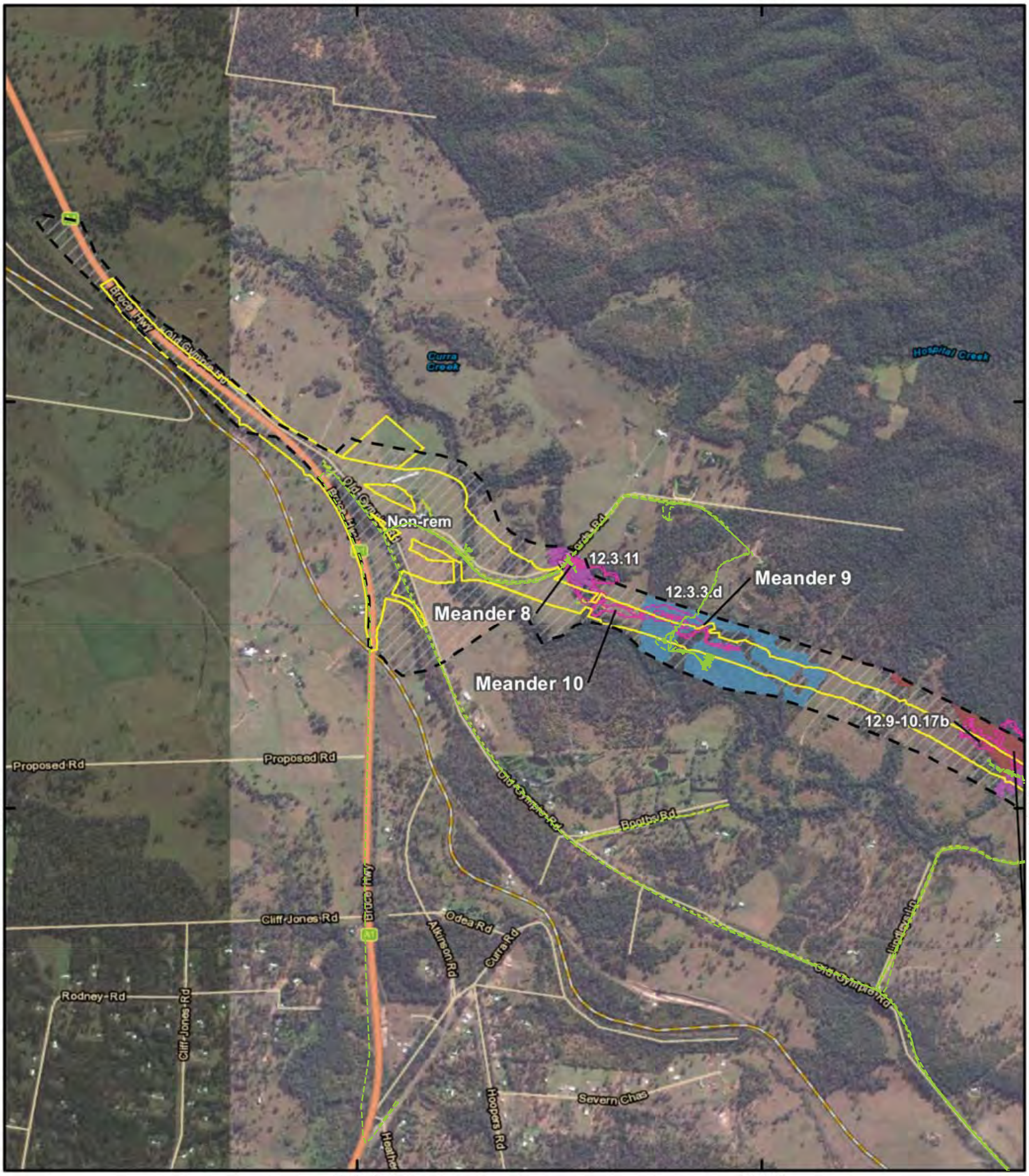
The targeted flora field survey was undertaken over four days from 22 to 25 February 2016 by two experienced flora ecologists, Lui Weber and Dr Penn Lloyd. The timing of the field survey fell within the optimal survey period for all species except *Pterostylis chaetophora*. Details of the survey locations, survey effort and EVNT plant species encountered are summarised in **Table 3.3**, and mapped in relation to the RE mapping for the study area in **Figure 3.1**. This RE mapping represents the refined and ground-truthed mapping of RE vegetation communities undertaken during 2015 for the Review of Environmental Factors (Business Case) for the project.

Two EVNT flora species were encountered during the field survey, namely Zamia Palm (*Macrozamia pauli-guilielmi*) and Slender Milkvine (*Marsdenia coronata*). Zamia Palm was found only in the Stage D2 portion of the study area, whereas Slender Milkvine was found in both Stages D1 and D2 of the study area. The survey results with respect to these two species are presented and discussed in more detail in the sections that follow. A complete list of all flora species identified in the study area during the present and previous surveys is provided in **Appendix A**.

Table 3.3. Summary of targeted flora field survey random meander locations in the study area.

Date	Meander	Duration (mins)*	Regional Ecosystem	EVNT plants encountered
22/02/2016	1	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	2	2 x 32	12.11.5e	*Marsdenia coronata*
22/02/2016	3	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	4	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	5	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	6	2 x 70	12.9-10.4	*Macrozamia pauli-guilielmi* (sub-population 2) and *Marsdenia coronata*
22/02/2016	7	2 x 15	12.9-10.4	
23/02/2016	8	2 x 60	12.3.11	
23/02/2016	9	2 x 30	12.3.3d	
23/02/2016	10	2 x 10	Non-remnant (grassland)	
23/02/2016	11	2 x 80	12.9-10.17b & 12.3.11	*Macrozamia pauli-guilielmi* (sub-population 1)
23/02/2016	12	2 x 40	12.9-10.4	
23/02/2016	13	2 x 30	12.9-10.4	
23/02/2016	14	2 x 70	12.11.5e	*Marsdenia coronata*
24/02/2016	15	2 x 45	12.3.11 & 12.11.5e	
24/02/2016	16	2 x 35	12.3.11 & 12.9-10.17b	
24/02/2016	17	2 x 60	12.11.3 & 12.11.5e	
24/02/2016	18	2 x 65	12.11.3	*Marsdenia coronata*
24/02/2016	19	2 x 30	12.11.3	
24/02/2016	20	2 x 145	12.11.3/12.11.14	*Marsdenia coronata*
25/02/2016	21	2 x 65	12.11.5e	*Macrozamia pauli-guilielmi* (sub-population 4)
25/02/2016	22	2 x 40	12.9-10.4	*Macrozamia pauli-guilielmi* (sub-population 3)
25/02/2016	23	2 x 35	12.3.1	
25/02/2016	24	2 x 30	12.11.14	
25/02/2016	25	2 x 25	12.11.16	*Marsdenia coronata*
25/02/2016	26	2 x 105	12.11.10/12.11.3	

* Each random meander involved the two field observers traversing the area either independently or at least 10 m apart to obtain independent meanders for survey effort replication.



Notes: imagery sourced from ArcGIS Online (c) 2016

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Datum: GDA 1994
Units: Degree

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LEGEND

Macrozamia ALA record
Study Area
Project Footprint
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4
Non-rem

Drawn By: MG   Reviewed by: PL   Date: 3/04/2016

Figure:	3-1 (1 of 7)
Title:	Locations of flora survey random meanders in relation to Regional Ecosystems
Project:	Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)
Client:	Advisian on behalf of QLD Dept. of Transport and Main Roads

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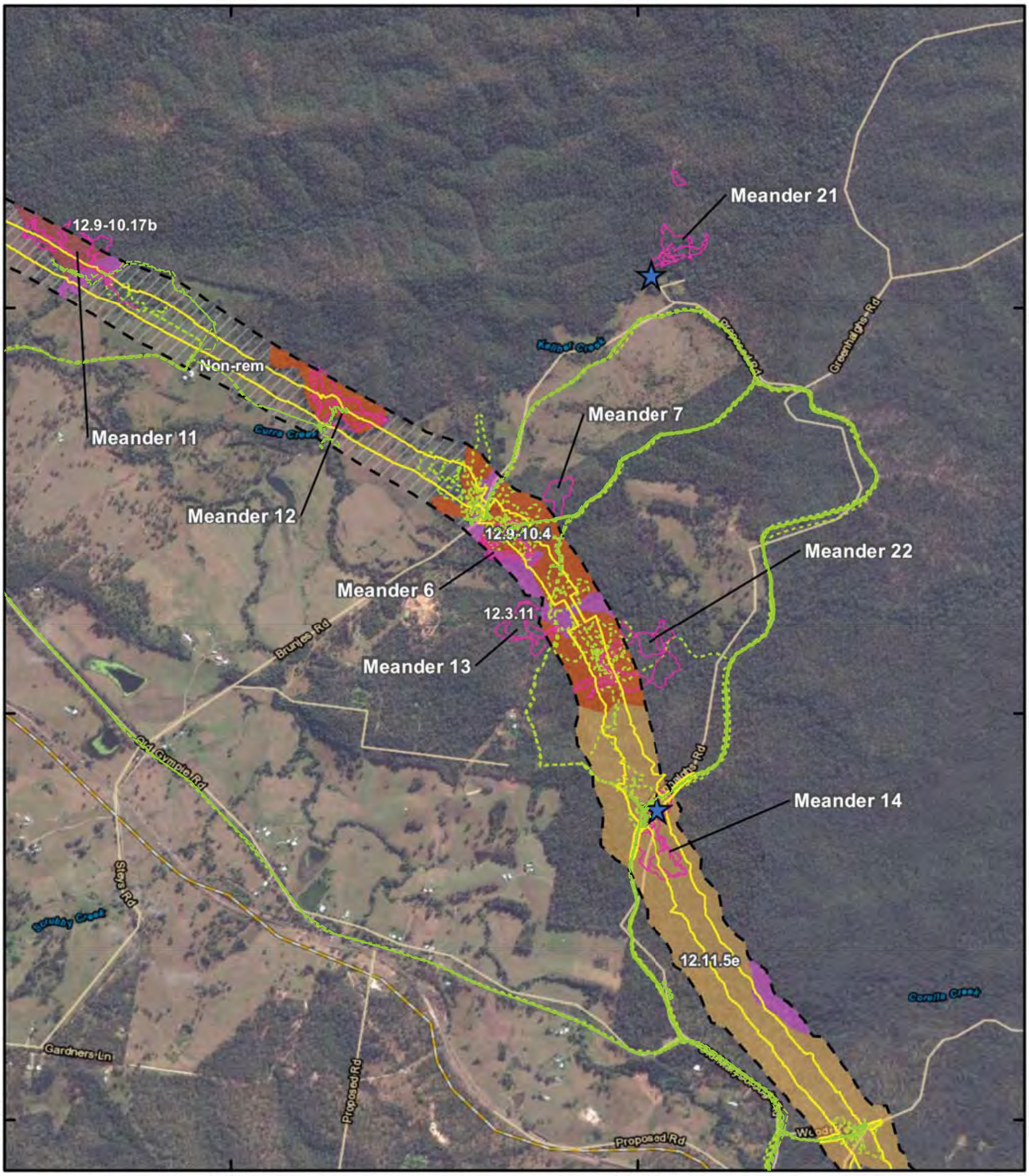

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Units: Degree

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LEGEND

Macrozamia ALA record
Study Area
Project Footprint
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4
Non-rem

Figure:	3-1 (2 of 7)
Title:	Locations of flora survey random meanders in relation to Regional Ecosystems
Project:	Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)
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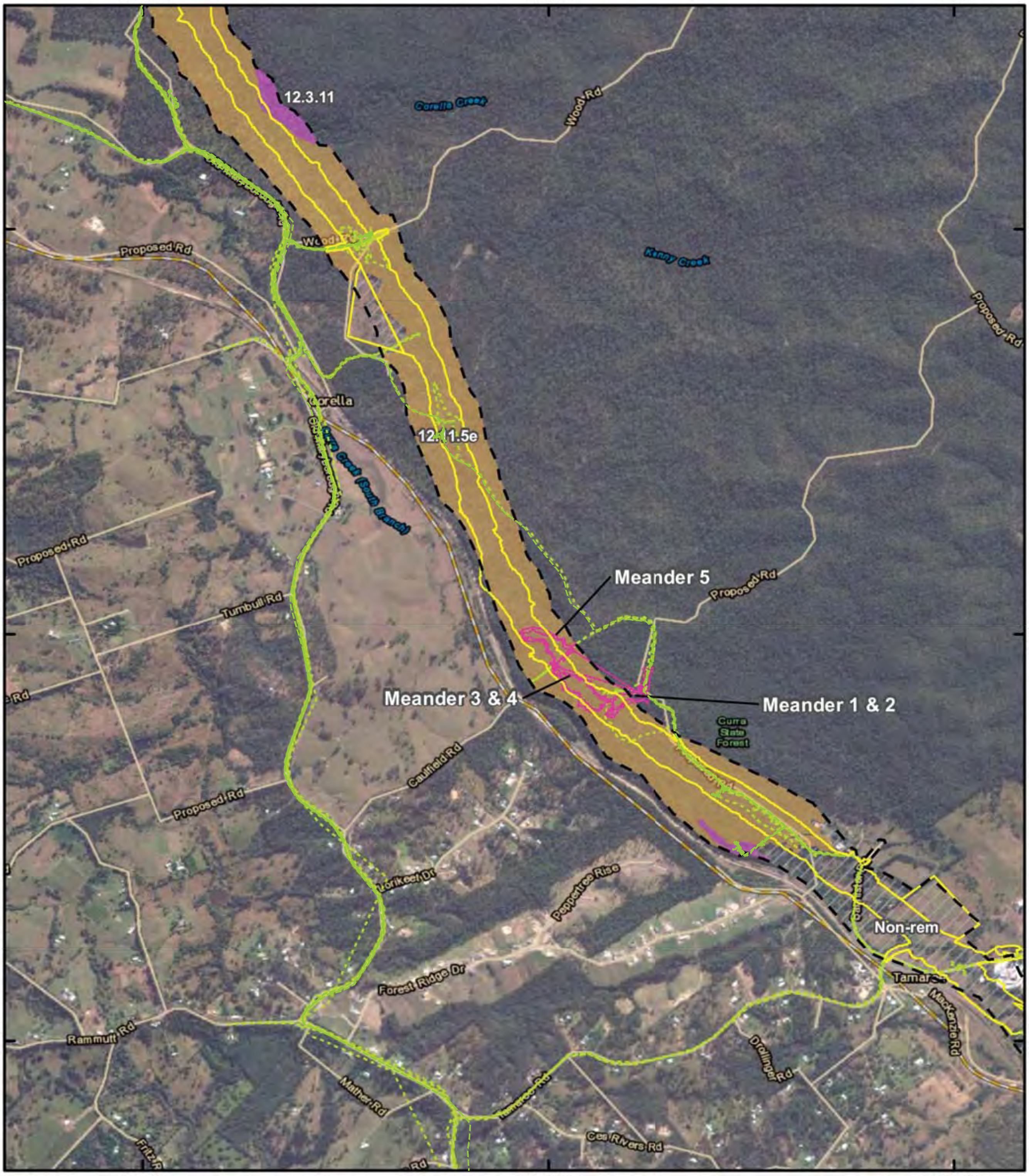

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LEGEND

Macrozamia ALA record
Study Area
Project Footprint
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4
Non-rem

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Figure: 3-1 (3 of 7)

Title: Locations of flora survey random meanders in relation to Regional Ecosystems

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

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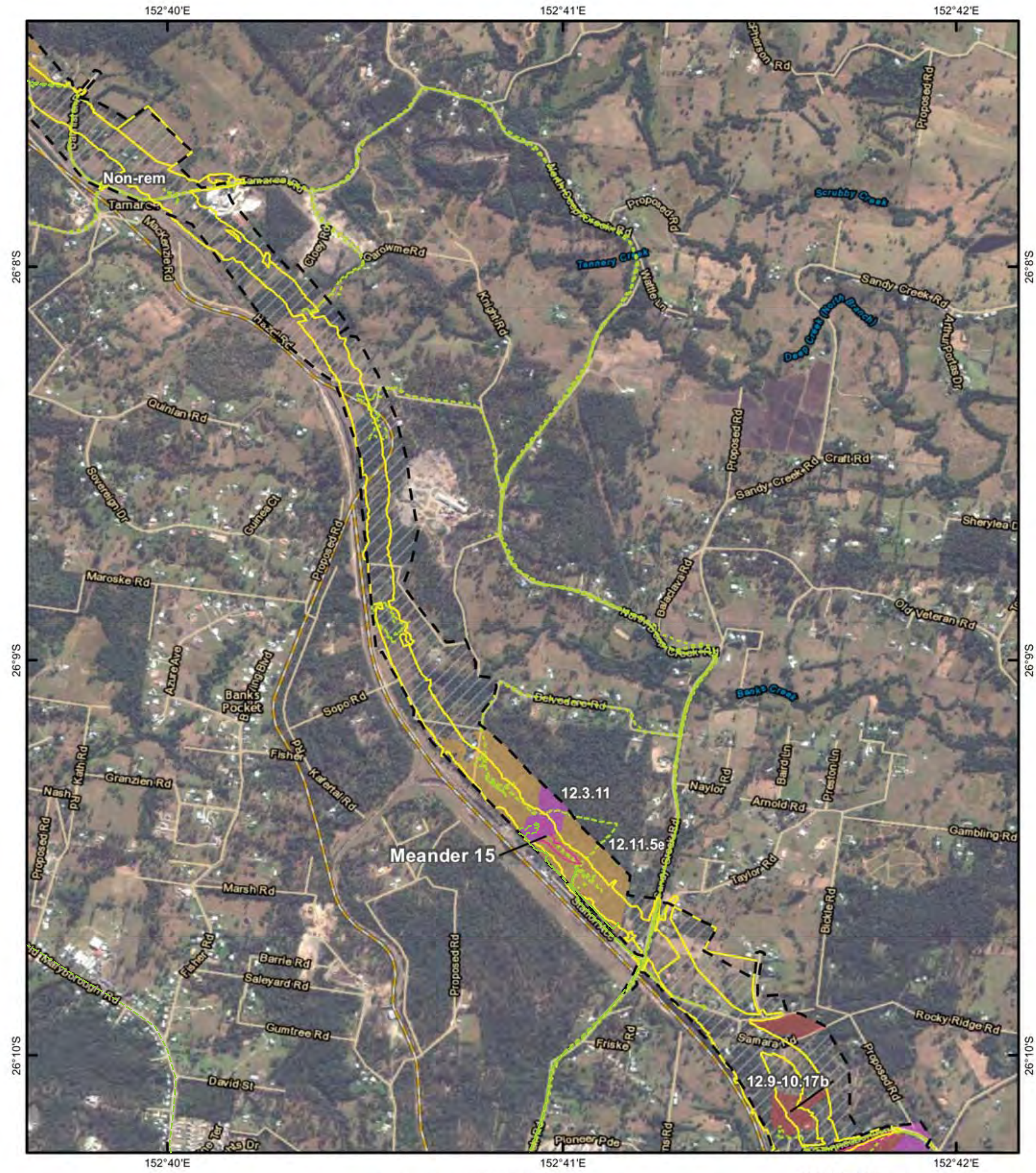

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LEGEND

Macrozamia ALA record
Study Area
Project Footprint
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4
Non-rem

Drawn By: MG   Reviewed by: PL   Date: 3/04/2016

Figure: 3-1 (4 of 7)

Title: Locations of flora survey random meanders in relation to Regional Ecosystems

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

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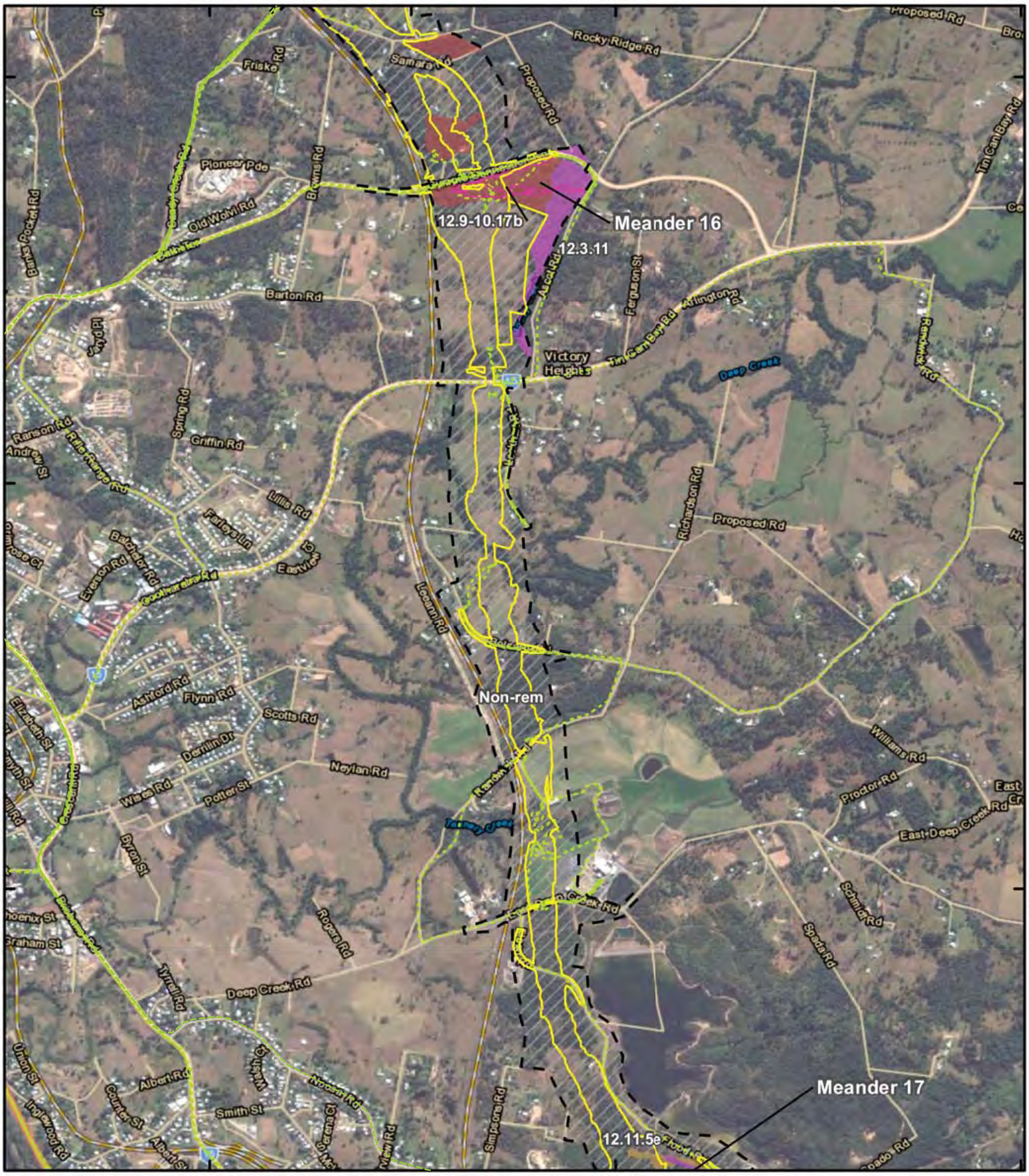

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Units: Degree

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LEGEND

- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

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Figure: 3-1 (5 of 7)
Title: Locations of flora survey random meanders in relation to Regional Ecosystems
Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)
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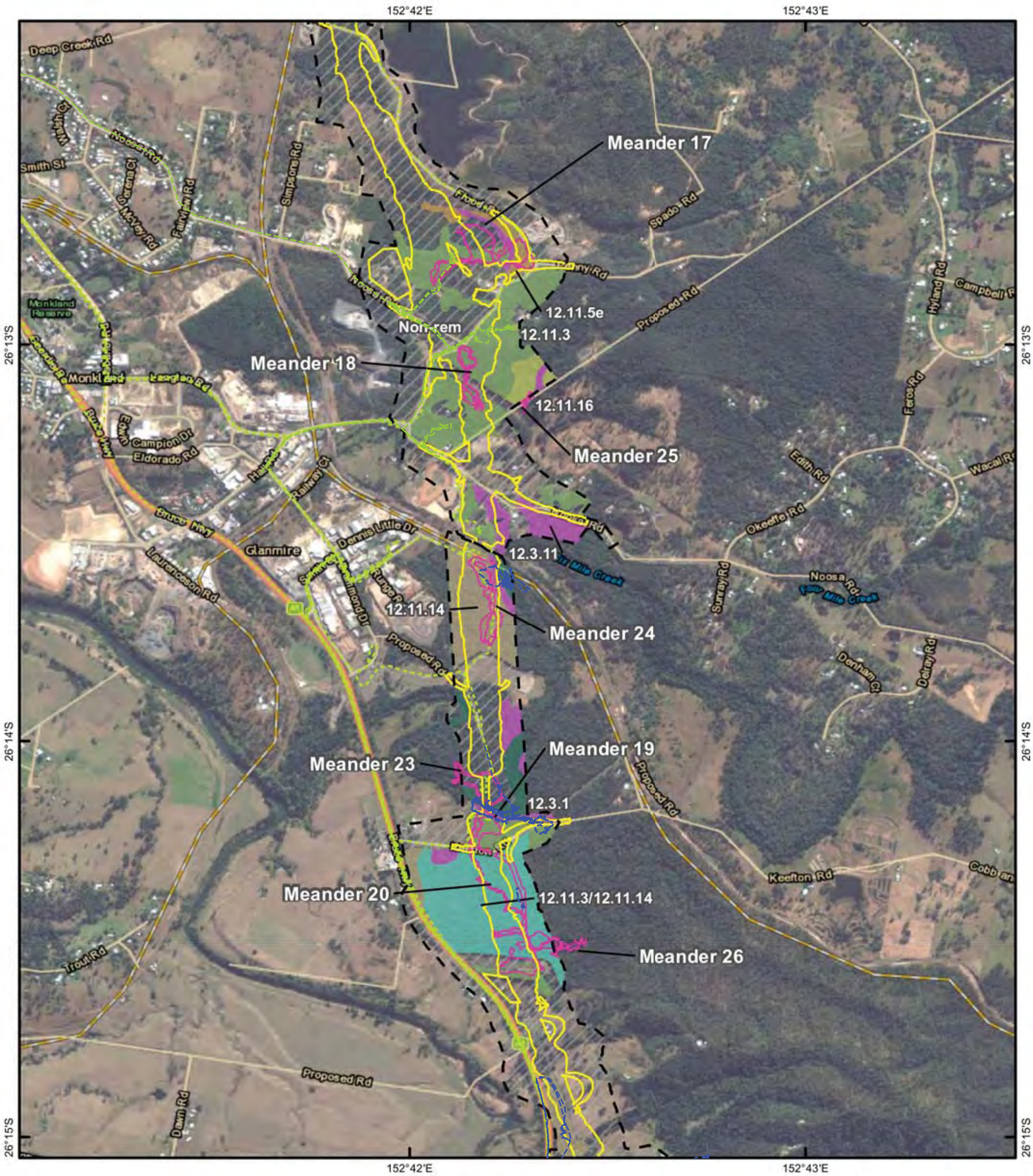

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Datum: GDA 1994
Units: Degree

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LEGEND

Macrozamia ALA record
Study Area
Project Footprint
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4
Non-rem

Drawn By: MG
Reviewed by: PL
Date: 3/04/2016

Figure:	**3-1 (6 of 7)**
Title:	**Locations of flora survey random meanders in relation to Regional Ecosystems**
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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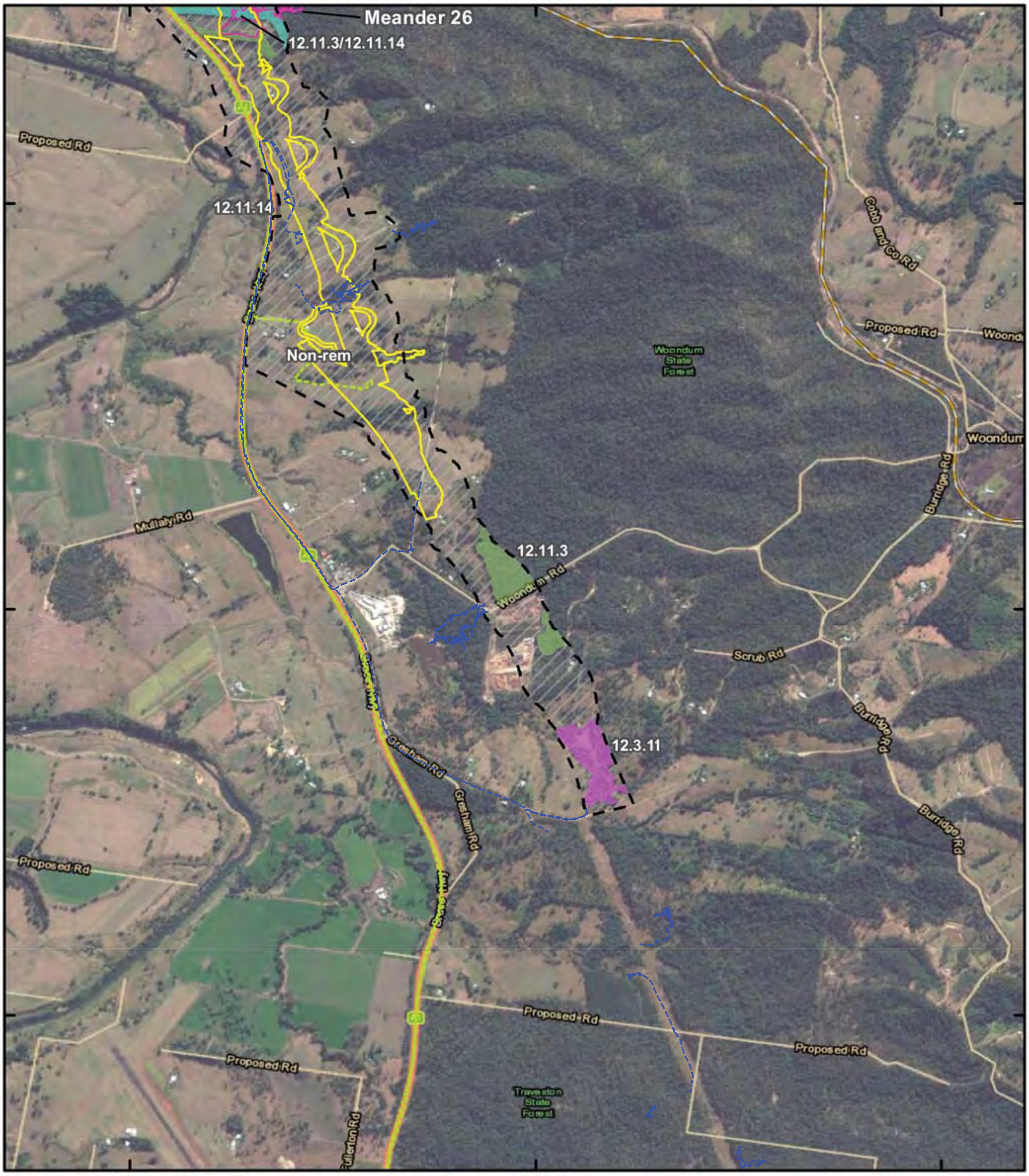

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Datum: GDA 1994
Units: Degree

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0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

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Figure: 3-1 (7 of 7)

Title: Locations of flora survey random meanders in relation to Regional Ecosystems

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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3.2.1 Zamia Palm (*Macrozamia pauli-guilielmi*)

Field survey results

Zamia Palm has a swollen underground stem from which several leaf fronds grow to a height of up to 1 m (**Photo 1**). A diagnostic feature is a spirally twisted leaf rachis. Wherever Zamia Palm was found during the field survey, the broader vicinity was searched to establish the total size of the sub-population in the area. Based on the results of the present survey and previous surveys, three sub-populations of Zamia Palm have been detected within or in close proximity to the Project footprint. The locations of these sub-populations are mapped in **Figure 3.2**, and details of the sub-population sizes and supporting habitats are summarised in **Table 3.4**. The three sub-populations were all found growing in soft, sandy soils derived from sandstone (Land Zone 10), in two different REs, namely RE 12.9-10.4 (*Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks) and RE 12.9-10.17b (*Corymbia citriodora* subsp. *variegata* mixed open forest to woodland on sedimentary rocks) (**Table 3.4**). All the most suitable habitat areas for the species on Land Zone 10 within the Project footprint area have been surveyed during the various surveys; therefore further sub-populations are not expected to occur elsewhere on the proposed Project footprint area on Land Zone 10. In addition, suitable habitat on Land Zone 10 immediately to the west of sub-populations 2 and 3 was searched to establish whether any sub-populations may become isolated by the Project and therefore potentially subject to indirect impacts; however no Zamia Palms were located in this area. A further sub-population (sub-population 4) was confirmed at the site of historical specimen records (from 1997 and 2011) located 1.3 km east of the study area (**Figure 3.2, Table 3.4**).

Sub-population 4 was found growing in a different substrate (Land Zone 11) to the other sub-populations, in RE 12.11.5e (*Corymbia citriodora* subsp. *variegata* open forest on metamorphics +/- interbedded volcanics, usually including *Eucalyptus siderophloia*, *E. propinqua* and *E. acmenoides*). No Zamia Palm plants were located at the location of the 1997 specimen record of two adult plants at the edge of the study area on Land Zone 11; part of this area was found to have been disturbed by logging activities, which may have impacted on the original plants. Due to the extensive coverage of the previous and present surveys, there is a low probability of undetected Zamia Palm sub-populations occurring on un-surveyed portions of the study area.

The presence of seedlings (**Photo 3**) in all sub-populations suggests that all have reproduced successfully in the recent past, even the relatively small sub-population 1. Many female plants in sub-populations 2 to 4 had green, growing cones, whereas many male plants had old, open cones (see **Photos 2** and **4**). The presence of cones and multiple seedlings indicate healthy, successfully reproducing sub-populations.

The Zamia Palm sub-populations are highly localised and discrete, despite extensive suitable habitat in adjoining areas. This pattern of occurrence is typical of the species (Queensland Herbarium 2007), and is thought to be a consequence of very limited dispersal opportunities following the extinction of megafauna (which previously dispersed the seeds) from the area tens of thousands of years ago (Snow and Walter 2007, Hall and Walter 2013).

Photo 1. *Macrozamia pauli-guilielmi* – male (left) and female (right) plants in sub-population 3.

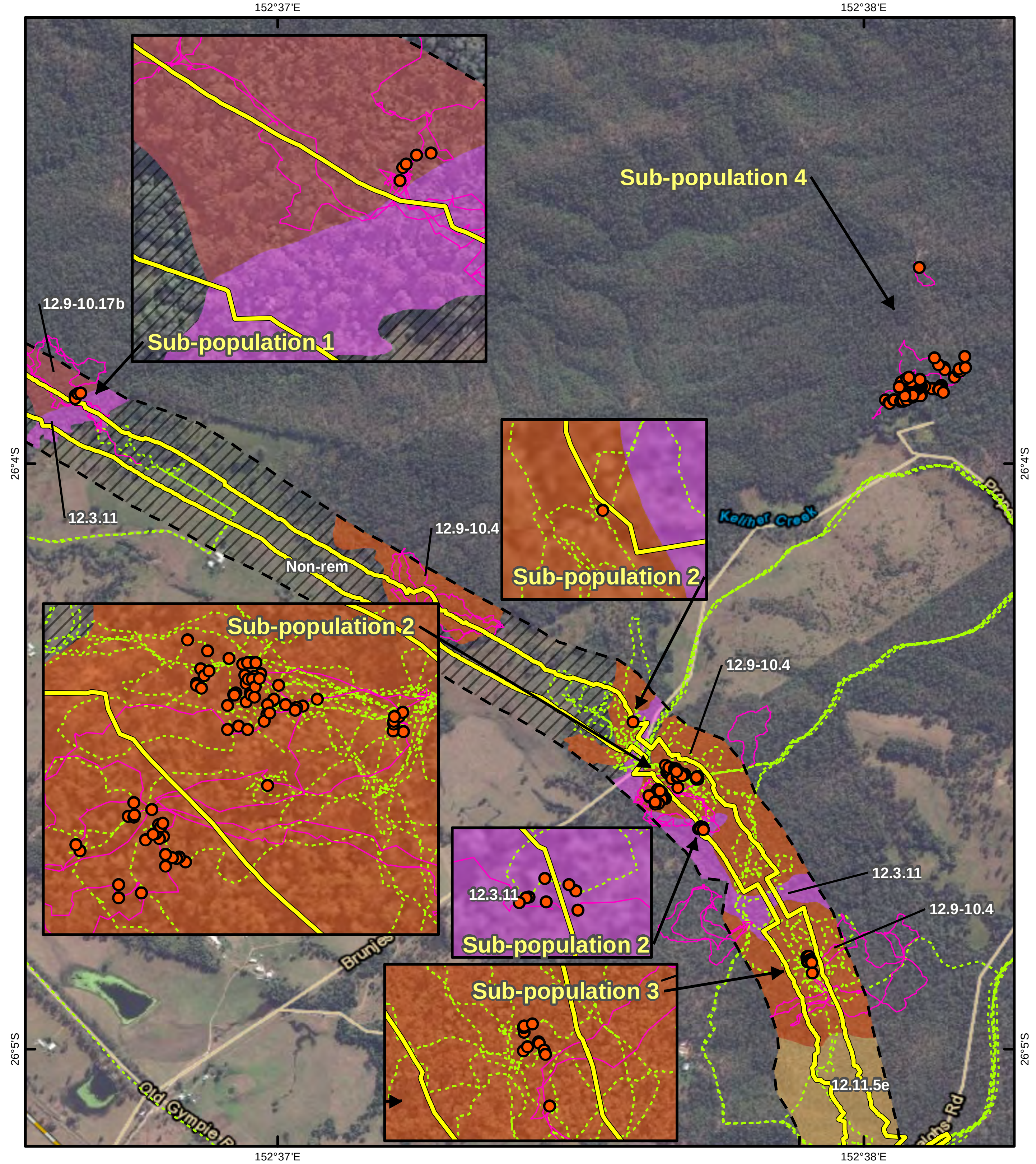
Photo 2. *Macrozamia pauli-guilielmi* – female plant with ripe seed cone shedding seeds.

Photo 3. *Macrozamia pauli-guilielmi* – cluster of seedlings near the base of a female plant.

Photo 4. *Macrozamia pauli-guilielmi* – male plant with old cone.

Photo 5. *Macrozamia pauli-guilielmi* habitat of sub-population 2 in good condition.

Photo 6. *Macrozamia pauli-guilielmi* habitat of sub-population 1 invaded by *Lantana camara** and *Passiflora suberosa** weeds.



Notes: imagery sourced from ArcGIS Online (c) 2016

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Units: Degree

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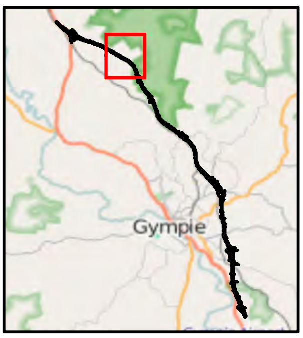

LEGEND

Study Area

Protected Plant Species:

- *Macrozamia pauli-guiliemi*
- Project Footprint
- Field track (2016)
- Field track (2015)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Figure:	**3-2**
Title:	Locations of Zamia Palm (*Macrozamia pauli-guilielmi*) sub-populations
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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Table 3.4. Details of Zamia Palm (*Macrozamia pauli-guilielmi*) sub-populations in the study area.

	Sub-population size	RE	Habitat description
1	16 adults, 2 seedlings.	12.9-10.17b	Structure and position: Remnant open forest, canopy ht 19 m, on lower, south-facing footslope adjacent to creek. Tree1: *Corymbia citriodora* (d), *Eucalyptus acmenoides, E. longirostrata, E. siderophloia*. Tree2: *Lophostemon confertus, E. acmenoides, E. longirostrata, E. siderophloia*. Shrub: *Lantana camara** (d), *Lophostemon confertus, Jagera pseudorhus*. Ground: *Megathyrsus maximus*, Passiflora suberosa*, Themeda triandra*. Substrate: soft sand derived from sandstone, sandstone outcrop nearby. Comments: Zamia Palms becoming overgrown by *Lantana camara** and *Passiflora suberosa** weeds.
2	61 adults, at least 109 seedlings.	12.9-10.4	Structure and position: Remnant open forest, canopy ht 14-18 m, on hill crest and north-facing and south-facing slopes between two creeks. Tree1: *Eucalyptus racemosa* subsp. *racemosa* (d), with *E. acmenoides, Corymbia trachyphloia, C. intermedia* and *Angophora leiocarpa* subdominant. Tree2: *Acacia disparrima* (d) with *Alphitonia excelsa* and *Banksia integrifolia* associated. Shrub: *Lantana camara** (d) with scattered *Banksia integrifolia, Acacia disparrima, A. excelsa* and *Leucopogon juniperinus*. Ground: *Imperata cylindrical* (d) with *Lomandra multiflora, Hibbertia* sp., *Xanthorrhoea johnsonii* and *Gahnia aspera*. Substrate: soft sand derived from sandstone, several sandstone outcrops through the sub-population. Comments: A few Zamia Palms becoming overgrown by *Lantana camara** weeds.
3	15 adults, 83 seedlings.	12.9-10.4	Structure and position: Remnant open forest, canopy ht 15-20 m, on lower, gently sloping north-facing footslope adjacent to creek. Tree1: *Eucalyptus racemosa* subsp. *racemosa, E. propinqua, Corymbia intermedia, Angophora leiocarpa*. Tree2: *Lophostemon suaveolens, Acacia disparrima*. Shrub: *Lantana camara** (d), Tree1 and Tree2 species saplings. Ground: *Aristida gracilipes, Imperata cylindrica* and *Themeda triandra,* with *Lomandra multiflora, Xanthorrhoea johnsonii* and *Gahnia aspera*. Substrate: soft sand derived from sandstone, sandstone outcrop nearby. Comments: A few Zamia Palms becoming overgrown by *Passiflora suberosa** weeds; habitat of southern end of population subject to substantial recent logging.
4	At least 98 adults, abundant seedlings.	12.11.5e	Structure and position: Remnant open forest, canopy ht 15-20 m, on moderate to steeply-sloping, south-facing hillslope adjacent to creek. Tree1: *Corymbia intermedia, C. citriodora, Eucalyptus acmenoides, E. propinqua*. Tree2: *Lophostemon confertus (d).* Shrub: *Lantana camara**, *Lophostemon confertus* (d). Ground: *Themeda triandra*. Substrate: shallow, loamy, gravelly soils derived from metasediments. Comments: A large, dispersed population that may extend further east of the portion surveyed; a few Zamia Palms on the western edge of the sub-population becoming overgrown by *Lantana camara** weeds.

Potential impacts of the Project on Zamia Palm

Key threats to Zamia Palm include habitat loss and clearing of plants, illegal removal of plants (for which the potential is greater in closer proximity to roads), inappropriate fire regimes, loss of individuals affecting the ability of the species to be viable into the future, and loss of critical pollinators and mycorrhizal fungi (Queensland Herbarium 2007, Department of the Environment 2016). A further threat observed in the study area is the threat posed by invasive weeds such as *Lantana camara* and *Passiflora suberosa* overgrowing and shading Zamia Palm plants; this threat is exacerbated by habitat disturbance and edge effects.

Potential impacts of the Project on Zamia Palm include loss of habitat, loss of individuals from dispersed sub-populations, fragmentation of sup-populations causing isolation of small groups of individuals and disturbance leading to weed invasion that may affect the viability of isolated plants into the future, and increased risk of illegal removal of plants in proximity to new roads that increase accessibility of the plants.

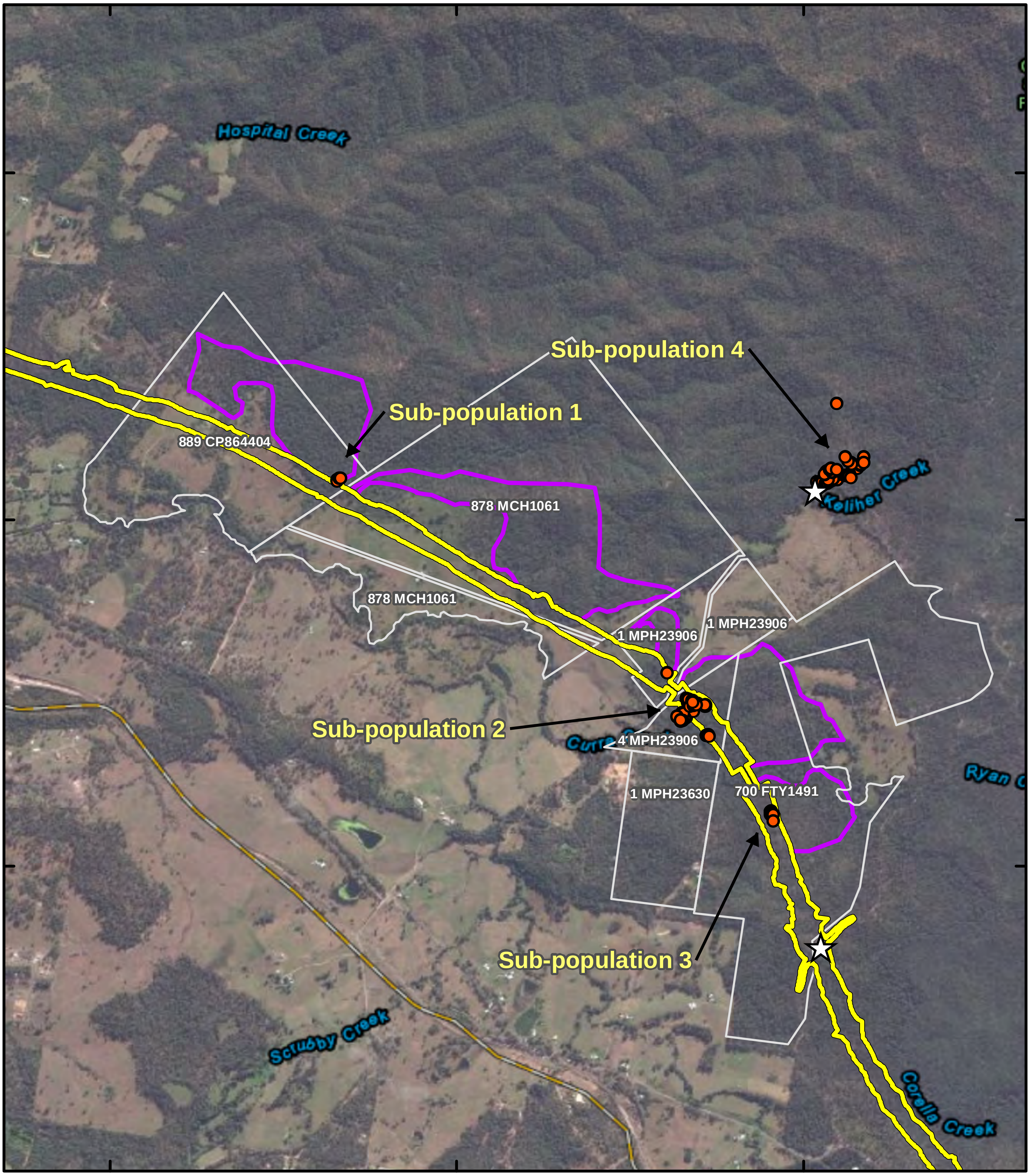
The number of Zamia Palm plants likely to be directly impacted (i.e. within the proposed Project footprint) and indirectly impacted (due to close proximity to the proposed Project footprint and/or fragmentation/isolation) by the Project are detailed in **Table 3.5**.

Table 3.5. Summary of Zamia Palm (*Macrozamia pauli-guilielmi*) plants within the Project footprint (direct impact) or close to the Project footprint (indirect impact).

Sub-population	Plants directly impacted	Plants indirectly impacted (distance from Project footprint)
1	None	16 adults, 2 seedlings (10 m to 30 m)
2	33 adults, 84 seedlings	28 adults, 25 seedlings (1 m to 50 m)
3	15 adults, 83 seedlings	None
4	None	None
Total	48 adults, 167 seedlings	44 adults, 27 seedlings

The residual impact of the Project on Zamia Palm subpopulations will likely require mitigation and offsetting in accordance with the Commonwealth EPBC Act Environmental Offsets Policy and the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. A suitable mitigation and offset action for Zamia Palm would be to salvage and translocate plants proposed to be impacted by the Project to suitable habitat(s) in the local region (Queensland Herbarium 2007, Department of the Environment 2016). Ideally, translocated plants should be translocated into or close to existing nearby sub-populations that are at risk of decline and local extinction (Queensland Herbarium 2007, Department of the Environment 2016). However, the only sub-population known to occur locally (sub-population 4 shown on **Figure 3.2**) is a large, healthily reproducing population that is located on a different substrate type, namely gravelly soils derived from metasediments (Land Zone 11) to the sub-populations to be translocated, which are growing in soft sands derived from sandstone (Land Zone 10). Zamia Palms depend critically on mutualistic associations with mycorrhizal fungi and cyanobacteria in their root systems that respectively facilitate the uptake of mineral nutrients and water from the soil and fix nitrogen for the plant in nutrient-poor soils. The mycorrhizal fungi and cyanobacteria symbionts are expected to be sensitive to substrate type; therefore translocation of plants between different substrate types may compromise the success of the translocation and presents a risk to the translocation program. Five patches of suitable habitat with the same substrate type as the plants to be translocated (i.e. Land Zone 10) are present to the east of the current sub-populations (see **Figure 3.3**):

- Curra State Forest (lot/plan 700 FTY1491) to the east of sub-population 3 and south of Curra Creek. The suitable habitat area on Land Zone 10 is relatively restricted and in close proximity to the Project footprint, but is gently sloping and can be accessed on existing tracks.
- Curra State Forest (lot/plan 700 FTY1491) and the freehold property on lot/plan 4 MPH23906 to the east of sub-population 2 and north of Curra Creek. The suitable habitat area on Land Zone 10 occurs on relatively steep, rocky slopes in close proximity to the Project footprint.
- The freehold property on lot/plan 1 MPH23906 to the north-east of sub-population 2. The small patch of suitable habitat on Land Zone 10 occurs on a steep rocky slope in close proximity to the Project footprint.



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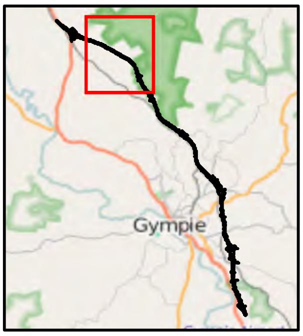

LEGEND

Protected Plant Species:

- Macrozamia pauli-guiliemi
- Macrozamia ALA record
- Suitable Zamia Palm offset habitat
- Property boundaries
- Project Footprint

Figure:	**3-3**
Title:	Locations of suitable Zamia Palm (*Macrozamia pauli-guilielmi*) offset habitat
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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Drawn By: MG Reviewed by: PL Date: 4/04/2016

Document Location: D:\GIS\Jobs\0402-001 C2C Secion D FloraSurvey\GIS\MXDs\ReportMaps\Figure3-3 Suitable Zamia Palm offset habitat.mxdDate: 4/04/2016 10:12:05 AM

- The freehold property on lot/plan 878/MCH1061 to the south-east of sub-population 1 and north-west of sub-population 2. This is the most suitable site for translocation as the suitable habitat area is extensive, more distant from the Project footprint than other potential sites, yet relatively close to (within 1 km of) the existing large sub-population 4 in Curra State Forest. Much of the suitable habitat area on this property has not yet been surveyed; therefore there may be existing sub-populations of Zamia Palm on this site.
- The freehold property on lot/plan 889/CP864404 immediately to the east of sub-population 1. The suitable habitat area on 889/CP864404 is relatively large, but is relatively close to the Project footprint and more distant from sub-population 4.

The selection of the translocation site should be informed by the proposed land use and protection status of the land involved.

Slender Milkvine (Marsdenia coronata)

Field survey results

Slender Milkvine was encountered during nearly half of the random meanders (see **Table 3.3**), and at some locations it was widely distributed and relatively common, particularly on Land Zone 11 in Curra State Forest. The locations of the plants detected are mapped in **Figure 3.4**, and details of the supporting habitats associated with each meander are summarised in **Table 3.6**. Slender Milkvine was rarely encountered on surveys of REs on Land Zone 9-10; indeed only a single concentrated cluster of 5 adult plants and 16 seedlings was found on a sandstone outcrop in RE 12.9-10.4 (**Table 3.6**). Three flowering and fruiting specimens from different locations were collected and submitted to the Queensland Herbarium for confirmation of identification; these were confirmed as Slender Milkvine. Photographs of the different habitats in which the species was located, together with similar species encountered, are presented in **Appendix B**.

Slender Milkvine is a relatively inconspicuous species of climbing vine, characterised by opposite, relatively narrow, oval-shaped leaves with whitish veins that exude a milky, white latex when plucked (**Photos 7** to **10**). Adult plants and seedlings were typically only detected within 3 m of either side of the random meander track, yet the survey recorded a total of 649 plants, comprising 177 adults and 472 seedlings in the limited total area surveyed. Seedlings tended to be clustered in the close vicinity of dead climbing stems that likely represent the remains of the previous season's adult, reproducing plants. Due to this pattern of occurrence, it is appropriate to quantify the density of the species in supporting habitats. To calculate plant densities, the random meander survey tracks on which Slender Milkvine was detected were buffered by 3 m to estimate the total area of habitat surveyed. These details are summarised in **Table 3.6**. Estimated Slender Milkvine densities ranged between 2 and 88 adult plants per hectare, with between 11 and 148 seedlings per hectare (**Table 3.6**).

Based on the results of the field survey and the known preferred habitat characteristics of the species (see **Table 3.1**), the habitat mapping characterised habitat for the species as:

- **Known habitat** – all remnant RE polygons that intersect with a *Marsdenia coronata* record from the field surveys (includes polygons of REs 12.9-10.4, 12.11.3, 12.11.5e and 12.11.16).
- **Potential habitat** – polygons of remnant REs 12.9-10.4, 12.9-10.17b, 12.11.3, 12.11.5e and 12.11.16 that do not intersect with a *Marsdenia coronata* record from the field surveys, including polygons in which the species was not located during the field survey.
- **Not generally suitable** – all other remnant RE polygons (REs 12.3.1, 12.3.3, 12.3.11 and 12.11.14) and non-remnant areas that do not provide suitable habitat for the species.

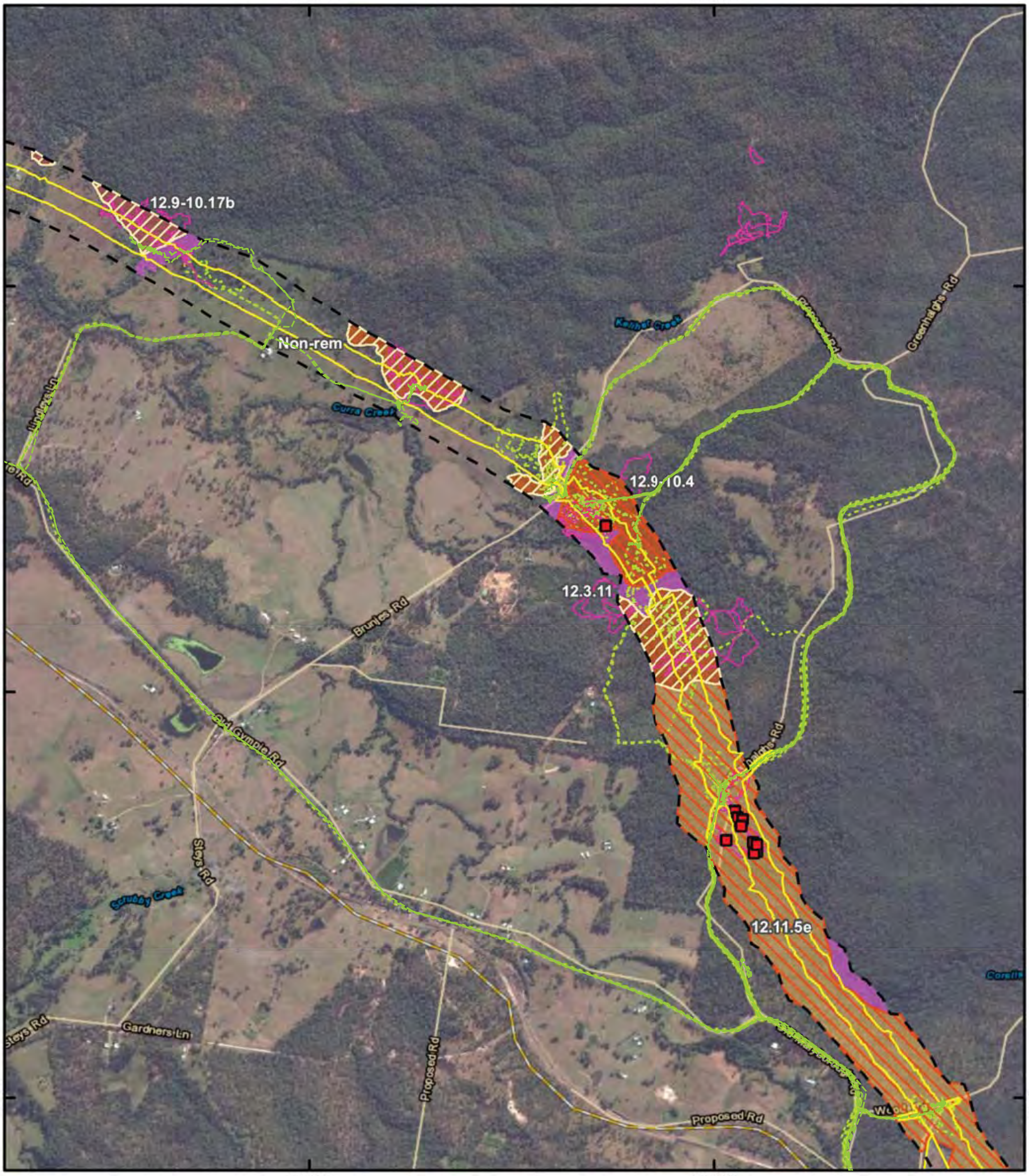
The distributions of the different Slender Milkvine habitat areas in the study area are mapped in **Figure 3.4**.

Photo 7. *Marsdenia coronata* adult vine in a shrub.

Photo 8. *Marsdenia coronata* flowers.

Photo 9. *Marsdenia coronata* seed pod.

Photo 10. *Marsdenia coronata* seedling.



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LEGEND

Study Area

Direct Footprint Area

Protected Plant Species record:

Marsdenia coronata

Marsdenia coronata:

Known habitat

Potential habitat

Field Track (2011)

Field Track (2015)

Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4

Date: 10/03/2016

Figure:	**3-4 1 of 5**
Title:	**Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats**
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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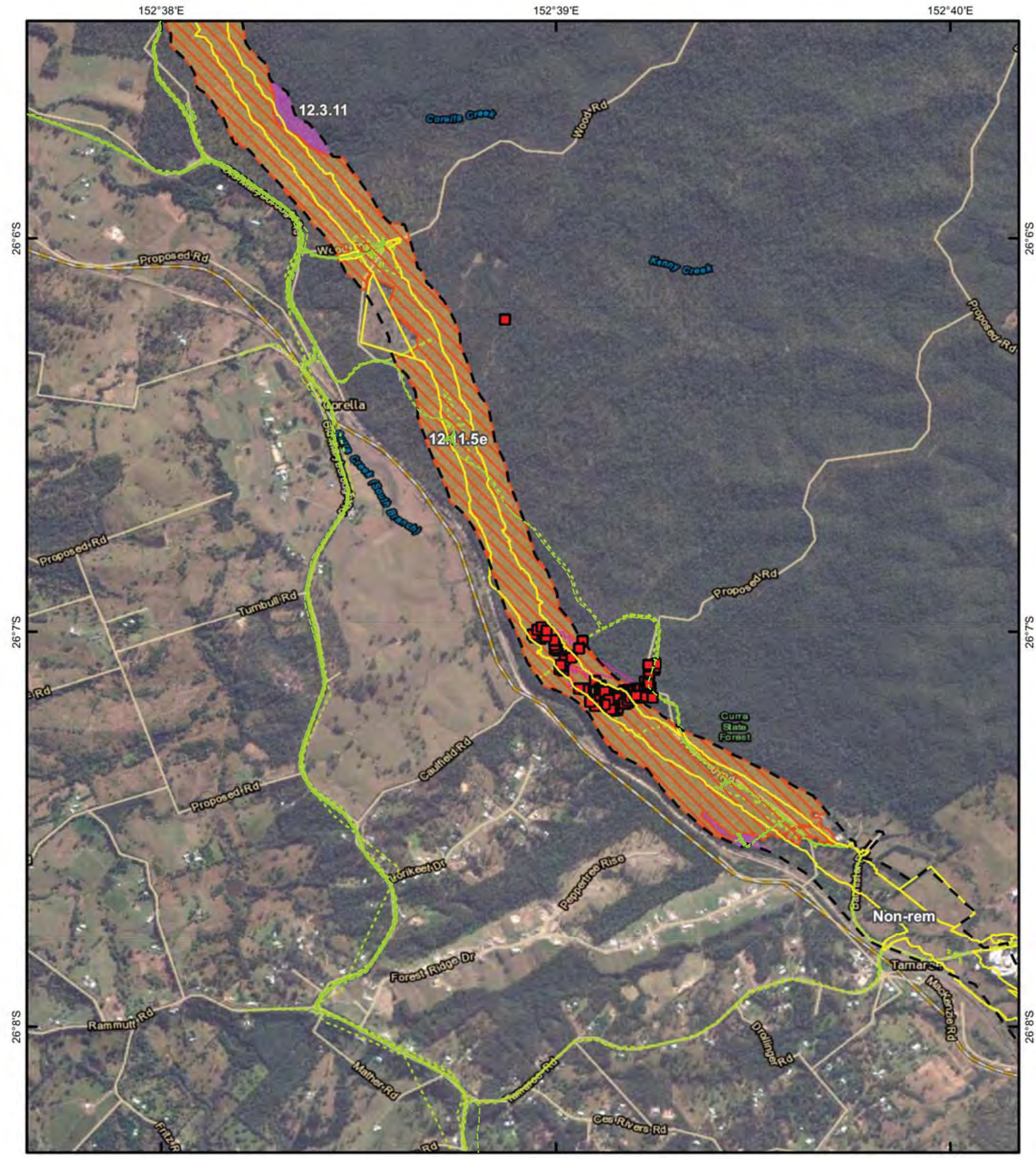

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Datum: GDA 1994
Units: Degree

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0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Study Area
- Direct Footprint Area

Protected Plant Species record:

- *Marsdenia coronata*

Marsdenia coronata:

- Known habitat
- Potential habitat
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

12.11.14	12.3.1
12.11.16	12.3.11
12.11.3	12.3.3.d
12.11.3/12.11.14	12.3.7
12.11.5e	12.9-10.17b
	12.9-10.4

Date: 10/03/2016

Figure: 3-4 2 of 5

Title: Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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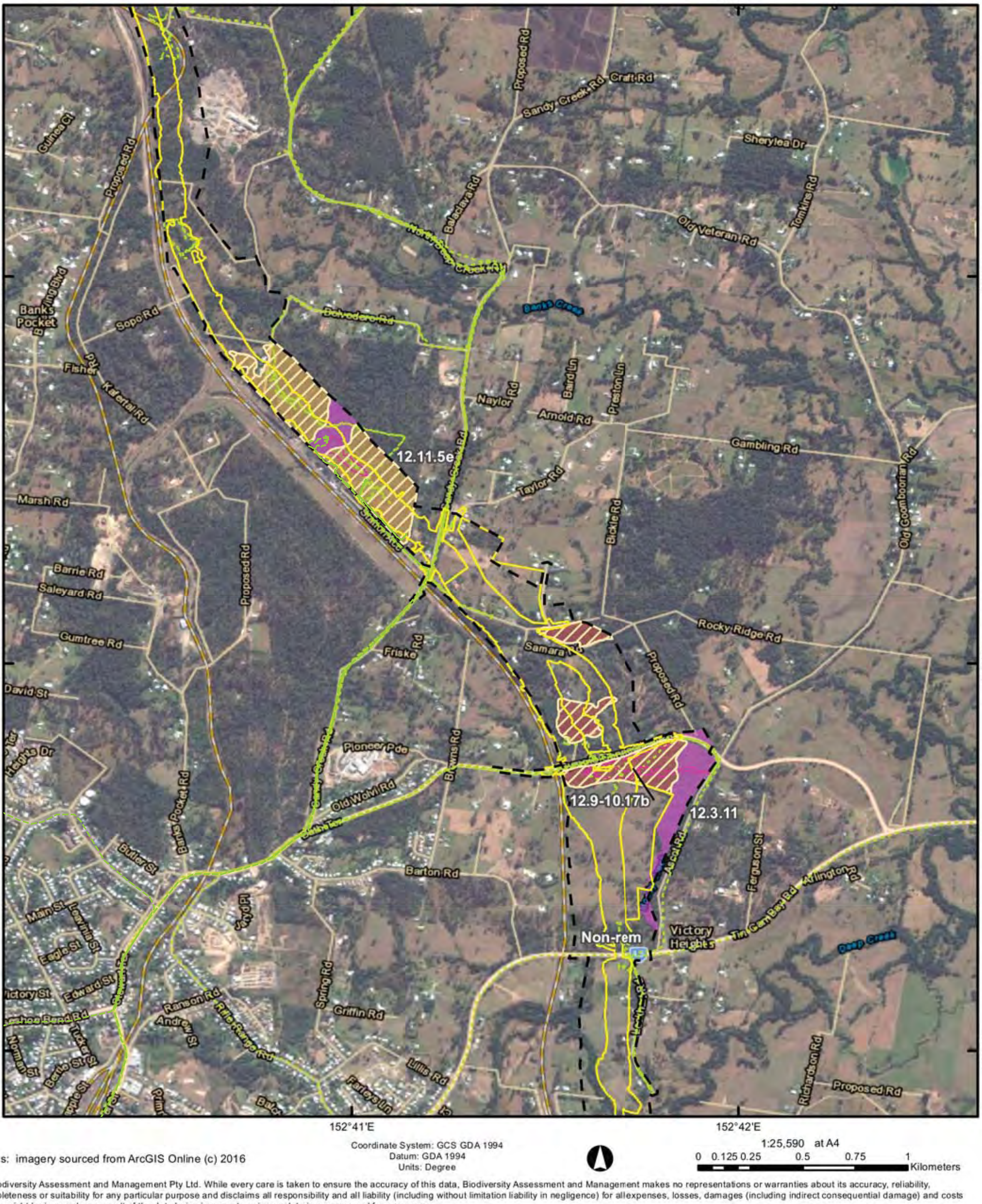

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Datum: GDA 1994
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LEGEND

Study Area

Direct Footprint Area

Protected Plant Species record:

Marsdenia coronata

Marsdenia coronata:

Known habitat

Potential habitat

Field Track (2011)

Field Track (2015)

Field Track (2016)

Regional Ecosystem

12.11.14	12.3.1
12.11.16	12.3.11
12.11.3	12.3.3.d
12.11.3/12.11.14	12.3.7
12.11.5e	12.9-10.17b
	12.9-10.4

Date: 10/03/2016

Figure: 3-4 3 of 5

Title: Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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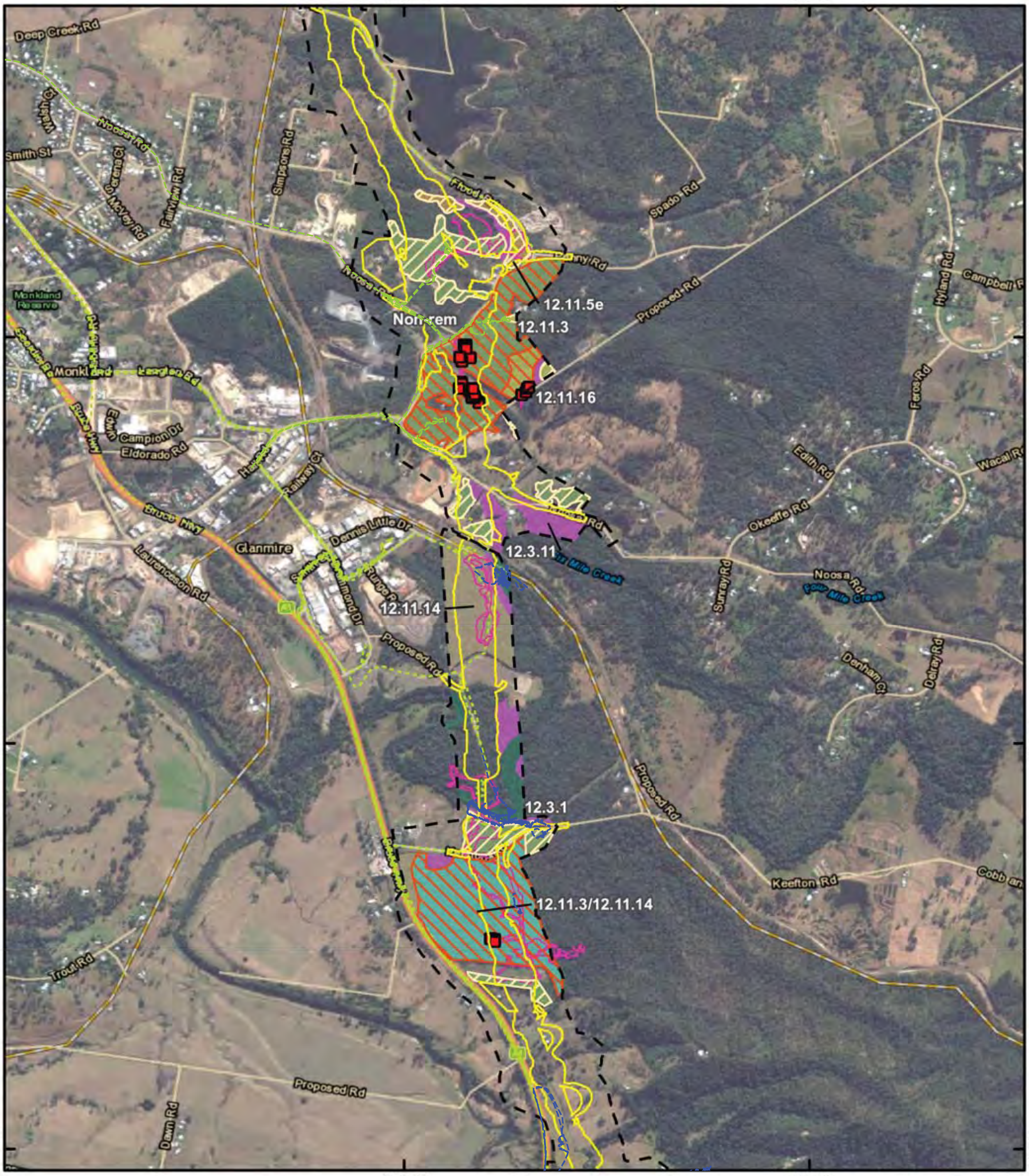

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LEGEND

Study Area

Direct Footprint Area

Protected Plant Species record:

Marsdenia coronata

Marsdenia coronata:

Known habitat

Potential habitat

Field Track (2011)

Field Track (2015)

Field Track (2016)

Regional Ecosystem

12.11.14	12.3.1
12.11.16	12.3.11
12.11.3	12.3.3.d
12.11.3/12.11.14	12.3.7
12.11.5e	12.9-10.17b
	12.9-10.4

Date: 10/03/2016

Figure: 3-4 4 of 5

Title: Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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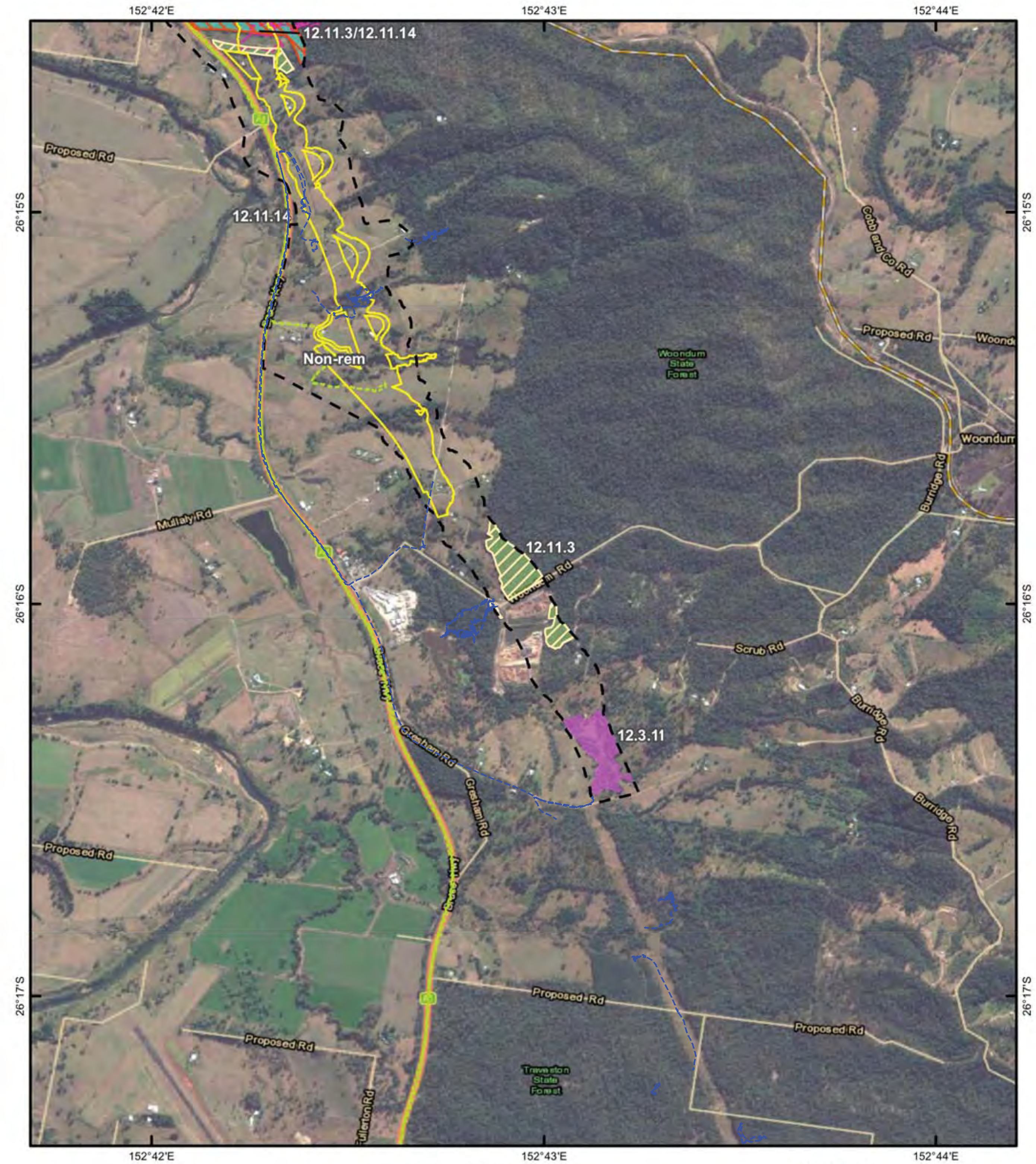

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4
0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

Study Area
Direct Footprint Area

Protected Plant Species record:

Marsdenia coronata

Marsdenia coronata:

Known habitat
Potential habitat
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14	12.3.1
12.11.16	12.3.11
12.11.3	12.3.3.d
12.11.3/12.11.14	12.3.7
12.11.5e	12.9-10.17b
	12.9-10.4

Date: 10/03/2016

Figure: 3-4 5 of 5

Title: Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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Table 3.6. Details of Slender Milkvine (*Marsdenia coronata*) supporting habitats and occurrences in the study area.

Meander (Stage)	Regional Ecosystem	Habitat description	*M. coronata* plants encountered	Survey area (ha)	*M. coronata* density (plants per ha)
1 (D2)	12.11.5e	Structure and position: Remnant open forest, canopy ht 18 m, on hillslope with gentle gradients. Tree1: *Corymbia citriodora* (cd), *Eucalyptus fibrosa* (cd), *E. longirostrata*. Tree2: *E. fibrosa, E. acmenoides, E. longirostrata* Shrub: *Acrotriche aggregata*, *Carissa ovata, Petalostigma triloculare, Lophostemon confertus,* Ground: *Entolasia stricta, Lomandra confertifolia, Lepidosperma laterale*. Substrate: gravelly soils derived from metasediments. Comments: Widely dispersed *Marsdenia coronata* on slopes; abundant seedlings, one adult flowering, one adult fruiting.	35 adults 38 seedlings	0.40	88 adults 95 seedlings
2 (D2)	12.11.5e	Same as for Meander 1.	21 adults 70 seedlings	0.54	39 adults 131 seedlings
3 (D2)	12.11.5e	Structure and position: Remnant open forest, canopy ht 22 m, on hillslope with moderate gradients. Tree1: *Corymbia citriodora* (cd), *Eucalyptus acmenoides* (cd). Tree2: *E. fibrosa, E. acmenoides, E. longirostrata* Shrub1: *Petalostigma triloculare, Acacia complanata,* Tree1 and Tree2 saplings. Shrub2: *Myrsine angusta, Acrotriche aggregata* Ground: *Entolasia stricta, Lomandra laxa, Dianella caerulea*. Substrate: loamy gravelly soils derived from metasediments. Comments: *Marsdenia coronata* absent in gullies but widely dispersed on slopes and ridge crests; seedlings patchily abundant.	12 adults 42 seedlings	0.44	27 adults 95 seedlings
4 (D2)	12.11.5e	Same as for Meander 3.	19 adults 77 seedlings	0.48	40 adults 161 seedlings
5 (D2)	12.11.5e	Same as for Meander 3.	19 adults 47 seedlings	0.77	25 adults 61 seedlings
6 (D2)	12.9-10.4	Structure and position: Remnant open forest/woodland, canopy ht 16 m, on minor ridge crest with sandstone rock outcrop. Tree1: *Corymbia intermedia*, *Eucalyptus acmenoides*, *Angophora leiocarpa*. Tree2: *Lophostemon confertus, Acacia disparrima, A. concurrens.* Shrub: *Lantana camara**. Ground: *Imperata cylindrica, Lomandra longifolia, Xanthorrhoea johnsonii*. Substrate: shallow soft sand derived from sandstone on a sandstone rock outcrop. Comments: *Marsdenia coronata* highly localised to a single cluster on the rock outcrop; Land Zone 9-10 clearly not typical habitat for the species.	5 adults 16 seedlings	1.26	4 adults 13 seedlings

Meander (Stage)	Regional Ecosystem	Habitat description	*M. coronata* plants encountered	Survey area (ha)	*M. coronata* density (plants per ha)
14 (D2)	12.11.5e	Structure and position: Remnant open forest, canopy ht 20 m, on south-facing hillslope and gullies. Tree1: *Eucalyptus fibrosa* (d), *E. citriodora*. Tree2: *Lophostemon confertus* (d), *E. fibrosa, E. citriodora.* Shrub: *Acrotriche aggregata, Carissa ovata, Daviesia villifera, Leucopogon juniperinus* Ground: *Entolasia stricta, Lomandra longifolia, Lepidosperma laterale*. Substrate: thin gravelly soils derived from metasediments. Comments: *Marsdenia coronata* scattered on slopes and in gullies; seedlings patchily abundant, one adult flowering.	17 adults 26 seedlings	1.32	13 adults 20 seedlings
18 (D1)	12.11.3 (upper hillslope)	Structure and position: Remnant open forest, canopy ht 15 m, steep upper hillslope. Tree1: *Lophostemon confertus* (cd), *Corymbia intermedia* (cd), *Eucalyptus acmenoides* (cd), *E. longirostrata*. Tree2: *Lophostemon confertus, Acacia disparrima.* Shrub: *Lantana camara** (d). Ground: *Passiflora suberosa*, Imperata cylindrica*. Substrate: thin gravelly soils derived from metasediments. Comments: *Marsdenia coronata* widespread on steep south-facing slope; abundant seedlings.	39 adults 128 seedlings	0.86	45 adults 148 seedlings
18 (D1)	12.11.3 (lower hillslope gullies)	Structure and position: Remnant open forest, canopy ht 22 m, hillslope with moderate gradient and gullies. Tree1: *Eucalyptus acmenoides* (d), *E. propinqua, E. moluccana, E. siderophloia*. Tree2: *Lophostemon confertus, Syncarpia glomulifera* Shrub: *Lophostemon confertus, Lantana camara*, Acrotriche aggregata, Petalostigma triloculare* Ground: *Entolasia stricta, Lomandra confertifolia, Dianella caerulea*. Substrate: thin gravelly soils derived from metasediments. Comments: *Marsdenia coronata* widespread on slopes and in gullies; abundant seedlings.			
20 (D1)	12.11.3/12.11.14	Structure and position: Remnant open forest with vine forest understorey, canopy ht 16 m, emergent to 25 m, on bench/plateau. Emergent: *Eucalyptus propinqua* (d), *E. siderophloia*. Tree1: *Lophostemon confertus* (cd), *Syncarpia glomulifera* (cd), *Acacia disparrima*, *Jagera pseudorhus*. Tree2: *Alectryon reticulatus, Alphitonia excelsa, Cyclophyllum longipetalum, Pilidiostigma rhytispermum, Claoxylon australe.* Shrub: *Pavetta australis, Alyxia ruscifolia, Diospyros geminata, Alchornea ilicifolia*. Ground: *Carissa ovata, Lomandra longifolia, Passiflora suberosa**. Substrate: loamy gravelly soils derived from metasediments. Comments: *M. coronata* sparse and localised in this habitat.	4 adults 20 seedlings	1.89	2 adults 11 seedlings

Meander (Stage)	Regional Ecosystem	Habitat description	*M. coronata* plants encountered	Survey area (ha)	*M. coronata* density (plants per ha)
25 (D1)	12.11.16	Structure and position: Remnant tall open forest, canopy ht 30 m, on footslope with moderate gradient. Tree1: *Eucalyptus cloeziana* (d), *E. propinqua* (associated). Tree2: *E. cloeziana, Syncarpia glomulifera* (d), *Lophostemon confertus* Tree3: *Lophostemon confertus* (d), *Syncarpia glomulifera*. Shrub: *Lantana camara** (d), *Acacia disparrima, Pilidiostigma rhytispermum, Acronychia laevis.* Ground: *Carissa ovata, Smilax australis, Lomandra longifolia, Dianella caerulea, Ottochloa gracillima*. Substrate: loamy gravelly soils derived from metasediments. Comments: *M. coronata* absent in gullies but widely dispersed on slopes and ridge crests; seedlings patchily abundant.	5 adults 8 seedlings	0.22	23 adults 36 seedlings

Potential impacts of the Project on Slender Milkvine

The total areas of the three categories of habitat for Slender Milkvine in each of the Stage D1 and Stage D2 portions of the Project footprint are summarised in **Table 3.7**.

Table 3.7. Summary of Slender Milkvine (*Marsdenia coronata*) habitat areas within the Project footprint (potential direct impact) of each of the D1 (south of Sandy Creek Road) and D2 (north of Sandy Creek Road) stages of the Project.

Habitat type	Stage D1 (ha)	Stage D2 (ha)	Total (ha)
Known habitat	12.56	65.62	78.18
Potential habitat	19.74	18.63	38.37
Not generally suitable habitat	182.37	137.25	319.62

The residual impact of the Project on Slender Milkvine will likely require mitigation and offsetting in accordance with the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. Due to the relatively high abundance of Slender Milkvine in known habitat areas within the Project footprint area, the translocation of plants is unlikely to be cost-effective as a mitigation and offsetting action. Instead, a habitat offset should be considered, based on the area of known habitat to be impacted by the Project. Given the apparent success of seedling establishment in proximity to parent plant locations from the previous season, the collection of seed from plants within the highway alignment for subsequent manual dispersal to establish plants in habitat offset areas could be an effective mitigation and offsetting action. Slender Milkvine flowers from November to March and the fruit pods mature to release their seeds three to four months later (Forster 1995, 1996). The suitable time period for collecting seed is therefore within the period March to June; however, timing may vary with rainfall during the spring and summer growing season for Slender Milkvine.

3.2.2 Other EVNT flora species with potential to occur

Thirteen of the 17 species assessed as having potential to occur in the study area during the desktop assessment are associated with rainforest or wet sclerophyll forest (see **Table 3.1**). Rainforest-associated tree species were recorded in the understorey of wet sclerophyll forest types in many parts of the study area, together with a narrow patch of RE 12.3.1 (Gallery rainforest (notophyll vine forest) on alluvial plains) and a previously unsurveyed 1 ha patch of RE 12.11.10 (notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics) in the south of the Stage D1 portion of the study area. Despite the extensive survey of habitats supporting rainforest-associated trees, none of the rainforest-associated EVNT species assessed as having potential to occur were detected. Furthermore, the survey of suitable habitats for the other four species assessed as having potential to occur did not detect these species in the study area. On the basis of these results in relation to the extensive survey effort over several surveys, it is concluded that there is a low probability that any of the 17 species assessed as having potential to occur in the study area may actually occur.

A small patch of RE 12.11.10 was encountered in the southern portion of the study area and located partially in the study area (see **Appendix D Figure 1** for the mapped location of this patch). As this patch had not been detected in a previous survey and can correspond to the Lowland Rainforest of Subtropical Australia, listed as a threatened ecological community (TEC) under the EPBC Act, it was assessed against the listing advice for this TEC to determine whether it met the key diagnostic characteristics and condition thresholds for recognition as the TEC (see **Appendix C** for assessment details). This assessment determined that the patch had high flora species richness (96 species recorded), but did not quite meet all the key diagnostic characteristics of the Lowland Rainforest of Subtropical Australia TEC. Specifically, a total of 38 woody species from Appendix A of the listing advice were detected in the patch, only two less than the 40 species required to meet the species richness condition threshold for recognition as the TEC.

3.2.3 Other key habitat features

Other key habitat features recorded opportunistically during the survey included:

- Large hollow-bearing trees;
- Large hollow logs;
- Large log piles; and
- Platelets (feeding sign) consistent with Black-breasted Buttonquail (*Turnix melanogaster*: EPBC Act: vulnerable; NC Act: vulnerable) in habitat with dense undergrowth and thick leaf litter around the perimeter of the 1 ha patch of RE 12.11.10 notophyll vine forest referred to in **Section 3.2.3** above.

The locations of these features are detailed in **Appendix D**. As these features were recorded opportunistically, they have not been comprehensively surveyed for within either the Project footprint or study area.

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APPENDIX A

Flora species recorded in the study area

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Conifers							
Araucariaceae	*Agathis robusta*	LC	-	-	-	X	
Araucariaceae	*Araucaria bidwillii*	LC	-	-	-	X	
Araucariaceae	*Araucaria cunninghamii*	LC	-	-	-		X
Podocarpaceae	*Podocarpus elatus*	LC	-	-	-	X	
Cycads							
Zamiaceae	*Macrozamia pauli-guilielmi* +	E	E	-	-	X	X
Ferns							
Adiantaceae	*Adiantum aethiopicum*	LC	-	-	-		X
Adiantaceae	*Adiantum diaphanum*	LC	-	-	-		X
Adiantaceae	*Adiantum hispidulum*	LC	-	-	-	X	X
Adiantaceae	*Blechnum cartilagineum*	LC	-	-	-		X
Adiantaceae	*Cheilanthes sieberi*	LC	-	-	-	X	X
Adiantaceae	*Cheilanthes tenuifolia*	LC	-	-	-	X	X
Aspleniaceae	*Asplenium attenuatum*	LC	-	-	-		X
Aspleniaceae	*Asplenium australasicum*	LC	-	-	-		X
Blechnaceae	*Doodia aspera*	LC	-	-	-	X	X
Blechnaceae	*Doodia caudata*	LC	-	-	-	X	X
Dennstaedtiaceae	*Hypolepis muelleri*	LC	-	-	-	X	
Dennstaedtiaceae	*Pteridium esculentum*	LC	-	-	-	X	X
Dicksoniaceae	*Calochlaena dubia*	LC	-	-	-	X	X
Dryopteridaceae	*Arachniodes aristata*	LC	-	-	-		X
Polypodiaceae	*Platycerium superbum*	LC	-	-	-		X
Psilotaceae	*Psilotum nudum*	LC	-	-	-		X
Pteridaceae	*Pellaea paradoxa*	LC	-	-	-		X
Tectariaceae	*Arthropteris tenella*	LC	-	-	-		X
Thelypteridaceae	*Christella dentata*	LC	-	-	-	X	X
Higher dicots							
Acanthaceae	*Brunoniella australis*	LC	-	-	-	X	X
Acanthaceae	*Harnieria hygrophiloides*	LC	-	-	-		X
Acanthaceae	*Pseuderanthemum variabile*	LC	-	-	-	X	X
Acanthaceae	*Rostellularia adscendens*	LC	-	-	-		X
Amaranthaceae	*Alternanthera denticulata*	LC	-	-	-	X	
Anacardiaceae	*Mangifera indica**	-	-	-	-	X	
Anacardiaceae	*Rhodosphaera rhodanthema*	LC	-	-	-	X	X
Anacardiaceae	*Schinus terebinthifolius**	-	-	*3	-	X	X
Annonaceae	*Melodorum leichhardtii*	LC	-	-	-		X
Annonaceae	*Polyalthia nitidissima*	LC	-	-	-		X
Apiaceae	*Centella asiatica*	LC	-	-	-	X	X
Apocynaceae	*Alstonia constricta*	LC	-	-	-	X	X
Apocynaceae	*Alyxia magnifolia*	LC	-	-	-	X	
Apocynaceae	*Alyxia ruscifolia*	LC	-	-	-	X	X
Apocynaceae	*Asclepias curassavica**	-	-	-	-	X	X
Apocynaceae	*Carissa ovata*	LC	-	-	-	X	X
Apocynaceae	*Cynanchum bowmanii*	LC	-	-	-	X	X
Apocynaceae	*Gomphocarpus physocarpus**	-	-	-	-	X	X
Apocynaceae	*Parsonsia eucalyptophylla*	LC	-	-	-	X	
Apocynaceae	*Parsonsia brisbanensis*	LC	-	-	-		X
Apocynaceae	*Parsonsia lanceolata*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Apocynaceae	*Parsonsia paulforsteri*	LC	-	-	-		X
Apocynaceae	*Parsonsia rotata*	LC	-	-	-		X
Apocynaceae	*Parsonsia straminea*	LC	-	-	-	X	X
Apocynaceae	*Parsonsia velutina*	LC	-	-	-		X
Apocynaceae	*Secamone elliptica*	LC	-	-	-		X
Apocynaceae	*Tabernaemontana pandacaqui*	LC	-	-	-	X	X
Apocynaceae	*Tylophora benthamii*	LC	-	-	-	X	
Apocynaceae	*Marsdenia coronata* +	V	-	-	-		X
Apocynaceae	*Marsdenia lloydii*	LC	-	-	-		X
Apocynaceae	*Marsdenia microlepis*	LC	-	-	-		X
Apocynaceae	*Marsdenia rostrata* +	LC	-	-	-	X	
Araliaceae	*Astrotricha latifolia*	LC	-	-	-	X	X
Araliaceae	*Polyscias elegans*	LC	-	-	-	X	X
Araliaceae	*Trachymene incisa subsp. incisa*	LC	-	-	-	X	X
Arecaceae	*Calamus muelleri*	LC	-	-	-		X
Arecaceae	*Syagrus romanzoffiana**	-	-	-	-	X	X
Asteraceae	*Acmella grandiflora*	LC	-	-	-	X	
Asteraceae	*Ageratum conyzoides*	LC	-	-	-	X	X
Asteraceae	*Ageratum houstonianum**	-	-	-	-	X	
Asteraceae	*Baccharis halimifolia**	-	-	*2	-	X	X
Asteraceae	*Bidens pilosa**	-	-	-	-	X	X
Asteraceae	*Chrysocephalum apiculatum*	LC	-	-	-	X	X
Asteraceae	*Cirsium vulgare**	-	-	-	-	X	
Asteraceae	*Conyza sumatrensis*	LC	-	-	-	X	X
Asteraceae	*Crassocephalum crepidioides**	-	-	-	-	X	
Asteraceae	*Cyanthillium cinereum*	LC	-	-	-	X	X
Asteraceae	*Emilia sonchifolia**	-	-	-	-	X	X
Asteraceae	*Gamochaeta coarctata**	-	-	-	-	X	
Asteraceae	*Glossocardia bidens*	LC	-	-	-		X
Asteraceae	*Hypochaeris radicata**	-	-	-	-	X	X
Asteraceae	*Lagenifera stipitata*	LC	-	-	-		X
Asteraceae	*Ozothamnus diosmifolius*	LC	-	-	-	X	X
Asteraceae	*Praxelis clematidea**	-	-	-	-	X	
Asteraceae	*Pterocaulon redolens*	LC	-	-	-	X	X
Asteraceae	*Senecio amygdalifolius*	LC	-	-	-		X
Asteraceae	*Sigesbeckia orientalis*	LC	-	-	-	X	X
Asteraceae	*Sonchus oleraceus**	-	-	-	-	X	X
Asteraceae	*Praxelis clematidea*	LC	-	-	-	X	
Bignoniaceae	*Jacaranda mimosifolia**	-	-	-	-	X	X
Bignoniaceae	*Pandorea jasminoides*	LC	-	-	-		X
Bignoniaceae	*Pandorea pandorana*	LC	-	-	-	X	X
Bignoniaceae	*Macfadyena unguis-cati**	-	-	*3	-	X	X
Bignoniaceae	*Tecoma stans**	-	-	*3	-	X	
Burseraceae	*Canarium australasicum*	LC	-	-	-	X	
Byttneriaceae	*Commersonia bartramia*	LC	-	-	-	X	
Cactaceae	*Hylocereus undatus*	-	-	-	-		X
Cactaceae	*Opuntia stricta**	-	-	*2	-	X	X
Caesalpiniaceae	*Caesalpinia subtropica*	LC	-	-	-	X	
Caesalpiniaceae	*Cassia tomentella*	LC	-	-	-		X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Caesalpiniaceae	*Senna acclinis*	LC	-	-	-	X	
Caesalpiniaceae	*Senna occidentalis**	-	-	-	-	X	
Caesalpiniaceae	*Senna pendula var. glabrata**	-	-	-	-	X	X
Campanulaceae	*Lobelia purpurascens*	LC	-	-	-	X	X
Campanulaceae	*Lobelia stenophylla*	LC	-	-	-		X
Capparaceae	*Capparis arborea*	LC	-	-	-		X
Capparaceae	*Capparis sarmentosa*	LC	-	-	-		X
Casuarinaceae	*Allocasuarina littoralis*	LC	-	-	-	X	X
Casuarinaceae	*Allocasuarina torulosa*	LC	-	-	-	X	X
Celastraceae	*Denhamia bilocularis*	LC	-	-	-		
Celastraceae	*Celastrus australis*	LC	-	-	-		X
Celastraceae	*Denhamia celastroides*	LC	-	-	-	X	X
Celastraceae	*Maytenus bilocularis*	LC	-	-	-	X	
Chenopodiaceae	*Einadia hastata*	LC	-	-	-	X	X
Clusiaceae	*Hypericum gramineum*	LC	-	-	-	X	X
Convolvulaceae	*Ipomoea plebeia*	LC	-	-	-	X	X
Convolvulaceae	*Polymeria calycina*	LC	-	-	-	X	X
Crassulaceae	*Bryophyllum delagoense**	-	-	*2	-		X
Cucurbitaceae	*Momordica cochinchinensis**	-	-	-	-	X	
Cunoniaceae	*Pseudoweinmannia lachnocarpa*	LC	-	-	-		X
Dilleniaceae	*Hibbertia aspera subsp. aspera*	LC	-	-	-	X	X
Dilleniaceae	*Hibbertia linearis*	LC	-	-	-	X	X
Ebenaceae	*Diospyros fasciculosa*	LC	-	-	-		X
Ebenaceae	*Diospyros geminata*	LC	-	-	-	X	X
Elaeocarpaceae	*Elaeocarpus obovatus*	LC	-	-	-	X	X
Ericaceae	*Acrotriche aggregata*	LC	-	-	-	X	X
Ericaceae	*Leucopogon juniperinus*	LC	-	-	-	X	X
Ericaceae	*Leucopogon leptospermoides*	LC	-	-	-	X	
Erythroxylaceae	*Erythroxylum* sp. Splityard Creek (L.Pedley 5360)	LC	-	-	-		X
Euphorbiaceae	*Acalypha capillipes*	LC	-	-	-	X	X
Euphorbiaceae	*Acalypha nemorum*	LC	-	-	-		X
Euphorbiaceae	*Alchornea ilicifolia*	LC	-	-	-	X	X
Euphorbiaceae	*Claoxylon australe*	LC	-	-	-	X	X
Euphorbiaceae	*Cleistanthus cunninghamii*	LC	-	-	-		X
Euphorbiaceae	*Croton insularis*	LC	-	-	-		X
Euphorbiaceae	*Croton stigmatosus*	LC	-	-	-		X
Euphorbiaceae	*Dissiliaria baloghioides*	LC	-	-	-		X
Euphorbiaceae	*Actephila lindleyi*	LC	-	-	-		X
Euphorbiaceae	*Homalanthus nutans*	LC	-	-	-	X	
Euphorbiaceae	*Homalanthus stillingiifolius*	LC	-	-	-		X
Euphorbiaceae	*Mallotus claoxyloides*	LC	-	-	-	X	X
Euphorbiaceae	*Mallotus philippensis*	LC	-	-	-	X	X
Eupomatiaceae	*Eupomatia bennettiana*	LC	-	-	-	X	X
Fabaceae	*Austrosteenisia blackii*	LC	-	-	-	X	X
Fabaceae	*Callerya australis*	LC	-	-	-	X	
Fabaceae	*Chamaecrista rotundifolia*	LC	-	-	-	X	X
Fabaceae	*Chamaecrista nomame*	LC	-	-	-		X
Fabaceae	*Daviesia ulicifolia subsp.*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
	stenophylla						
Fabaceae	*Daviesia ulicifolia subsp. ulicifolia*	LC	-	-	-	X	
Fabaceae	*Daviesia umbellulata*	LC	-	-	-	X	
Fabaceae	*Daviesia villifera*	LC	-	-	-	X	X
Fabaceae	*Derris involuta*	LC	-	-	-		X
Fabaceae	*Desmodium rhytidophyllum*	LC	-	-	-	X	X
Fabaceae	*Desmodium varians*	LC	-	-	-		X
Fabaceae	*Flemingia parviflora*	LC	-	-	-	X	X
Fabaceae	*Galactia tenuiflora*	LC	-	-	-		X
Fabaceae	*Glycine clandestina*	LC	-	-	-	X	X
Fabaceae	*Glycine cyrtoloba*	LC	-	-	-	X	X
Fabaceae	*Glycine microphylla*	LC	-	-	-		X
Fabaceae	*Glycine tabacina*	LC	-	-	-	X	X
Fabaceae	*Hardenbergia violacea*	LC	-	-	-	X	X
Fabaceae	*Hovea acutifolia*	LC	-	-	-	X	X
Fabaceae	*Indigofera australis*	LC	-	-	-		X
Fabaceae	*Jacksonia scoparia*	LC	-	-	-	X	X
Fabaceae	*Macroptilium atropurpureum**	-	-	-	-	X	
Fabaceae	*Podolobium ilicifolium*	LC	-	-	-	X	X
Fabaceae	*Podolobium scandens*	LC	-	-	-	X	X
Fabaceae	*Pultenaea villosa*	LC	-	-	-	X	X
Fabaceae	*Tephrosia sp.*	LC	-	-	-		X
Fabaceae	*Zornia dyctiocarpa*	LC	-	-	-		X
Goodeniaceae	*Goodenia rotundifolia*	LC	-	-	-	X	X
Goodeniaceae	*Goodenia* sp. Mt Castletower (M.D. Crisp 2753)	LC	-	-	-		X
Lamiaceae	*Callicarpa pedunculata*	LC	-	-	-	X	
Lamiaceae	*Clerodendrum floribundum*	LC	-	-	-	X	X
Lamiaceae	*Gmelina leichhardtii*	LC	-	-	-	X	
Lamiaceae	*Plectranthus parviflorus*	LC	-	-	-	X	X
Lamiaceae	*Teucrium argutum*	LC	-	-	-	X	
Lamiaceae	*Vitex lignum-vitae*	LC	-	-	-		X
Lentibulariaceae	*Utricularia aurea*	LC	-	-	-		X
Loganiaceae	*Strychnos axillaris*	LC	-	-	-		X
Loranthaceae	*Amyema cambagei*	LC	-	-	-	X	
Loranthaceae	*Amyema conspicua*	LC	-	-	-		X
Loranthaceae	*Amyema pendula*	LC	-	-	-		X
Malvaceae	*Hibiscus heterophyllus*	LC	-	-	-	X	X
Malvaceae	*Seringia arborescens* +	LC	-	-	-	X	
Malvaceae	*Seringia* sp. (Chermside S.T.Blake 23068) +	LC	-	-	-		X
Malvaceae	*Sida abutifolia**	-	-	-	-	X	X
Malvaceae	*Sida cordifolia**	-	-	-	-	X	X
Malvaceae	*Sida hackettiana*	LC	-	-	-		X
Malvaceae	*Sida rhombifolia**	-	-	-	-	X	X
Malvaceae	*Sterculia quadrifida*	LC	-	-	-		X
Meliaceae	*Melia azedarach*	LC	-	-	-	X	X
Meliaceae	*Owenia venosa*	LC	-	-	-		X
Menispermaceae	*Hypserpa decumbens*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Menyanthaceae	*Nymphoides indica*	LC	-	-	-		X
Mimosaceae	*Acacia amblygona*	LC	-	-	-	X	
Mimosaceae	*Acacia bakeri*	LC	-	-	-		X
Mimosaceae	*Acacia complanata*	LC	-	-	-	X	X
Mimosaceae	*Acacia disparrima*	LC	-	-	-	X	X
Mimosaceae	*Acacia falcata*	LC	-	-	-	X	X
Mimosaceae	*Acacia fimbriata*	LC	-	-	-	X	X
Mimosaceae	*Acacia leiocalyx*	LC	-	-	-	X	X
Mimosaceae	*Acacia leiocalyx subsp. herveyensis*	LC	-	-	-	X	X
Mimosaceae	*Acacia maidenii*	LC	-	-	-	X	X
Mimosaceae	*Acacia melanoxylon*	LC	-	-	-	X	
Mimosaceae	*Acacia oshanesii*	LC	-	-	-	X	X
Mimosaceae	*Acacia penninervis var. penninervis*	LC	-	-	-	X	
Mimosaceae	*Acacia ulicifolia*	LC	-	-	-	X	
Mimosaceae	*Leucaena leucocephala subsp. leucocephala**	-	-	-	-	X	X
Monimiaceae	*Wilkiea macrophylla*	LC	-	-	-		X
Moraceae	*Ficus coronata*	LC	-	-	-	X	X
Moraceae	*Ficus macrophylla forma macrophylla*	LC	-	-	-	X	X
Moraceae	*Ficus obliqua*	LC	-	-	-	X	X
Moraceae	*Ficus opposita*	LC	-	-	-		X
Moraceae	*Ficus watkinsiana*	LC	-	-	-	X	
Moraceae	*Maclura cochinchinensis*	LC	-	-	-	X	X
Moraceae	*Streblus brunonianus*	LC	-	-	-	X	X
Moraceae	*Trophis scandens subsp. scandens*	LC	-	-	-	X	X
Myrsinaceae	*Embelia australiana*	LC	-	-	-	X	X
Myrsinaceae	*Myrsine angusta*	LC	-	-	-		X
Myrsinaceae	*Myrsine variabilis*	LC	-	-	-	X	X
Myrtaceae	*Acmena smithii*	LC	-	-	-	X	X
Myrtaceae	*Angophora leiocarpa*	LC	-	-	-	X	X
Myrtaceae	*Angophora subvelutina*	LC	-	-	-	X	X
Myrtaceae	*Archirhodomyrtus beckleri*	LC	-	-	-	X	
Myrtaceae	*Backhousia myrtifolia*	LC	-	-	-	X	X
Myrtaceae	*Corymbia citriodora*	LC	-	-	-	X	
Myrtaceae	*Corymbia citriodora subsp. variegata*	LC	-	-	-	X	X
Myrtaceae	*Corymbia intermedia*	LC	-	-	-	X	X
Myrtaceae	*Corymbia tessellaris*	LC	-	-	-	X	X
Myrtaceae	*Corymbia torelliana*	LC	-	-	-	X	X
Myrtaceae	*Corymbia trachyphloia subsp. trachyphloia*	LC	-	-	-	X	
Myrtaceae	*Eucalyptus acmenoides*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus cloeziana*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus crebra*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus exserta*	LC	-	-	-	X	
Myrtaceae	*Eucalyptus fibrosa subsp. fibrosa*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Myrtaceae	*Eucalyptus grandis*	LC				X	X
Myrtaceae	*Eucalyptus longirostrata*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus microcorys*	LC	-	-	-	X	
Myrtaceae	*Eucalyptus moluccana*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus propinqua*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus racemosa subsp. racemosa*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus siderophloia*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus tereticornis subsp. tereticornis*	LC	-	-	-	X	X
Myrtaceae	*Gossia bidwillii*	LC	-	-	-		X
Myrtaceae	*Leptospermum polygalifolium*	LC	-	-	-	X	X
Myrtaceae	*Lophostemon confertus*	LC	-	-	-	X	X
Myrtaceae	*Lophostemon suaveolens*	LC	-	-	-	X	X
Myrtaceae	*Melaleuca salicina*	LC	-	-	-	X	X
Myrtaceae	*Melaleuca styphelioides*	LC	-	-	-	X	
Myrtaceae	*Melaleuca viminalis*	LC	-	-	-	X	
Myrtaceae	*Pilidiostigma rhytispermum*	LC	-	-	-	X	X
Myrtaceae	*Rhodamnia dumicola*	LC	-	-	-		X
Myrtaceae	*Rhodamnia rubescens*	LC	-	-	-	X	
Myrtaceae	*Rhodomyrtus psidioides*	LC	-	-	-	X	X
Myrtaceae	*Syncarpia glomulifera subsp. glomulifera*	LC	-	-	-	X	X
Myrtaceae	*Syzygium australe*	LC	-	-	-	X	
Myrtaceae	*Syzygium oleosum*	LC	-	-	-	X	
Myrtaceae	*Tristaniopsis laurina*	LC	-	-	-	X	X
Myrtaceae	*Waterhousea floribunda*	LC	-	-	-	X	X
Myrtaceae	*Xanthostemon oppositifolius* (planted specimen)	V	V	-	-	X	
Ochnaceae	*Ochna serrulata**		-	-	-	X	X
Oleaceae	*Jasminum simplicifolium*	LC	-	-	-	X	X
Oleaceae	*Ligustrum lucidum**	-	-	*3	-	X	X
Oleaceae	*Ligustrum sinense**	-	-	*3	-	X	X
Oleaceae	*Notelaea longifolia*	LC	-	-	-	X	X
Oleaceae	*Olea paniculata*	LC	-	-	-	X	
Onagraceae	*Ludwigia octovalvis*	LC	-	-	-	X	
Onagraceae	*Oenothera lindheimeri**	-	-	-	-	X	
Oxalidaceae	*Oxalis corniculata**	-	-	-	-	X	X
Oxalidaceae	*Oxalis exilis*	LC	-	-	-		X
Passifloraceae	*Passiflora aurantia*	LC	-	-	-	X	X
Passifloraceae	*Passiflora edulis**	-	-	-	-	X	
Passifloraceae	*Passiflora foetida**	-	-	-	-	X	X
Passifloraceae	*Passiflora suberosa**	-	-	-	-	X	X
Passifloraceae	*Passiflora subpeltata**	-	-	-	-	X	
Petiveriaceae	*Rivina humilis**	-	-	-	-	X	X
Phyllanthaceae	*Breynia oblongifolia*	LC	-	-	-	X	X
Phyllanthaceae	*Bridelia exaltata*	LC	-	-	-		X
Phyllanthaceae	*Glochidion ferdinandi*	LC	-	-	-	X	X
Phyllanthaceae	*Glochidion sumatranum*	LC	-	-	-	X	X

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Phyllanthaceae	*Phyllanthus fuernrohrii*	LC	-	-	-	X	X
Phyllanthaceae	*Phyllanthus gunnii*	LC	-	-	-		X
Phyllanthaceae	*Phyllanthus microcladus*	LC	-	-	-	X	X
Phyllanthaceae	*Phyllanthus similis*	LC	-	-	-	X	X
Phyllanthaceae	*Phyllanthus virgatus*	LC	-	-	-	X	X
Picrodendraceae	*Petalostigma pubescens*	LC	-	-	-		X
Picrodendraceae	*Petalostigma triloculare*	LC	-	-	-	X	X
Pittosporaceae	*Pittosporum multiflorum*	LC	-	-	-	X	X
Pittosporaceae	*Pittosporum revolutum*	LC	-	-	-	X	X
Plantaginaceae	*Scoparia dulcis**	-	-	-	-	X	
Plantaginaceae	*Veronica plebeia*	LC	-	-	-		X
Polygalaceae	*Polygala triflora*	LC	-	-	-		X
Polygalaceae	*Polygala virgata**	-	-	-	-		X
Polygonaceae	*Persicaria decipiens*	LC	-	-	-	X	
Polygonaceae	*Persicaria orientalis*	LC	-	-	-		X
Polygonaceae	*Persicaria strigosa*	LC	-	-	-	X	
Polygonaceae	*Muehlenbeckia gracillima*	LC	-	-	-	X	
Proteaceae	*Banksia integrifolia*	LC	-	-	-	X	X
Proteaceae	*Grevillea baileyana*	LC	-	-	-	X	
Proteaceae	*Grevillea hilliana*	LC	-	-	-		X
Proteaceae	*Grevillea robusta*	LC	-	-	-	X	X
Proteaceae	*Stenocarpus sinuatus*	LC	-	-	-	X	X
Putranjivaceae	*Drypetes deplanchei*	LC	-	-	-		X
Rhamnaceae	*Alphitonia excelsa*	LC	-	-	-	X	X
Ripogonaceae	*Ripogonum discolor*	LC	-	-	-	X	X
Rosaceae	*Rubus moluccanus*	LC	-	-	-	X	
Rosaceae	*Rubus parvifolius*	LC	-	-	-	X	X
Rubiaceae	*Atractocarpus chartaceus*	LC	-	-	-	X	X
Rubiaceae	*Coelospermum paniculatum*	LC	-	-	-		X
Rubiaceae	*Cyclophyllum longipetalum*	LC	-	-	-	X	X
Rubiaceae	*Cyclophyllum coprosmoides*	LC	-	-	-	X	
Rubiaceae	*Everistia vacciniifolia var. nervosa*	LC	-	-	-	X	X
Rubiaceae	*Morinda jasminoides*	LC	-	-	-	X	X
Rubiaceae	*Pavetta australiensis*	LC	-	-	-	X	X
Rubiaceae	*Pomax umbellata*	LC	-	-	-	X	X
Rubiaceae	*Psychotria daphnoides*	LC	-	-	-	X	X
Rubiaceae	*Psychotria loniceroides*	LC	-	-	-		X
Rubiaceae	*Psydrax odorata*	LC	-	-	-	X	X
Rubiaceae	*Richardia brasiliensis**	-	-	-	-	X	X
Rubiaceae	*Triflorensia cameronii*	LC	-	-	-		X
Rutaceae	*Acronychia laevis*	LC	-	-	-	X	X
Rutaceae	*Acronychia oblongifolia*	LC	-	-	-	X	X
Rutaceae	*Acronychia pauciflora*	LC	-	-	-		X
Rutaceae	*Citrus australis*	LC	-	-	-		X
Rutaceae	*Citrus limon**	-	-	-	-	X	
Rutaceae	*Flindersia australis*	LC	-	-	-	X	X
Rutaceae	*Flindersia bennettiana*	LC	-	-	-	X	X
Rutaceae	*Flindersia collina*	LC	-	-	-		X
Rutaceae	*Flindersia schottiana*	LC	-	-	-	X	X

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Rutaceae	*Flindersia xanthoxyla*	LC	-	-	-		X
Rutaceae	*Melicope hayesii*	LC	-	-	-	X	X
Rutaceae	*Melicope micrococca*	LC	-	-	-		X
Rutaceae	*Pentaceras australe*	LC	-	-	-		X
Rutaceae	*Sarcomelicope simplicifolia*	LC	-	-	-		X
Rutaceae	*Zieria minutiflora subsp. minutiflora*	LC	-	-	-	X	X
Rutaceae	*Zieria smithii*	LC	-	-	-	X	X
Sapindaceae	*Alectryon connatus*	LC	-	-	-	X	X
Sapindaceae	*Alectryon reticulatus*	LC	-	-	-		X
Sapindaceae	*Cupaniopsis parvifolia*	LC	-	-	-	X	X
Sapindaceae	*Cupaniopsis serrata*	LC	-	-	-		X
Sapindaceae	*Dodonaea triquetra*	LC	-	-	-	X	X
Sapindaceae	*Elattostachys bidwillii*	LC	-	-	-		X
Sapindaceae	*Guioa acutifolia*	LC	-	-	-		X
Sapindaceae	*Guioa semiglauca*	LC	-	-	-	X	X
Sapindaceae	*Harpullia hillii*	LC	-	-	-	X	
Sapindaceae	*Jagera pseudorhus var. pseudorhus*	LC	-	-	-	X	X
Sapindaceae	*Mischocarpus australis*	LC	-	-	-	X	X
Sapindaceae	*Toechima tenax*	LC	-	-	-		X
Sapotaceae	*Planchonella cotinifolia*	LC	-	-	-		X
Sapotaceae	*Planchonella queenslandica*	LC	-	-	-		X
Sapotaceae	*Planchonella pohlmaniana*	LC	-	-	-		X
Scrophulariaceae	*Artanema fimbriatum*	LC	-	-	-	X	X
Scrophulariaceae	*Eremophila debilis*	LC	-	-	-	X	X
Scrophulariaceae	*Myoporum acuminatum*	LC	-	-	-	X	
Solanaceae	*Solanum densevestitum*	LC	-	-	-	X	
Solanaceae	*Solanum gympiense*	LC	-	-	-	X	X
Solanaceae	*Solanum mauritianum**	-	-	-	-	X	X
Solanaceae	*Solanum nigrum**	-	-	-	-	X	X
Solanaceae	*Solanum seaforthianum**	-	-	-	-	X	X
Solanaceae	*Solanum stelligerum**	-	-	-	-		X
Solanaceae	*Solanum torvum**	-	-	-	-	X	X
Sterculiaceae	*Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198)	LC	-	-	-		X
Sterculiaceae	*Brachychiton discolor*	LC	-	-	-		X
Sterculiaceae	*Brachychiton populneus*	LC	-	-	-	X	X
Sterculiaceae	*Sterculia quadrifida*	LC	-	-	-	X	X
Thymelaeaceae	*Wikstroemia indica*	LC	-	-	-	X	
Thymelaeaceae	*Pimelia linifolia*	LC	-	-	-	X	X
Ulmaceae	*Aphananthe philippinensis*	LC	-	-	-	X	X
Ulmaceae	*Celtis sinensis**	-	-	*3	-	X	X
Ulmaceae	*Trema tomentosa var. aspera*	LC	-	-	-	X	X
Verbenaceae	*Duranta erecta**	-	-	-	-	X	X
Verbenaceae	*Lantana camara**	-	-	*3	X	X	X
Verbenaceae	*Lantana montevidensis**	-	-	*3	-	X	X
Verbenaceae	*Verbena bonariensis**	-	-	-	-	X	X
Violaceae	*Hybanthus stellarioides*	LC	-	-	-	X	X

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		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Violaceae	*Viola banksii*	LC	-	-	-		X
Violaceae	*Viola hederacea*	LC	-	-	-	X	X
Vitaceae	*Cayratia clematidea*	LC	-	-	-	X	X
Vitaceae	*Cissus antarctica*	LC	-	-	-	X	X
Vitaceae	*Clematicissus opaca*	LC	-	-	-	X	X
Myoporaceae	*Myoporum acuminatum*	LC	-	-	-	X	
Primulaceae	*Myrsine angusta*	LC	-	-	-	X	X
Lower dicots							
Aristolochiaceae	*Aristolochia elegans**	-	-	-	-	X	
Aristolochiaceae	*Aristolochia meridionalis*	LC	-	-	-		X
Lauraceae	*Cassytha filiformis*	LC	-	-	-	X	X
Lauraceae	*Cassytha pubescens*	LC	-	-	-		X
Lauraceae	*Cinnamomum camphora**	-	-	*3	-	X	X
Lauraceae	*Cryptocarya bidwillii*	LC	-	-	-		X
Lauraceae	*Cryptocarya laevigata*	LC	-	-	-		X
Lauraceae	*Cryptocarya sclerophylla*	LC	-	-	-		X
Lauraceae	*Cryptocarya* sp. 'Worlds End Pocket'	LC	-	-	-		X
Lauraceae	*Cryptocarya triplinervis*	LC	-	-	-	X	X
Lauraceae	*Endiandra discolor*	LC	-	-	-	X	X
Lauraceae	*Endiandra muelleri*	LC	-	-	-	X	X
Lauraceae	*Endiandra virens*	LC	-	-	-	X	
Menispermaceae	*Pleogyne australis*	LC	-	-	-		X
Menispermaceae	*Sarcopetalum harveyanum*	LC	-	-	-	X	X
Menispermaceae	*Stephania japonica var. discolor*	LC	-	-	-	X	X
Menispermaceae	*Tinospora smilacina*	LC	-	-	-	X	
Nymphaeaceae	*Nymphaea capensis*	-	-	-	-		X
Piperaceae	*Peperomia blanda var. floribunda*	LC	-	-	-	X	
Monocots							
Anthericaceae	*Laxmannia gracilis*	LC	-	-	-	X	X
Araceae	*Gymnostachys anceps*	LC	-	-	-	X	X
Arecaceae	*Livistona decora*	LC	-	-	-	X	X
Asparagaceae	*Asparagus aethiopicus**	-	-	*3	X	X	
Asparagaceae	*Asparagus africanus**	-	-	*3	X	X	
Asparagaceae	*Asparagus plumosus**	-	-	*3	X	X	X
Commelinaceae	*Aneilema acuminatum*	LC	-	-	-	X	X
Commelinaceae	*Commelina diffusa*	LC	-	-	-		X
Commelinaceae	*Commelina ensifolia*	LC	-	-	-		X
Commelinaceae	*Pollia macrophylla*	LC	-	-	-	X	
Commelinaceae	*Murdannia graminea*	LC	-	-	-	X	X
Cyperaceae	*Abildgaardia ovata*	LC	-	-	-	X	X
Cyperaceae	*Carex appressa*	LC	-	-	-		X
Cyperaceae	*Cyperus gracilis*	LC	-	-	-	X	X
Cyperaceae	*Cyperus lhotskyanus*	LC	-	-	-		X
Cyperaceae	*Cyperus polystachyos*	LC	-	-	-	X	X
Cyperaceae	*Eleocharis plana*	LC	-	-	-		X
Cyperaceae	*Fimbristylis dichotoma*	LC	-	-	-	X	X
Cyperaceae	*Gahnia aspera*	LC	-	-	-	X	X
Cyperaceae	*Lepidosperma laterale*	LC	-	-	-	X	X

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		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Cyperaceae	*Lepironia articulata*	LC	-	-	-		X
Dioscoreaceae	*Dioscorea transversa*	LC	-	-	-	X	X
Hemerocallidaceae	*Dianella caerulea var. vannata*	LC	-	-	-	X	X
Hemerocallidaceae	*Dianella revoluta*	LC	-	-	-	X	X
Hemerocallidaceae	*Geitonoplesium cymosum*	LC	-	-	-	X	X
Juncaceae	*Juncus continuus*	LC	-	-	-	X	X
Laxmanniaceae	*Cordyline rubra*	LC	-	-	-	X	X
Laxmanniaceae	*Eustrephus latifolius*	LC	-	-	-	X	X
Laxmanniaceae	*Lomandra laxa*	LC	-	-	-	X	X
Laxmanniaceae	*Lomandra longifolia*	LC	-	-	-	X	X
Laxmanniaceae	*Lomandra multiflora*	LC	-	-	-		X
Laxmanniaceae	*Thysanotus tuberosus*	LC	-	-	-	X	
Orchidaceae	*Cymbidium canaliculatum*	LC	-	-	-		X
Orchidaceae	*Cymbidium madidum*	LC	-	-	-	X	
Orchidaceae	*Cymbidium suave*	LC	-	-	-	X	X
Orchidaceae	*Dendrobium teretifolium*	LC	-	-	-		X
Orchidaceae	*Dendrobium tetragonum*	LC	-	-	-		X
Orchidaceae	*Dockrillia linguiformis*	LC	-	-	-		X
Orchidaceae	*Geodorum densiflorum*	LC	-	-	-		X
Poaceae	*Aristida gracilipes*	LC	-	-	-	X	X
Poaceae	*Aristida vagans*	LC	-	-	-	X	X
Poaceae	*Axonopus compressus**	-	-	-	-	X	X
Poaceae	*Bothriochloa bladhii*	LC	-	-	-	X	
Poaceae	*Bothriochloa decipiens var. decipiens*	LC	-	-	-	X	X
Poaceae	*Capillipedium spicigerum*	LC	-	-	-	X	X
Poaceae	*Chloris divaricata var. divaricata*	LC	-	-	-	X	
Poaceae	*Chloris gayana**	-	-	-	-	X	X
Poaceae	*Cymbopogon refractus*	LC	-	-	-	X	X
Poaceae	*Cynodon dactylon var. dactylon**	-	-	-	-	X	X
Poaceae	*Digitaria ciliaris**	-	-	-	-	X	
Poaceae	*Digitaria ramularis*	LC	-	-	-	X	X
Poaceae	*Entolasia stricta*	LC	-	-	-	X	X
Poaceae	*Eragrostis curvula**	-	-	-	-	X	
Poaceae	*Eragrostis elongata*	LC	-	-	-	X	X
Poaceae	*Eragrostis spartinoides*	LC	-	-	-	X	
Poaceae	*Eragrostis tenuifolia*	LC	-	-	-	X	
Poaceae	*Eriochloa pseudoacrotricha*	LC	-	-	-	X	
Poaceae	*Imperata cylindrica*	LC	-	-	-	X	X
Poaceae	*Megathyrsus maximus**	-	-	-	-	X	X
Poaceae	*Melinis minutiflora**	-	-	-	-	X	X
Poaceae	*Melinis repens**	-	-	-	-	X	X
Poaceae	*Oplismenus aemulus*	LC	-	-	-	X	X
Poaceae	*Oplismenus hirtellus subsp. imbecillis*	LC	-	-	-	X	X
Poaceae	*Ottochloa gracillima*	LC	-	-	-	X	X
Poaceae	*Panicum effusum*	LC	-	-	-	X	X
Poaceae	*Panicum maximum var. trichoglume*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Poaceae	*Panicum queenslandicum*	LC	-	-	-	X	
Poaceae	*Paspalidium distans*	LC	-	-	-	X	X
Poaceae	*Paspalidium gracile*	LC	-	-	-	X	
Poaceae	*Paspalum conjugatum**	-	-	-	-	X	
Poaceae	*Paspalum dilatatum**	-	-	-	-	X	
Poaceae	*Paspalum mandiocanum**	-	-	-	-	X	X
Poaceae	*Paspalum notatum**	-	-	-	-	X	X
Poaceae	*Paspalum scrobiculatum*	LC	-	-	-	X	X
Poaceae	*Paspalum urvillei**	-	-	-	-	X	
Poaceae	*Setaria sphacelata**	-	-	-	-	X	X
Poaceae	*Sporobolus fertilis**	-	-	*2	-	X	X
Poaceae	*Themeda triandra*	LC	-	-	-	X	X
Ripogonaceae	*Ripogonum album*	LC	-	-	-	X	X
Ripogonaceae	*Ripogonum brevifolium*	LC	-	-	-		X
Smilacaceae	*Smilax australis*	LC	-	-	-	X	X
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	LC	-	-	-	X	X
Xanthorrhoeaceae	*Xanthorrhoea latifolia*	LC	-	-	-	X	X
Xanthorrhoeaceae	*Xanthorrhoea macronema*	LC	-	-	-	X	

E = Endangered
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*****= naturalised species, exotic or not native to south-east QLD
***2**=Declared Class 2 pest plant under the *Land Protection (Pest and Stock Route Management) Act* (*LP Act)*
***3**=Declared Class 3 pest plant under the *LP Act*
WONS = Weed of National Significance
+ = species identification confirmed through submission of specimen to Queensland Herbarium

APPENDIX B

Marsdenia coronata habitat photos and similar species photos

 **Photo 1**. *Marsdenia coronata* habitat, Meander 1, RE 12.11.5e.	 **Photo 2**. *Marsdenia coronata* habitat, Meander 2, RE 12.11.5e.
 **Photo 3**. *Marsdenia coronata* habitat, Meander 3, RE 12.11.5e.	 **Photo 3**. *Marsdenia coronata* habitat, Meander 5, RE 12.11.5e.
 **Photo 5**. *Marsdenia coronata* habitat, Meander 6, RE 12.9-10.4.	 **Photo 6**. *Marsdenia coronata* habitat, Meander 14, RE 12.11.5e.

Photo 7. *Marsdenia coronata* habitat, Meander 18, RE 12.11.3, upper hillslope.

Photo 8. *Marsdenia coronata* habitat, Meander 18, RE 12.11.3, lower hillslope gully.

Photo 9. *Marsdenia coronata* seedling.

Photo 10. *Marsdenia lloydii* seedling.

Photo 11. *Parsonsia lanceolata* seedling.

Photo 12. *Secamone elliptica* seedling.

APPENDIX C

Threatened Ecological Community Assessment

Appendix C: Assessment summary for a patch of notophyll vine forest vegetation against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community

An approximately 1 ha patch of Regional Ecosystem 12.11.10 (notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics) in the south of the Stage D1 portion of the study area was assessed against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community during a 1.5 hour traverse of the patch by two ecologists on 25/02/2016. The results of this assessment are summarised in **Tables C.1** to **C.3** below.

Table C.1. Notophyll vine forest patch vegetation community details.

Vegetation layer	Height (m)	Dominant species
Assessment site coordinates: 26.241975 S 152.706652 E		
Emergent	35 m	*Araucaria cunninghamii* (d) *Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198) *Pseudoweinmannia lachnocarpa*
Tree1	22 m	*Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198) (d) *Brachychiton discolour* *Planchonella pohlmaniana* *Vitex lignum-vitae*
Tree2	12 m	*Dissiliaria baloghioides* (d) *Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198) *Acacia bakeri* *Polyalthia nitidissima*
Shrub1	3 m	*Dissiliaria baloghioides* *Acronychia pauciflora* *Gossia bidwillii* *Pentaceras australe*
Ground	0.5 m	*Asplenium attenuatum* *Dissiliaria baloghioides* *Arachniodes aristata* Leaf litter (90% cover)

Table C.2. Assessment summary against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community.

TEC criterion	Assessment	Meets criterion?
Key diagnostic characteristics		
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions.	Patch occurs in the South Eastern Queensland bioregion	Yes
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments	Occurs on land zone 11 (soils derived from metamorphic rocks).	Yes
The ecological community generally occurs at an altitude less than 300 m above sea level.	Occurs at an altitude of 100 m	Yes

TEC criterion	Assessment	Meets criterion?
The ecological community typically occurs in areas with high annual rainfall (>1300mm).	Occurs in an area with approximately 1,100 mm mean annual rainfall.	Marginal
The ecological community is typically more than 2 km inland from the coast.	Occurs 36 km inland from the coast.	Yes
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	Occurs as a tall closed forest with multiple tree layers (see **Table C.1**).	Yes
Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A).	The patch has high species richness (at least 96 native species), including 38 species from Appendix A (see **Table C.3**).	Yes
Condition thresholds		
Patch Type (evidence of remnant vegetation & regeneration status)	Natural remnant evident by the persistence of mature residual trees from Appendix B. AND	Yes
Patch Size (excludes buffer zone)	≥ 0.1 ha AND	Yes, 1 ha.
Canopy Cover (over entire patch)	Emergent/canopy/subcanopy cover is ≥ 70% AND	Yes, ≥ 90%
Species Richness (over entire patch)	Contains ≥ 40 native woody species from Appendix A AND	No, contains 38 species from Appendix A (see **Table C.3**).
Percent of total vegetation cover that is native (use sample plot)	≥70% of vegetation is native	Yes

Table C.3. Notophyll vine forest patch flora species list.

Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Mimosaceae	*Acacia bakeri*	LC	-	-	-	X
Rutaceae	*Acronychia laevis*	LC	-	-	-	
Rutaceae	*Acronychia pauciflora*	LC	-	-	-	
Euphorbiaceae	*Actephila lindleyi*	LC	-	-	-	X
Euphorbiaceae	*Alchornea ilicifolia*	LC	-	-	-	
Sapindaceae	*Alectryon reticulatus*	LC	-	-	-	
Rhamnaceae	*Alphitonia excelsa*	LC	-	-	-	X
Apocynaceae	*Alyxia ruscifolia*	LC	-	-	-	
Ulmaceae	*Aphananthe philippinensis*	LC	-	-	-	X
Dryopteridaceae	*Arachniodes aristata*	LC	-	-	-	
Araucariaceae	*Araucaria cunninghamii*	LC	-	-	-	X
Sterculiaceae	*Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198)	LC	-	-	-	

Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Tectariaceae	*Arthropteris tenella*	LC	-	-	-	
Aspleniaceae	*Asplenium attenuatum*	LC	-	-	-	
Aspleniaceae	*Asplenium australasicum*	LC	-	-	-	X
Rubiaceae	*Atractocarpus chartaceus*	LC	-	-	-	X
Sterculiaceae	*Brachychiton discolor*	LC	-	-	-	
Phyllanthaceae	*Breynia oblongifolia*	LC	-	-	-	X
Phyllanthaceae	*Bridelia exaltata*	LC	-	-	-	X
Arecaceae	*Calamus muelleri*	LC	-	-	-	X
Capparaceae	*Capparis arborea*	LC	-	-	-	X
Capparaceae	*Capparis sarmentosa*	LC	-	-	-	
Caesalpiniaceae	*Cassia tomentella*	LC	-	-	-	
Vitaceae	*Cissus antarctica*	LC	-	-	-	X
Rutaceae	*Citrus australis*	LC	-	-	-	
Euphorbiaceae	*Cleistanthus cunninghamii*	LC	-	-	-	X
Lamiaceae	*Clerodendrum floribundum*	LC	-	-	-	X
Laxmanniaceae	*Cordyline rubra*	LC	-	-	-	X
Euphorbiaceae	*Croton insularis*	LC	-	-	-	
Euphorbiaceae	*Croton stigmatosus*	LC	-	-	-	
Lauraceae	*Cryptocarya laevigata*	LC	-	-	-	
Lauraceae	*Cryptocarya sclerophylla*	LC	-	-	-	
Lauraceae	*Cryptocarya* sp. 'Worlds End Pocket'	LC	-	-	-	
Lauraceae	*Cryptocarya triplinervis*	LC	-	-	-	
Sapindaceae	*Cupaniopsis serrata*	LC	-	-	-	X
Rubiaceae	*Cyclophyllum longipetalum*	LC	-	-	-	
Orchidaceae	*Dendrobium teretifolium*	LC	-	-	-	
Orchidaceae	*Dendrobium tetragonum*	LC	-	-	-	
Fabaceae	*Derris involuta*	LC	-	-	-	
Dioscoreaceae	*Dioscorea transversa*	LC	-	-	-	X
Ebenaceae	*Diospyros fasciculosa*	LC	-	-	-	
Ebenaceae	*Diospyros geminata*	LC	-	-	-	
Euphorbiaceae	*Dissiliaria baloghioides*	LC	-	-	-	
Blechnaceae	*Doodia aspera*	LC	-	-	-	
Putranjivaceae	*Drypetes deplanchei*	LC	-	-	-	
Erythroxylaceae	*Erythroxylum* sp. Splityard Creek (L.Pedley 5360)	LC	-	-	-	
Rutaceae	*Flindersia australis*	LC	-	-	-	X
Rutaceae	*Flindersia bennettiana*	LC	-	-	-	
Rutaceae	*Flindersia xanthoxyla*	LC	-	-	-	X
Hemerocallidaceae	*Geitonoplesium cymosum*	LC	-	-	-	X
Myrtaceae	*Gossia bidwillii*	LC	-	-	-	X
Proteaceae	*Grevillea hilliana*	LC	-	-	-	X
Proteaceae	*Grevillea robusta*	LC	-	-	-	X
Sapindaceae	*Guioa semiglauca*	LC	-	-	-	X
Acanthaceae	*Harnieria hygrophiloides*	LC	-	-	-	
Sapindaceae	*Jagera pseudorhus* var. *pseudorhus*	LC	-	-	-	X
Oleaceae	*Jasminum simplicifolium*	LC	-	-	-	
Verbenaceae	*Lantana camara**	-	-	*3	X	
Myrtaceae	*Lophostemon confertus*	LC	-	-	-	X

Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Euphorbiaceae	*Mallotus philippensis*	LC	-	-	-	X
Apocynaceae	*Marsdenia microlepis*	LC	-	-	-	
Rutaceae	*Melicope micrococca*	LC	-	-	-	X
Annonaceae	*Melodorum leichhardtii*	LC	-	-	-	
Myrsinaceae	*Myrsine variabilis*	LC	-	-	-	
Oleaceae	*Notelaea longifolia*	LC	-	-	-	X
Meliaceae	*Owenia venosa*	LC	-	-	-	
Bignoniaceae	*Pandorea jasminoides*	LC	-	-	-	
Apocynaceae	*Parsonsia paulforsteri*	LC	-	-	-	
Apocynaceae	*Parsonsia velutina*	LC	-	-	-	
Pteridaceae	*Pellaea paradoxa*	LC	-	-	-	
Rutaceae	*Pentaceras australe*	LC	-	-	-	X
Pittosporaceae	*Pittosporum multiflorum*	LC	-	-	-	X
Pittosporaceae	*Pittosporum revolutum*	LC	-	-	-	X
Sapotaceae	*Planchonella cotinifolia*	LC	-	-	-	
Sapotaceae	*Planchonella pohlmaniana*	LC	-	-	-	
Sapotaceae	*Planchonella queenslandica*	LC	-	-	-	
Polypodiaceae	*Platycerium superbum*	LC	-	-	-	X
Menispermaceae	*Pleogyne australis*	LC	-	-	-	
Annonaceae	*Polyalthia nitidissima*	LC	-	-	-	
Araliaceae	*Polyscias elegans*	LC	-	-	-	X
Cunoniaceae	*Pseudoweinmannia lachnocarpa*	LC	-	-	-	
Rubiaceae	*Psychotria daphnoides*	LC	-	-	-	
Rubiaceae	*Psychotria loniceroides*	LC	-	-	-	
Rubiaceae	*Psydrax odorata*	LC	-	-	-	
Myrtaceae	*Rhodamnia dumicola*	LC	-	-	-	
Ripogonaceae	*Ripogonum brevifolium*	LC	-	-	-	
Petiveriaceae	*Rivina humilis**	-	-	-	-	
Rutaceae	*Sarcomelicope simplicifolia*	LC	-	-	-	X
Smilacaceae	*Smilax australis*	LC	-	-	-	X
Proteaceae	*Stenocarpus sinuatus*	LC	-	-	-	
Malvaceae	*Sterculia quadrifida*	LC	-	-	-	
Loganiaceae	*Strychnos axillaris*	LC	-	-	-	
Apocynaceae	*Tabernaemontana pandacaqui*	LC	-	-	-	X
Sapindaceae	*Toechima tenax*	LC	-	-	-	
Rubiaceae	*Triflorensia cameronii*	LC	-	-	-	X
Moraceae	*Trophis scandens* subsp. *scandens*	LC	-	-	-	
Lamiaceae	*Vitex lignum-vitae*	LC	-	-	-	
Monimiaceae	*Wilkiea macrophylla*	LC	-	-	-	

E = Endangered
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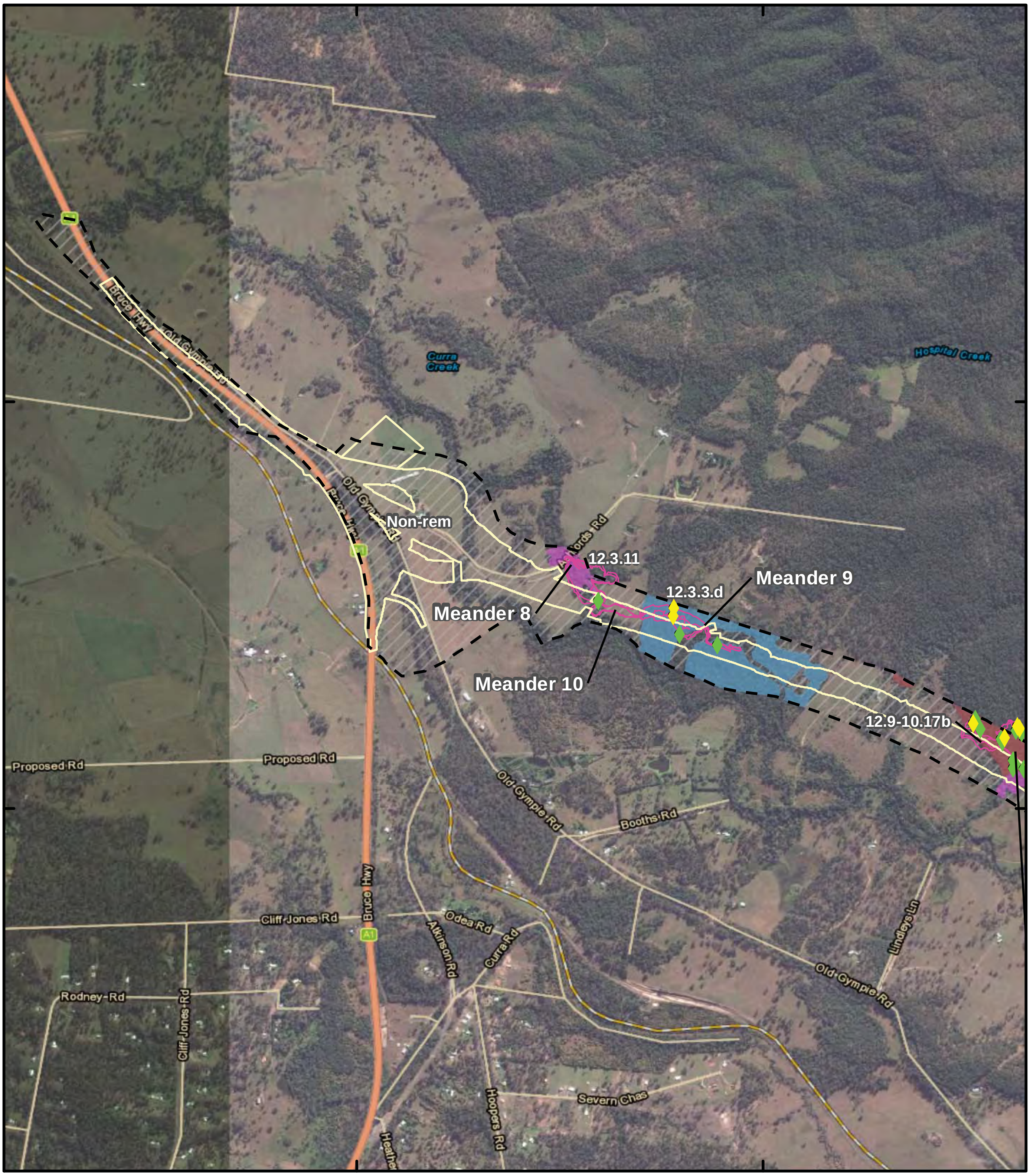
***3**=Declared Class 3 pest plant under the *LP Act*
WONS = Weed of National Significance

APPENDIX D

Locations of key habitat features recorded opportunistically

Latitude	Longitude	Habitat feature
-26.065168	152.611508	Hollow-bearing log
-26.235585	152.702819	Hollow-bearing tree
-26.235679	152.702933	Hollow-bearing tree
-26.235771	152.703041	Hollow-bearing tree
-26.23613	152.703297	Hollow-bearing tree
-26.116859	152.650513	Hollow-bearing tree
-26.058168	152.593237	Hollow-bearing tree
-26.059547	152.596577	Hollow-bearing tree
-26.059974	152.598114	Hollow-bearing tree
-26.065283	152.61162	Hollow-bearing tree
-26.065187	152.611278	Hollow-bearing tree
-26.063578	152.610609	Hollow-bearing tree
-26.063468	152.61052	Hollow-bearing tree
-26.063498	152.610359	Hollow-bearing tree
-26.063952	152.609819	Hollow-bearing tree
-26.063012	152.608712	Hollow-bearing tree
-26.063423	152.608899	Hollow-bearing tree
-26.064703	152.610253	Hollow-bearing tree
-26.06485	152.610351	Hollow-bearing tree
-26.065044	152.610247	Hollow-bearing tree
-26.065047	152.61069	Hollow-bearing tree
-26.071287	152.622912	Hollow-bearing tree
-26.219366	152.702758	Hollow-bearing tree
-26.063839	152.609746	Hollow-bearing tree
-26.05879	152.596309	Hollow-bearing log
-26.058457	152.596347	Hollow-bearing log
-26.064882	152.610934	Hollow-bearing log
-26.063407	152.610525	Hollow-bearing log
-26.063321	152.610435	Hollow-bearing log
-26.063787	152.609912	Hollow-bearing log
-26.063178	152.608616	Hollow-bearing log
-26.070724	152.620987	Hollow-bearing log
-26.211615	152.702689	Log pile
-26.213059	152.702336	Log pile
-26.216877	152.702326	Brush-turkey nest mound
-26.242013	152.704896	Brush-turkey nest mound
-26.242115	152.705398	Black-breasted Button-quail (platelets)
-26.241975	152.706652	TEC assessment site



Notes: imagery sourced from ArcGIS Online (c) 2016

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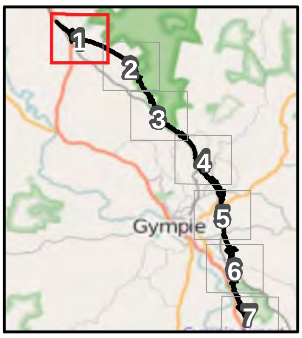

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	**1 (1 of 7) Appendix D**
Title:	Location of other key habitat features recorded opportunistically
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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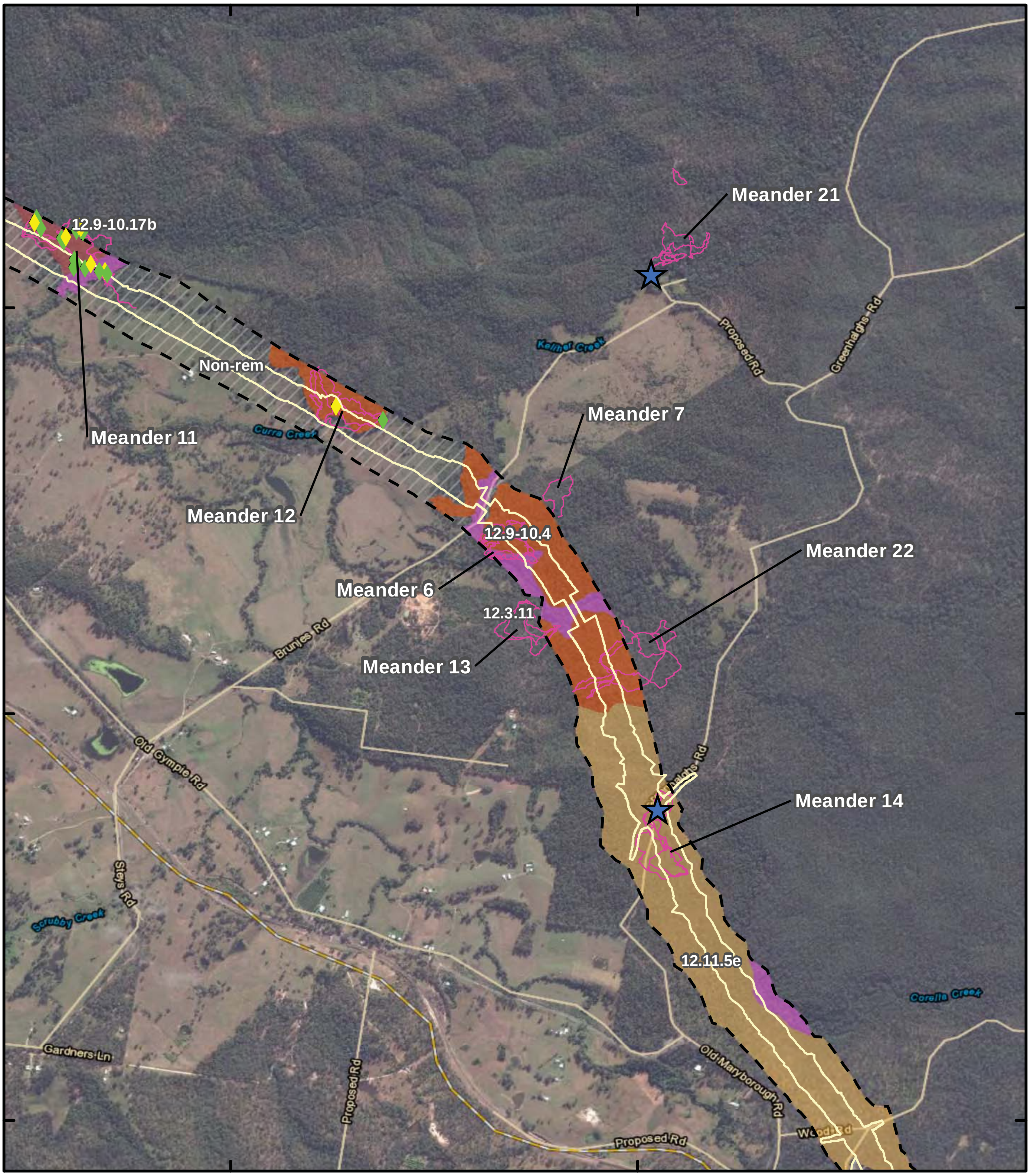
Document Location: D:\GIS\Jobs\0402-001 C2C Secion D FloraSurvey\GIS\MXDs\ReportMaps\Appendix D Figure 1 Other key habitat features.mxdDate: 4/04/2016 5:00:50 AM



Notes: imagery sourced from ArcGIS Online (c) 2016

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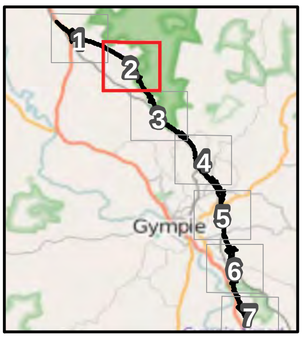

LEGEND

- Brush-turkey nest
- Hollow log
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- Log pile
- Platelets
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Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG   Reviewed by: PL   Date: 4/04/2016

Figure:	**1 (2 of 7) Appendix D**
Title:	Location of other key habitat features recorded opportunistically
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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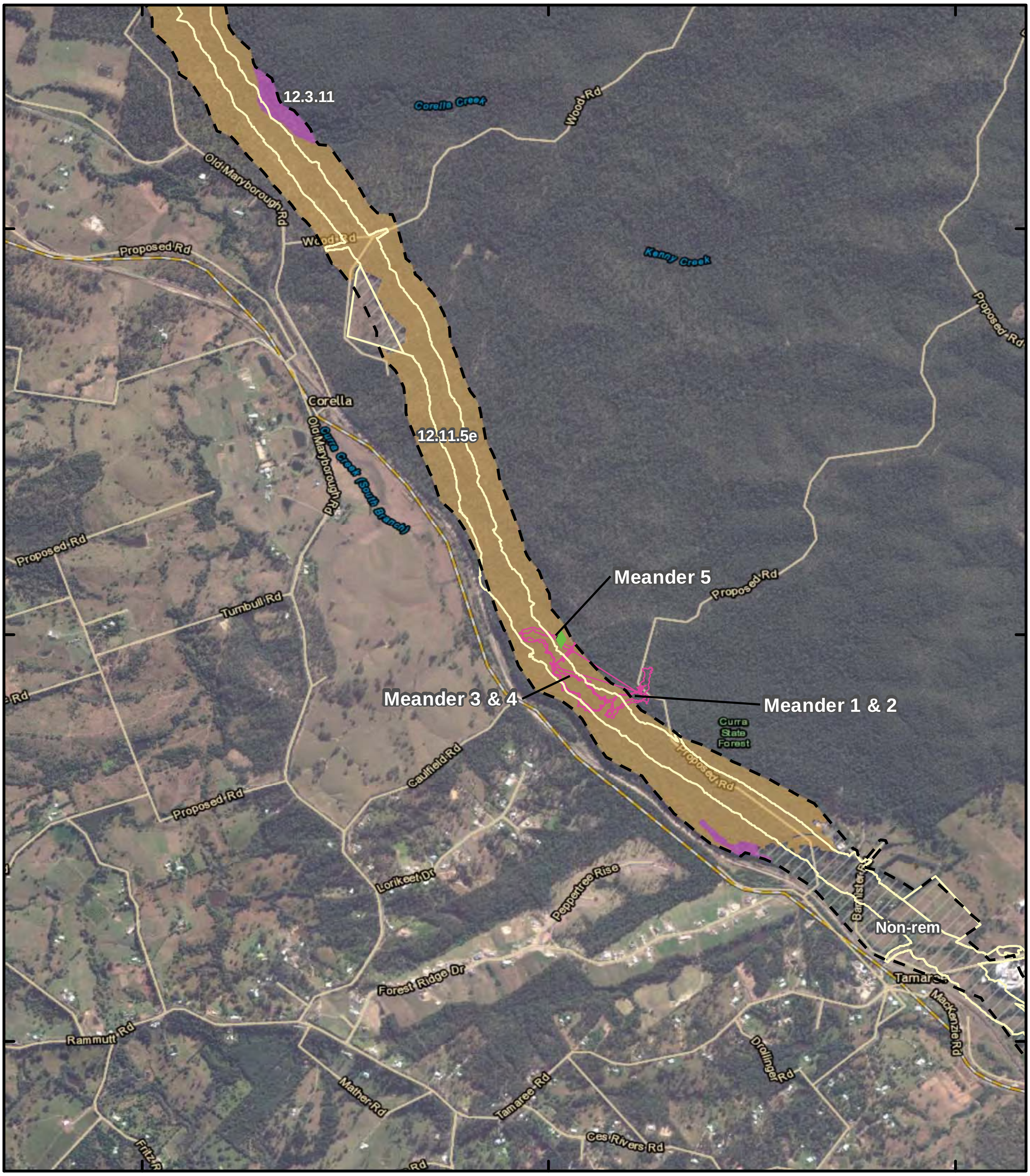

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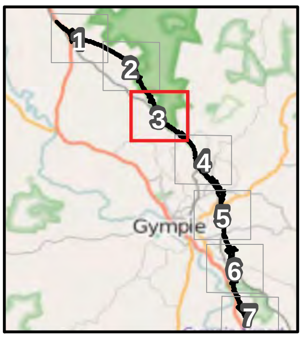

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure: **1 (3 of 7) Appendix D**

Title: Location of other key habitat features recorded opportunistically

Project: **Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**

Client: **Advisian on behalf of QLD Dept. of Transport and Main Roads**

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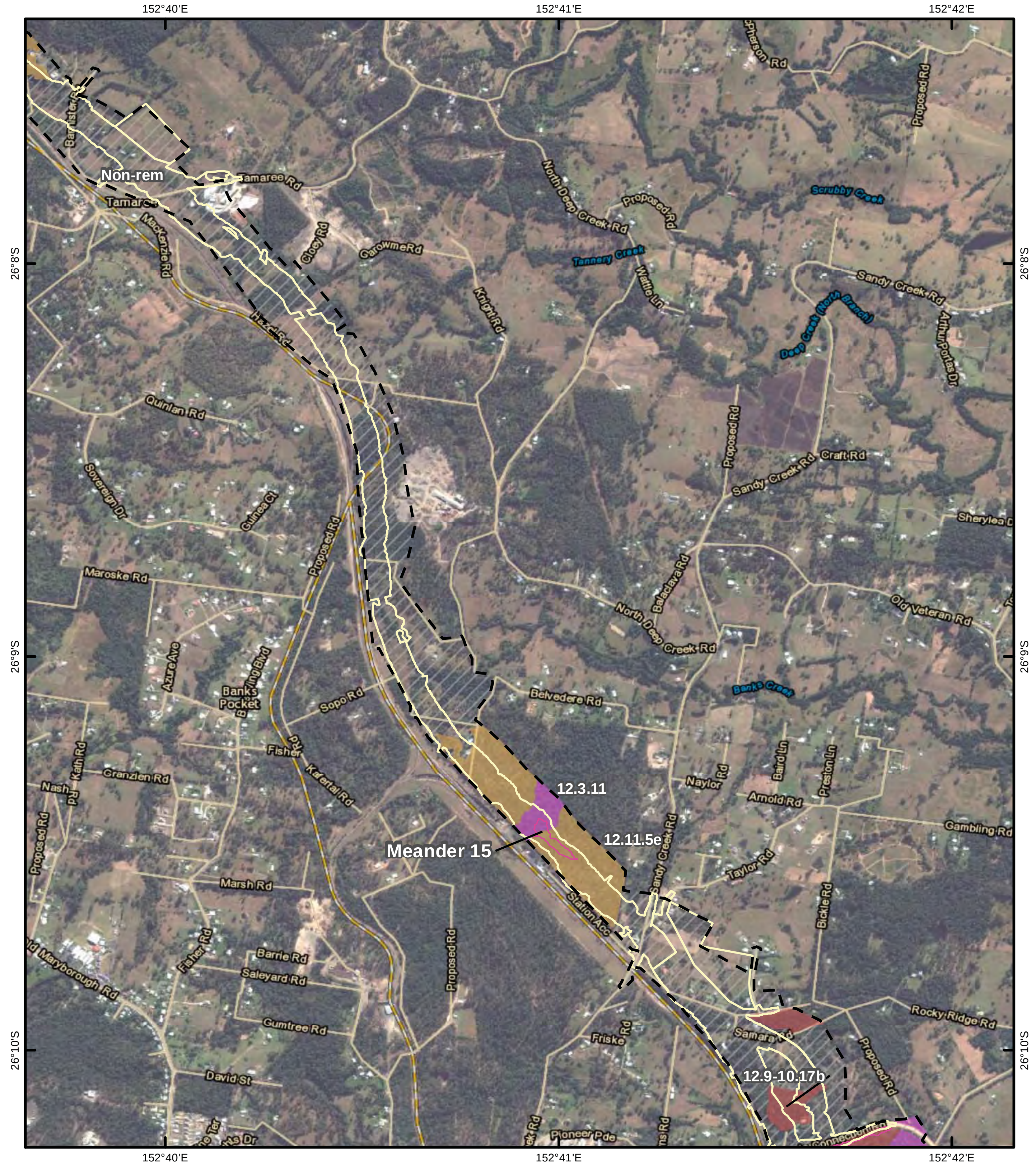

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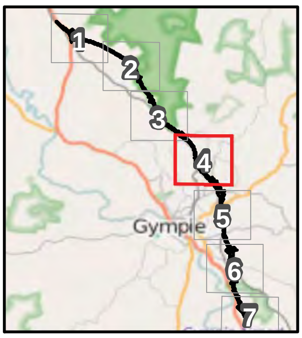

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
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Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
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- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG

Reviewed by: PL

Date: 4/04/2016

Figure: 1 (4 of 7) Appendix D

Title: Location of other key habitat features recorded opportunistically

Project: **Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**

Client: **Advisian on behalf of QLD Dept. of Transport and Main Roads**

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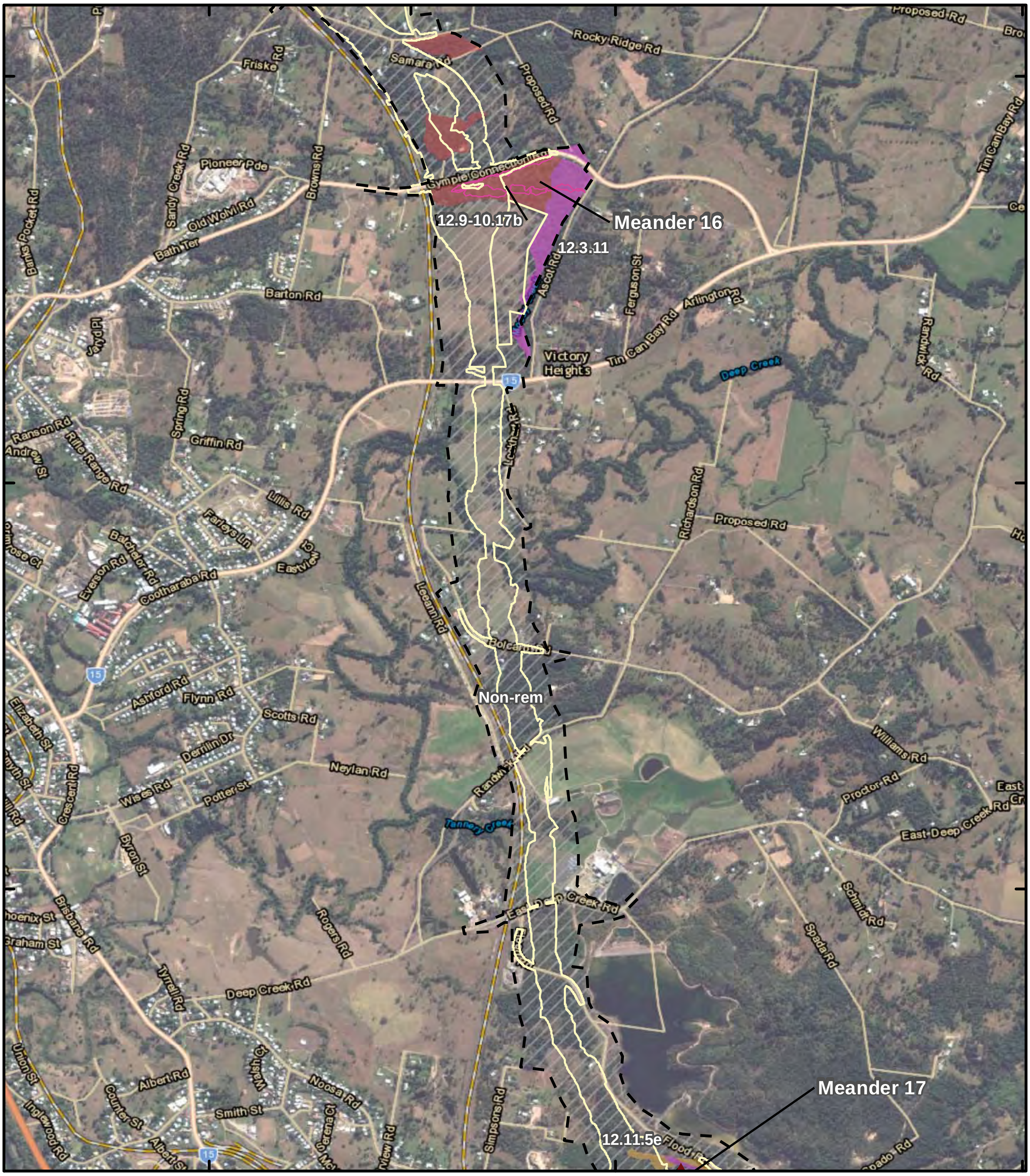

152°41'E 152°42'E 152°43'E

Notes: imagery sourced from ArcGIS Online (c) 2016

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Datum: GDA 1994
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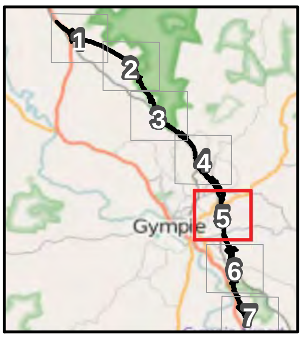


LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure: 1 (5 of 7) Appendix D

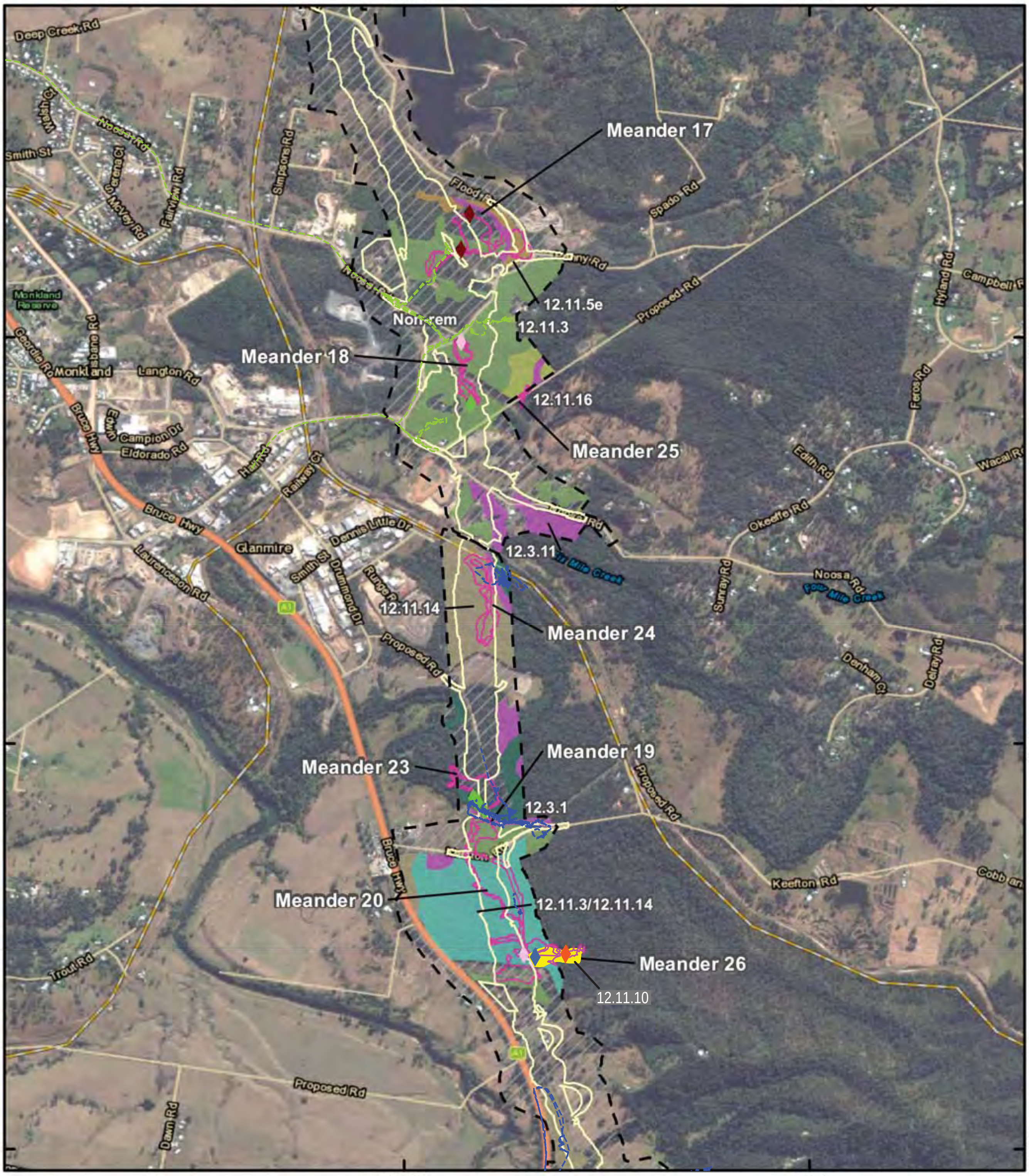
Title: Location of other key habitat features recorded opportunistically

Project: **Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**

Client: **Advisian on behalf of QLD Dept. of Transport and Main Roads**

BAAM ECOLOGICAL CONSULTANTS

152°42'E 152°43'E



26°13'S 26°14'S 26°15'S

152°42'E 152°43'E

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem
- 12.11.10

Drawn By: MG Reviewed by: PL Date: 4/04/2016

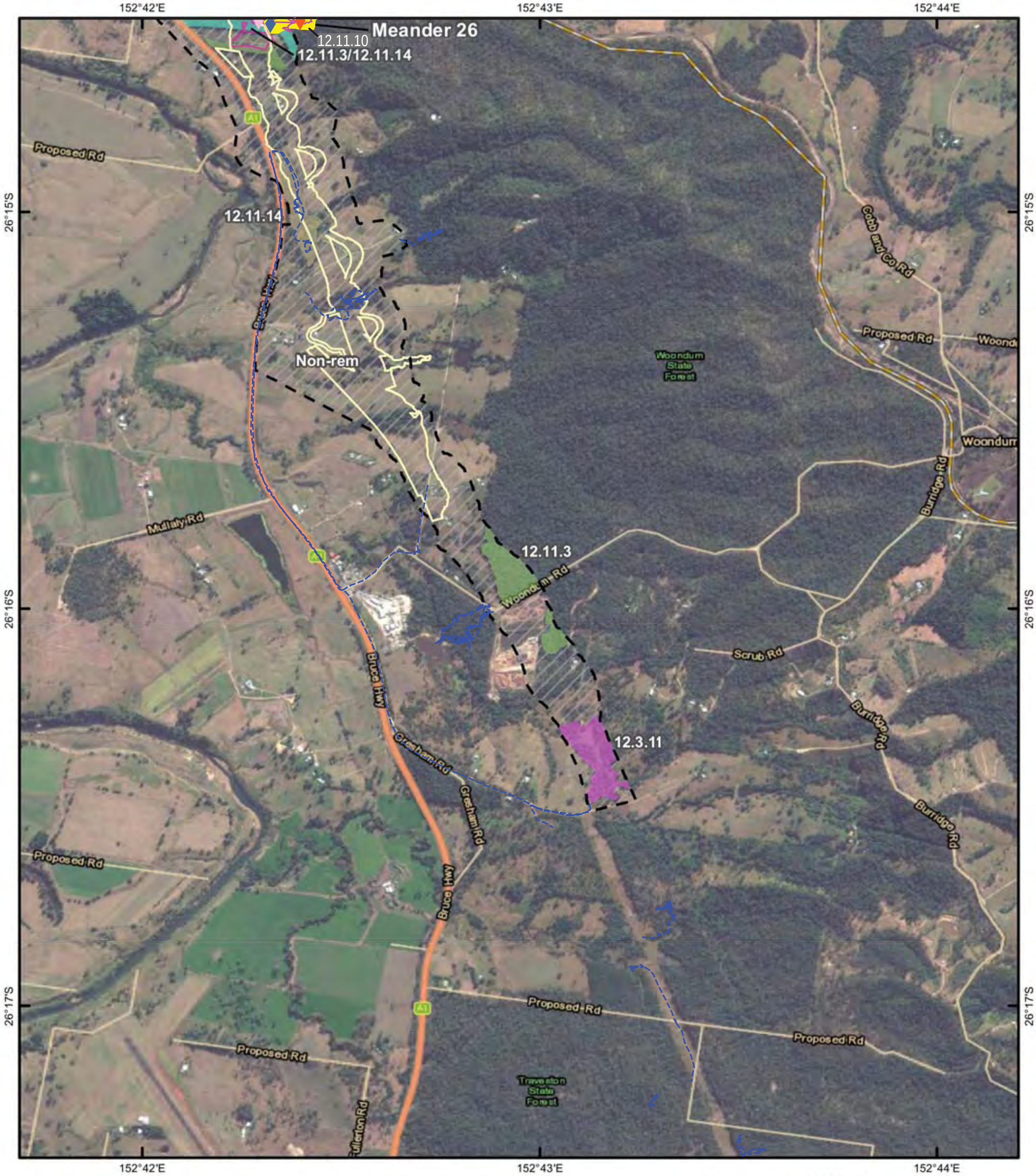
Figure: 1 (6 of 7) Appendix D

Title: Location of other key habitat features recorded opportunistically

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

BAAM ECOLOGICAL CONSULTANTS



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem
- 12.11.10

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	**1 (7 of 7) Appendix D**
Title:	**Location of other key habitat features recorded opportunistically**
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

BAAM
ECOLOGICAL CONSULTANTS

Addendum 1: Summary of survey effort in the Section D study area (2011 to 2016) and details of the Threatened Ecological Community (TEC) assessment of a patch of RE 12.3.1 conducted in 2011.

Flora surveys in the Section D study area that have contributed to the assessment of the occurrence of threatened flora species in this report include the following:

- A flora field survey undertaken over six days from the 5th to the 10th of December 2011 by two ecologists in the Section C study area, which included the southern portion of the current Section D study area (i.e. the portion south of the North Coast railway line). This survey is reported in BAAM (2012), and included completion of 13 secondary and 63 quaternary site surveys following the methodology of Neldner *et al.* (2012) as part of the process of ground-truthing Regional Ecosystems, as well as continuous searches for conservation significant species while traversing the study area over the survey period. The locations of the survey sites from this survey within the current Section D study area are shown in Appendix 7-B of Jacobs (2015), and reflect the mapped survey points south of the North Coast railway line.
- A flora field survey undertaken over six days from the 2nd to the 7th of March 2015 by two ecologists covering the portion of the Section D study area north of the North Coast railway line. This survey is reported in Jacobs (2015) and included completion of 12 secondary, one tertiary and 45 quaternary site surveys as part of the process of ground-truthing Regional Ecosystems, as well as continuous searches for conservation significant species while traversing the study area over the survey period. The locations of the survey sites from this survey are shown in Appendix 7-B of Jacobs (2015), and reflect the mapped survey points north of the North Coast railway line.
- Two sets of protected plant surveys undertaken following the methodology of EHP (2014) conducted by one ecologist at specific geotechnical investigation sites within the Section D study area over the periods 6th to 7th of March 2015 and 5th to 7th of May 2015. These surveys are reported in BAAM (2015 a,b).
- A targeted threatened flora species survey undertaken over four days from the 22nd to 25th February 2016 by two ecologists covering the Section D study area, which is reported on in the current report.

The December 2011 survey identified a narrow riparian patch of RE 12.3.1 (Gallery rainforest (notophyll vine forest) on alluvial plains) along Six Mile Creek. This patch was assessed against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community. The results of this assessment, reproduced from BAAM (2012) and associated data not presented in the BAAM (2012) report are summarised in **Tables A.1** to **A.3** below. The patch was in a relatively degraded condition, largely due to a substantial invasion of Cat's Claw Creeper (*Macfadyena unguis-cati**) (see photo in **Table A1.1** below) and did not meet the condition threshold of ≥ 40 native woody species from Appendix A of the listing advice.

Table A1.1. Gallery rainforest patch vegetation community details.

Vegetation layer	Height (m)	Dominant species
Assessment site coordinates: -26.236312 S 152.704185 E (site S08); -26.226200 S 152.704037 (site S11)		
Emergent		None
Tree1	16-24 m	*Waterhousea floribunda* (d) *Castanospermum australe* *Lophostemon suaveolens*

Tree2	8-17 m	*Cryptocarya triplinervis* *Aphananthe philippinensis* *Streblus brunonianus*
Shrub1	3-6 m	*Atractocarpus chartaceus* *Phyllanthus microcladus*
Ground	0-1 m	*Macfadyena unguis-cati** (d) *Oplismenus* spp. *Lomandra hystrix*

Photo of RE 12.3.1 on Six Mile Creek showing dense ground and vine cover of *Macfadyena unguis-cati** weed.

Table A1.2. Assessment summary against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community.

TEC criterion	Assessment	Meets criterion?
Key diagnostic characteristics		
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions.	Patch occurs in the South Eastern Queensland bioregion	Yes
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments	Occurs on land zone 11 (soils derived from metamorphic rocks).	Yes

TEC criterion	Assessment	Meets criterion?
The ecological community generally occurs at an altitude less than 300 m above sea level.	Occurs at an altitude of 100 m	Yes
The ecological community typically occurs in areas with high annual rainfall (>1300mm).	Occurs in an area with approximately 1,100 mm mean annual rainfall.	Marginal
The ecological community is typically more than 2 km inland from the coast.	Occurs 36 km inland from the coast.	Yes
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	Occurs as a tall closed forest with multiple tree layers (see **Table A1.1**).	Yes
Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A).	The patch has relatively low species richness, including only 38 species from Appendix A (see **Table A1.3**).	Yes
Condition thresholds		
Patch Type (evidence of remnant vegetation & regeneration status)	Natural remnant evident by the persistence of mature residual trees from Appendix B. AND	Yes
Patch Size (excludes buffer zone)	≥ 0.1 ha AND	Yes, ≥ 0.1 ha.
Canopy Cover (over entire patch)	Emergent/canopy/subcanopy cover is ≥ 70% AND	Yes, ≥ 70%
Species Richness (over entire patch)	Contains ≥ 40 native woody species from Appendix A AND	No, contains only 21 species from Appendix A (see **Table A1.3**).
Percent of total vegetation cover that is native (use sample plot)	≥70% of vegetation is native	Yes

Table A1.3. Gallery rainforest patch flora species list.

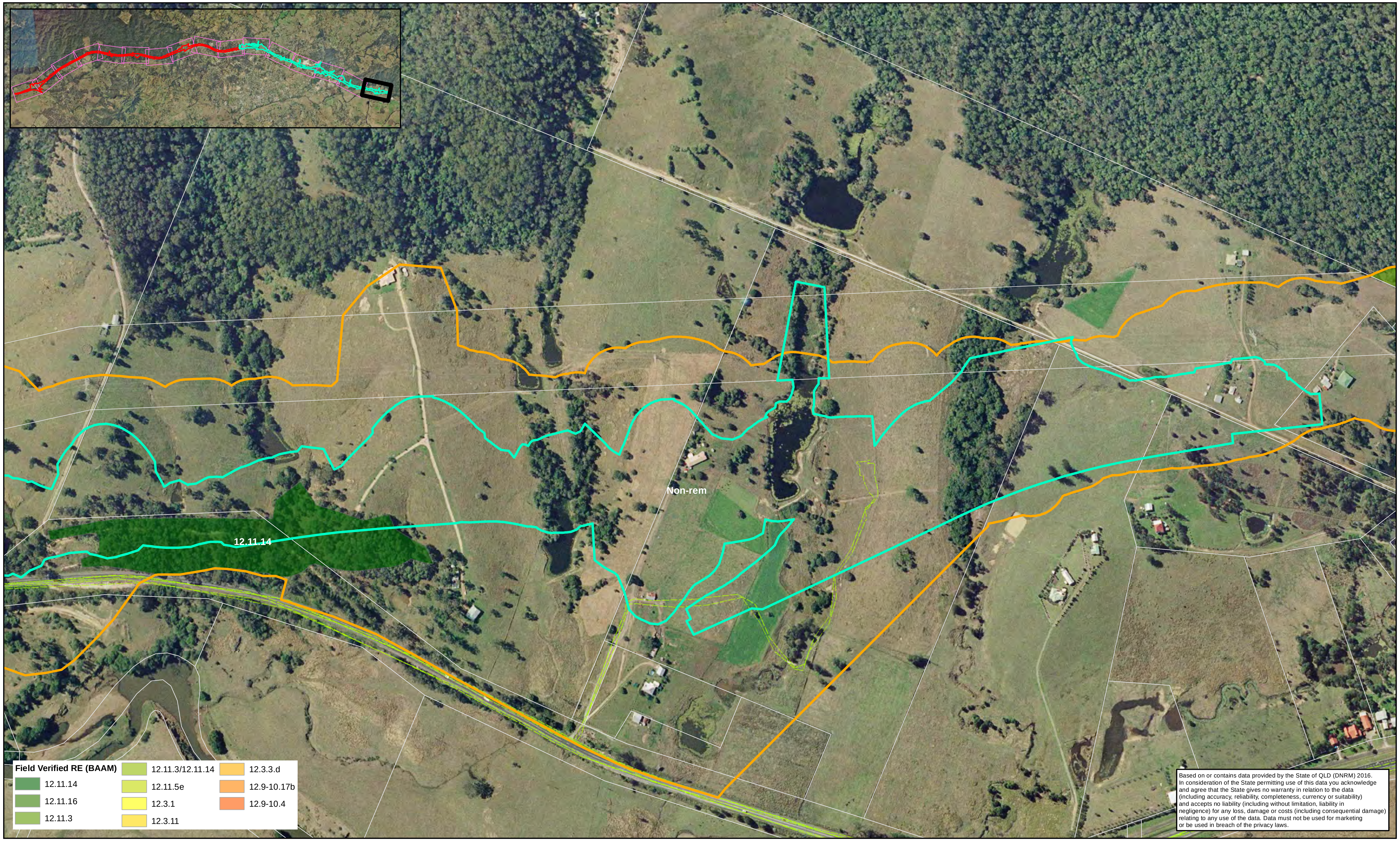
Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Mimosaceae	*Acacia bakeri*	LC	-	-	-	X
Rutaceae	*Acronychia oblongifolia*	LC	-	-	-	
Adiantaceae	*Adiantum diaphanum*	LC	-	-	-	
Adiantaceae	*Adiantum hispidulum*	LC	-	-	-	
Asteraceae	*Ageratum houstonianum**	-	-	-	-	
Euphorbiaceae	*Alchornea ilicifolia*	LC	-	-	-	
Commelinaceae	*Aneilema biflorum*	LC	-	-	-	
Ulmaceae	*Aphananthe philippinensis*	LC	-	-	-	X
Sterculiaceae	*Argyrodendron trifoliatum*	LC	-	-	-	X

Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Sapindaceae	*Arytera foveolata*	LC	-	-	-	
Rubiaceae	*Atractocarpus chartaceus*	LC	-	-	-	X
Burseraceae	*Canarium australasicum*	LC	-	-	-	
Cyperaceae	*Carex appressa*	LC	-	-	-	
Fabaceae	*Castanospermum australe*	LC	-	-	-	X
Ulmaceae	*Celtis sinensis**	-	-	*3	-	
Asteraceae	*Centipeda minima subsp. minima*	LC	-	-	-	
Euphorbiaceae	*Cleistanthus cunninghamii*	LC	-	-	-	X
Asteraceae	*Conyza bonariensis**		-	-	-	
Asteraceae	*Crassocephalum crepidioides**		-	-	-	
Lauraceae	*Cryptocarya glaucescens*	LC	-	-	-	
Lauraceae	*Cryptocarya obovata*	LC	-	-	-	X
Lauraceae	*Cryptocarya triplinervis*	LC	-	-	-	
Sapindaceae	*Cupaniopsis parvifolia*	LC	-	-	-	
Cyperaceae	*Cyperus tetraphyllus*	LC	-	-	-	
Thelypteridaceae	*Christella hispidula*	LC	-	-	-	
Blechnaceae	*Doodia caudata*	LC	-	-	-	
Elaeocarpaceae	*Elaeocarpus obovatus*	LC	-	-	-	
Sapindaceae	*Elattostachys bidwillii*	LC	-	-	-	
Myrsinaceae	*Embelia australiana*	LC	-	-	-	
Lauraceae	*Endiandra discolor*	LC	-	-	-	
Lauraceae	*Endiandra muelleri* subsp. *muelleri*	LC	-	-	-	
Apiaceae	*Eryngium expansum*	LC	-	-	-	
Moraceae	*Ficus coronata*	LC	-	-	-	X
Moraceae	*Ficus fraseri*	LC	-	-	-	X
Flagellariaceae	*Flagellaria indica*	LC	-	-	-	
Hemerocallidaceae	*Geitonoplesium cymosum*	LC	-	-	-	X
Phyllanthaceae	*Glochidion ferdinandi*	LC	-	-	-	X
Dennstaedtiaceae	*Hypolepis muelleri*	LC	-	-	-	
Oleaceae	*Ligustrum sinense**	-	-	*3	-	
Laxmanniaceae	*Lomandra hystrix*	LC	-	-	-	
Myrtaceae	*Lophostemon suaveolens*	LC	-	-	-	
Lygodiaceae	*Lygodium japonicum**	LC	-	-	-	
Bignoniaceae	*Macfadyena unguis-cati**	-	-	*3	-	
Euphorbiaceae	*Mallotus claoxyloides*	LC	-	-	-	
Myrtaceae	*Melaleuca saligna*	LC	-	-	-	
Apocynaceae	*Melodinus australis*	LC	-	-	-	X
Sapindaceae	*Mischocarpus australis*	LC	-	-	-	
Rubiaceae	*Morinda umbellata*	LC	-	-	-	X
Ochnaceae	*Ochna serrulata**		-	-	-	
Poaceae	*Oplismenus aemulus*	LC	-	-	-	
Poaceae	*Oplismenus imbecillis*	LC	-	-	-	X
Poaceae	*Oplismenus undulatifolius*	LC	-	-	-	
Apocynaceae	*Parsonsia straminea*	LC	-	-	-	X
Phyllanthaceae	*Phyllanthus microcladus*	LC	-	-	-	X
Pittosporaceae	*Pittosporum revolutum*	LC	-	-	-	X
Menispermaceae	*Pleogyne australis*	LC	-	-	-	
Acanthaceae	*Pseuderanthemum variabile*	LC	-	-	-	

Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Rubiaceae	*Psychotria daphnoides*	LC	-	-	-	
Myrtaceae	*Rhodomyrtus psidioides*	LC	-	-	-	
Ripogonaceae	*Ripogonum discolor*	LC	-	-	-	
Menispermaceae	Sarcopetalum harveyanum	LC	-	-	-	
Caesalpiniaceae	*Senna pendula**		-	-	-	
Smilacaceae	*Smilax australis*	LC	-	-	-	X
Solanaceae	*Solanum nigrum**		-	-	-	
Solanaceae	*Solanum seaforthianum**		-	-	-	
Moraceae	*Streblus brunonianus*	LC	-	-	-	X
Apocynaceae	*Tabernaemontana pandacaqui*	LC	-	-	-	X
Poaceae	*Themeda triandra*	LC	-	-	-	
Commelinaceae	*Tradescantia fluminensis**		-	-	-	
Moraceae	*Trophis scandens*	LC	-	-	-	
Violaceae	*Viola hederacea*	LC	-	-	-	
Campanulaceae	*Wahlenbergia gracilis*	LC	-	-	-	
Myrtaceae	*Waterhousea floribunda*	LC	-	-	-	X

E = Endangered
V = Vulnerable
LC = Least Concern
*****= naturalised species, exotic or not native to south-east QLD
***2**=Declared Class 2 pest plant under the *Land Protection (Pest and Stock Route Management) Act* (*LP Act)*
***3**=Declared Class 3 pest plant under the *LP Act*
WONS = Weed of National Significance

Appendix B – Survey Effort Mapping



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

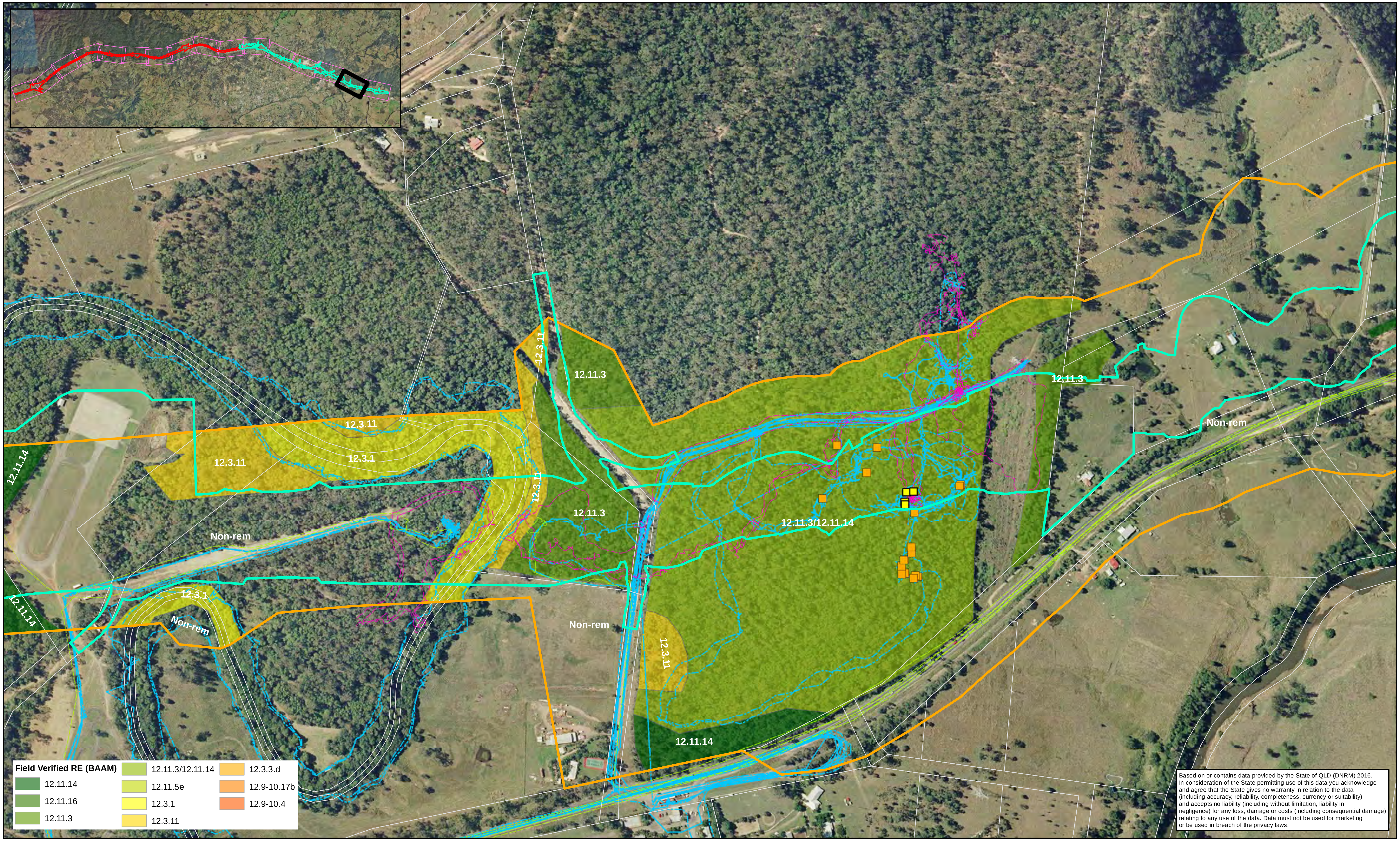
Survey Effort Mapping

Appendix B.1

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

Survey Effort Mapping

Appendix B.2

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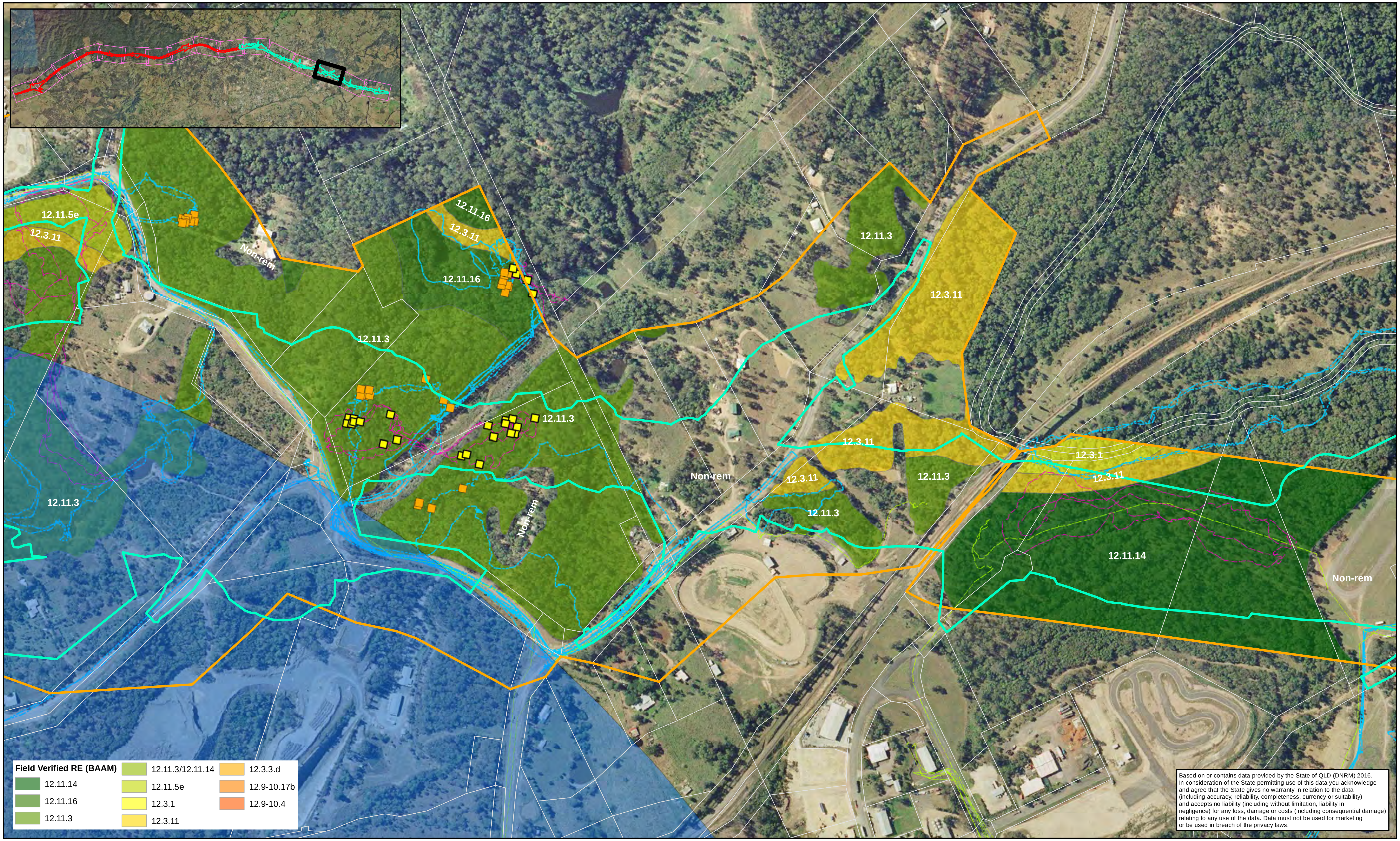
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

Survey Effort Mapping

Appendix B.3

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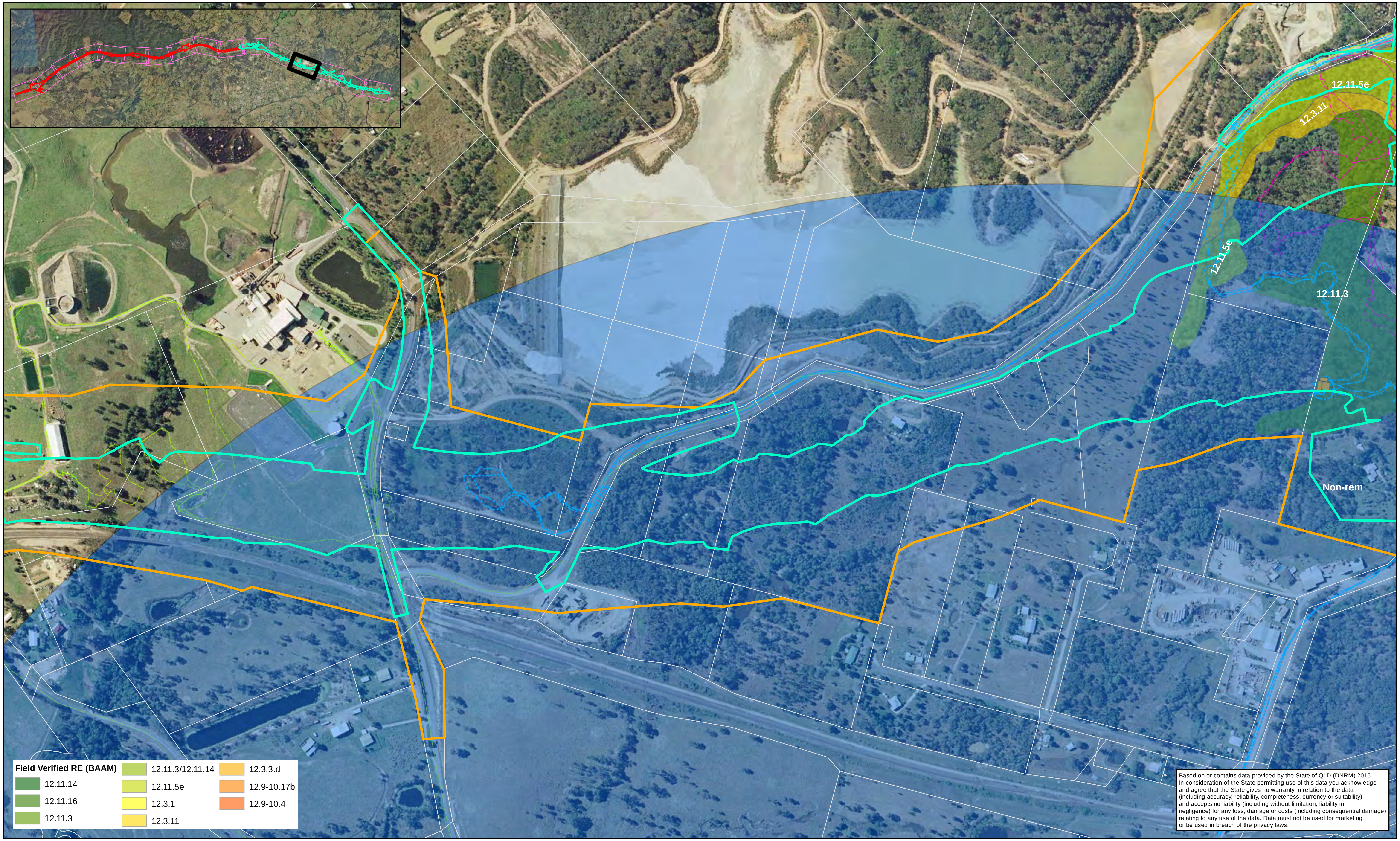
Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

Survey Effort Mapping

Appendix B.4

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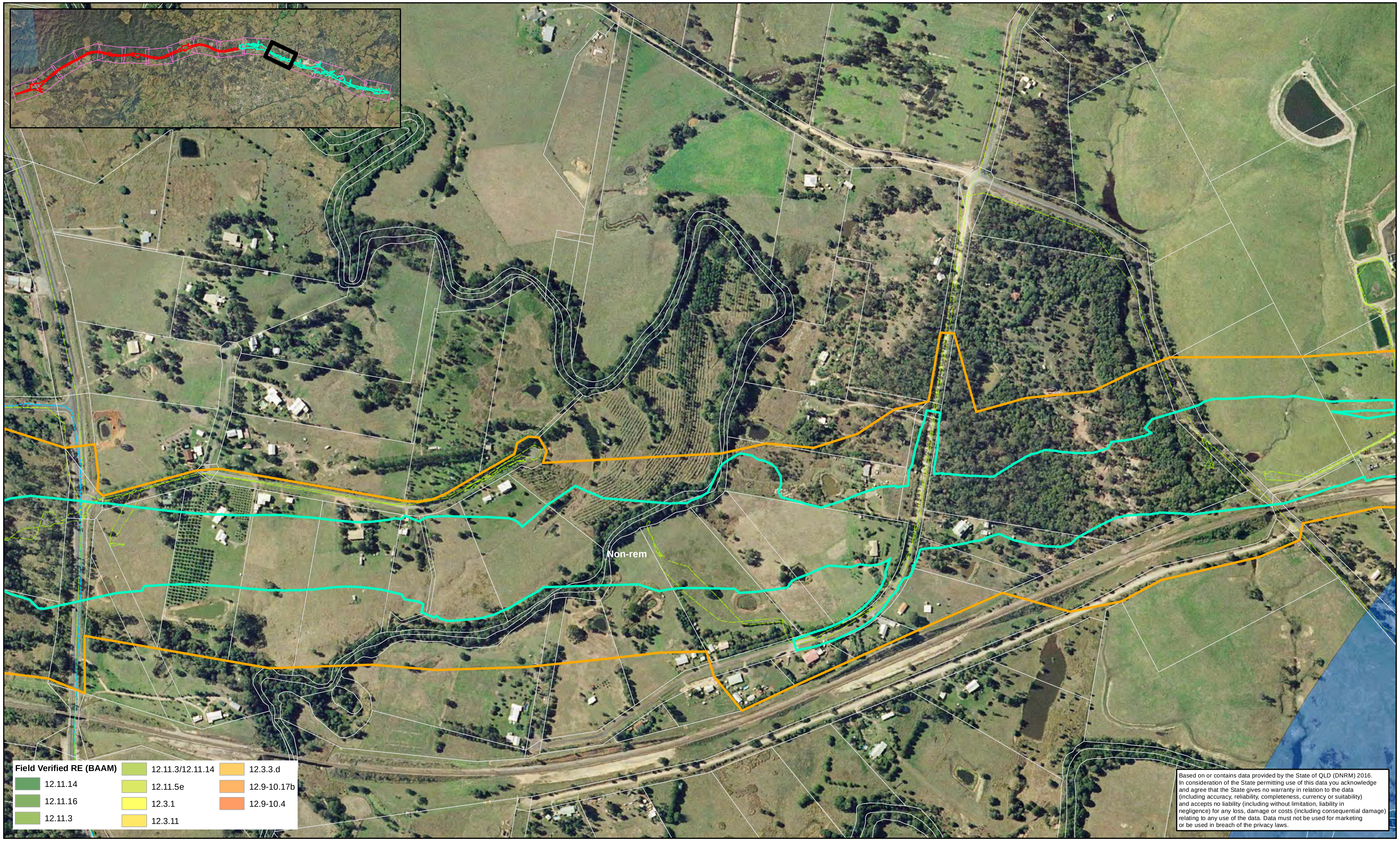
6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

Survey Effort Mapping

Appendix B.5

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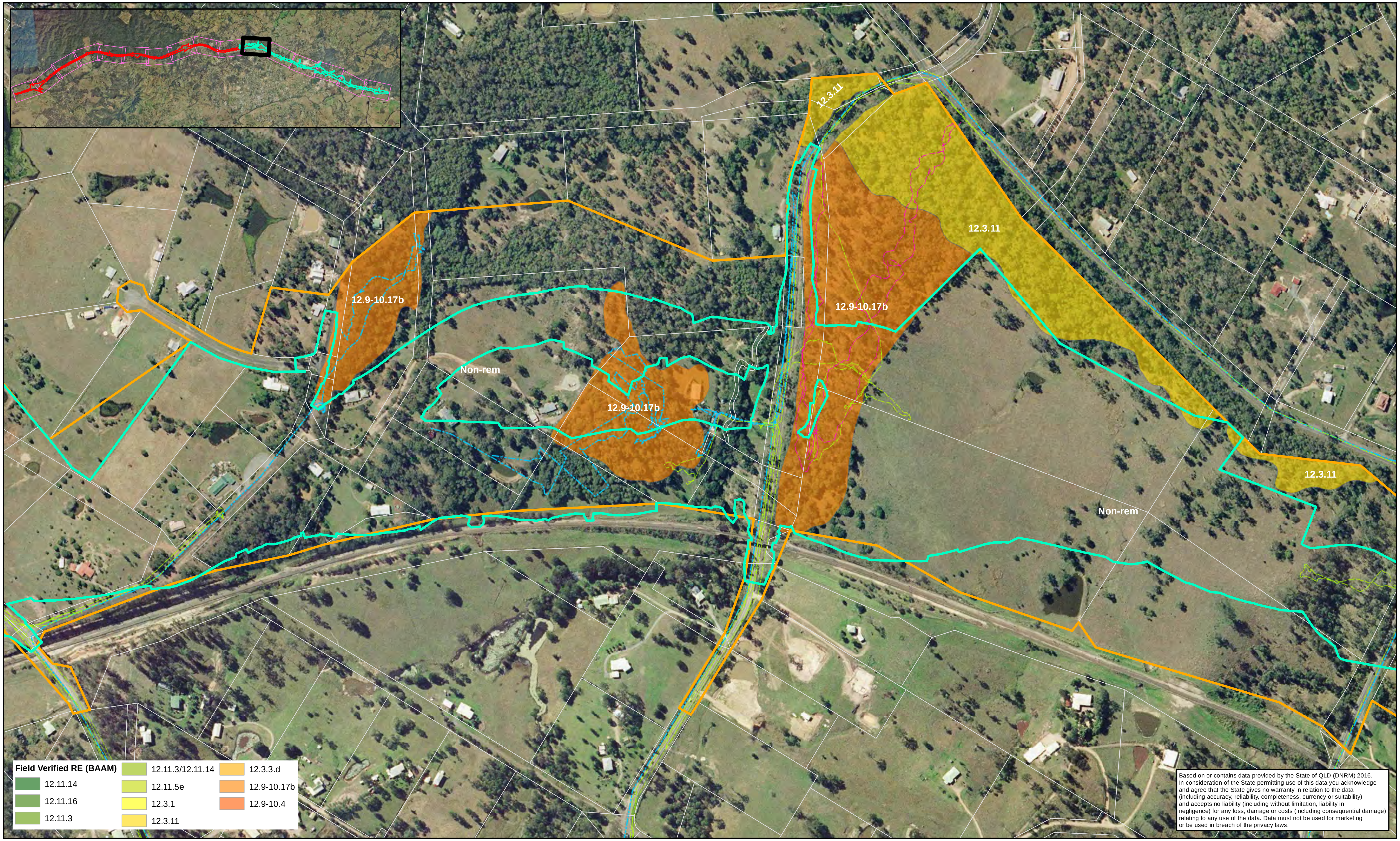
6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
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- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

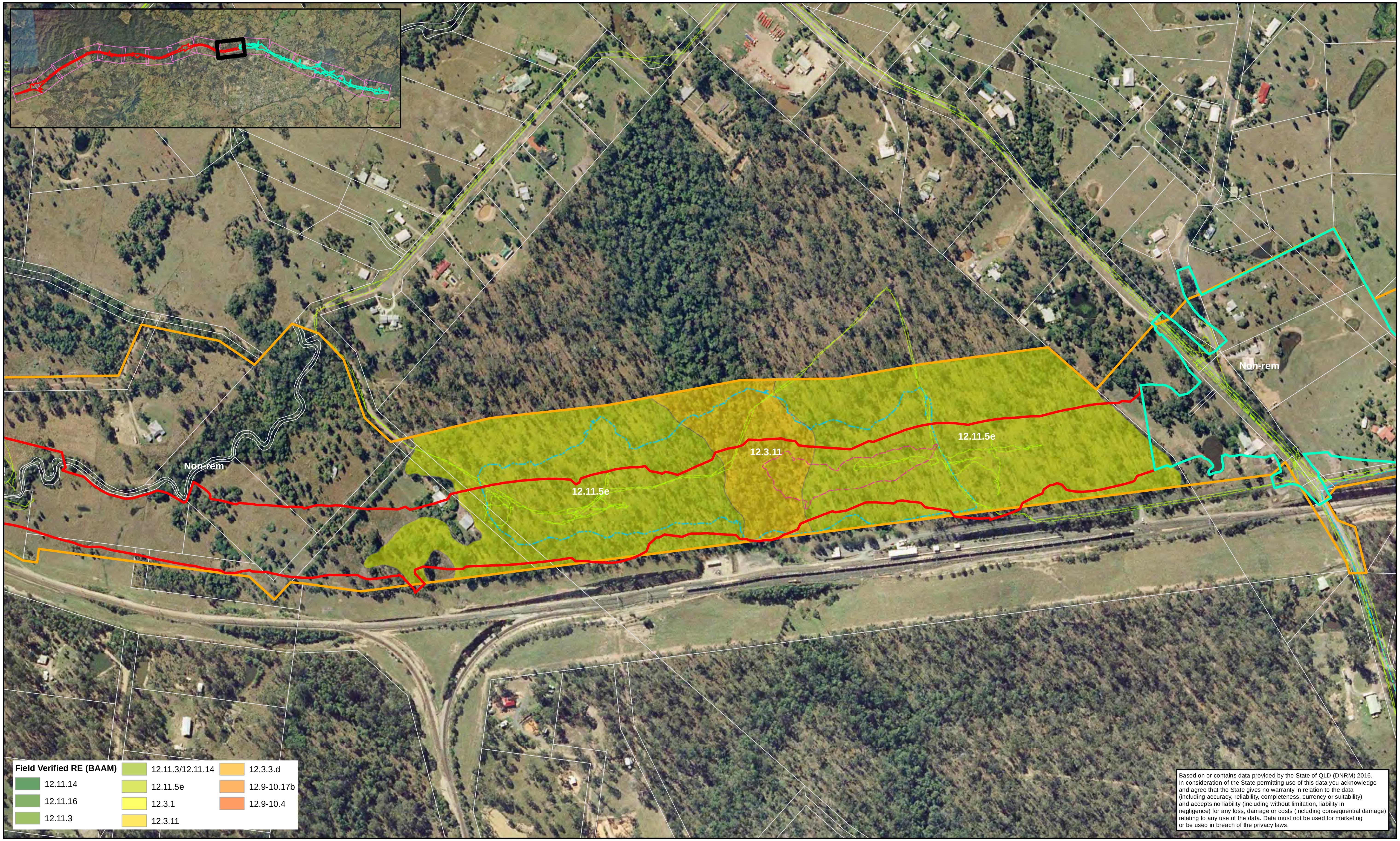
Survey Effort Mapping

Appendix B.6

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

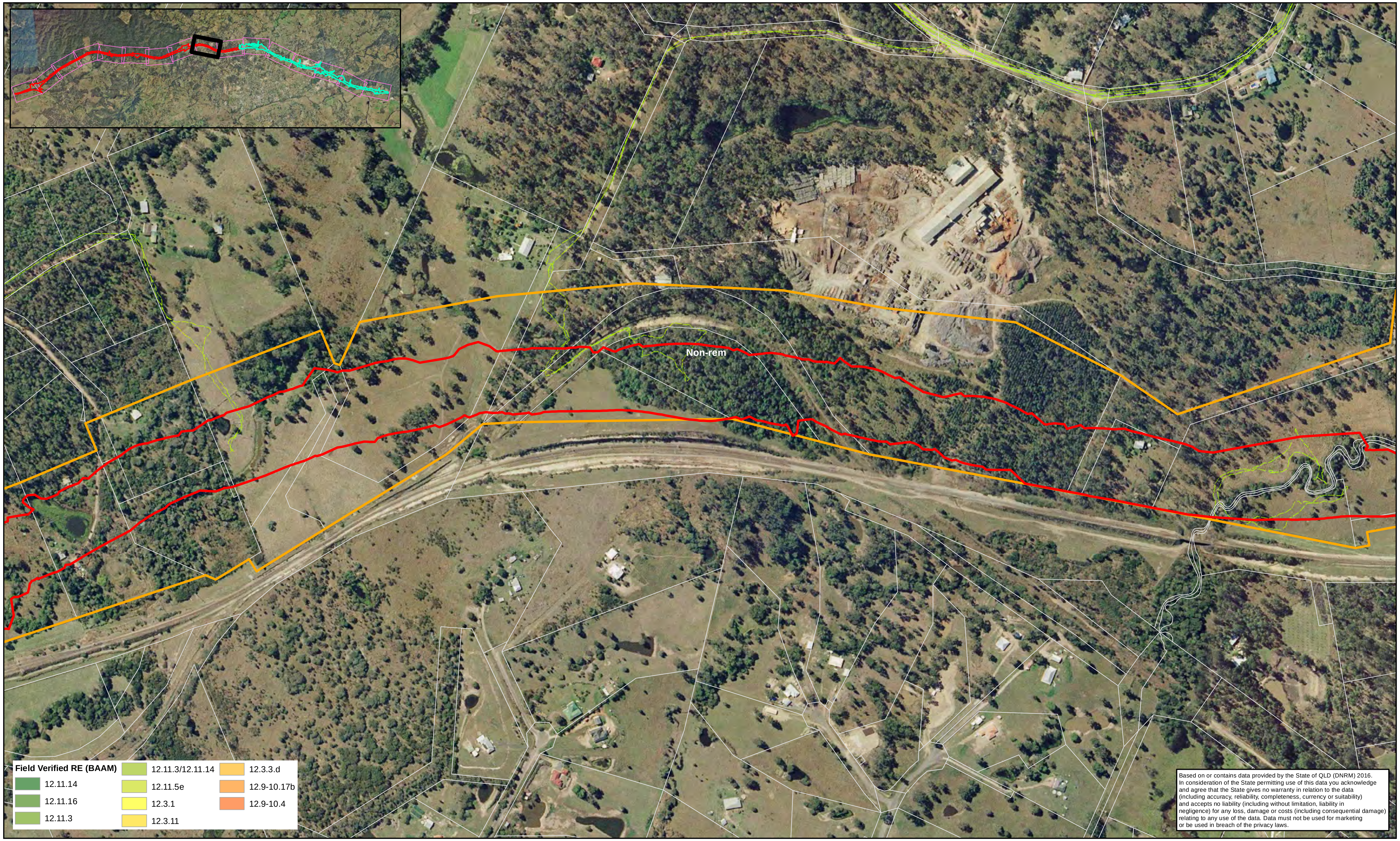
Survey Effort Mapping

Appendix B.7

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

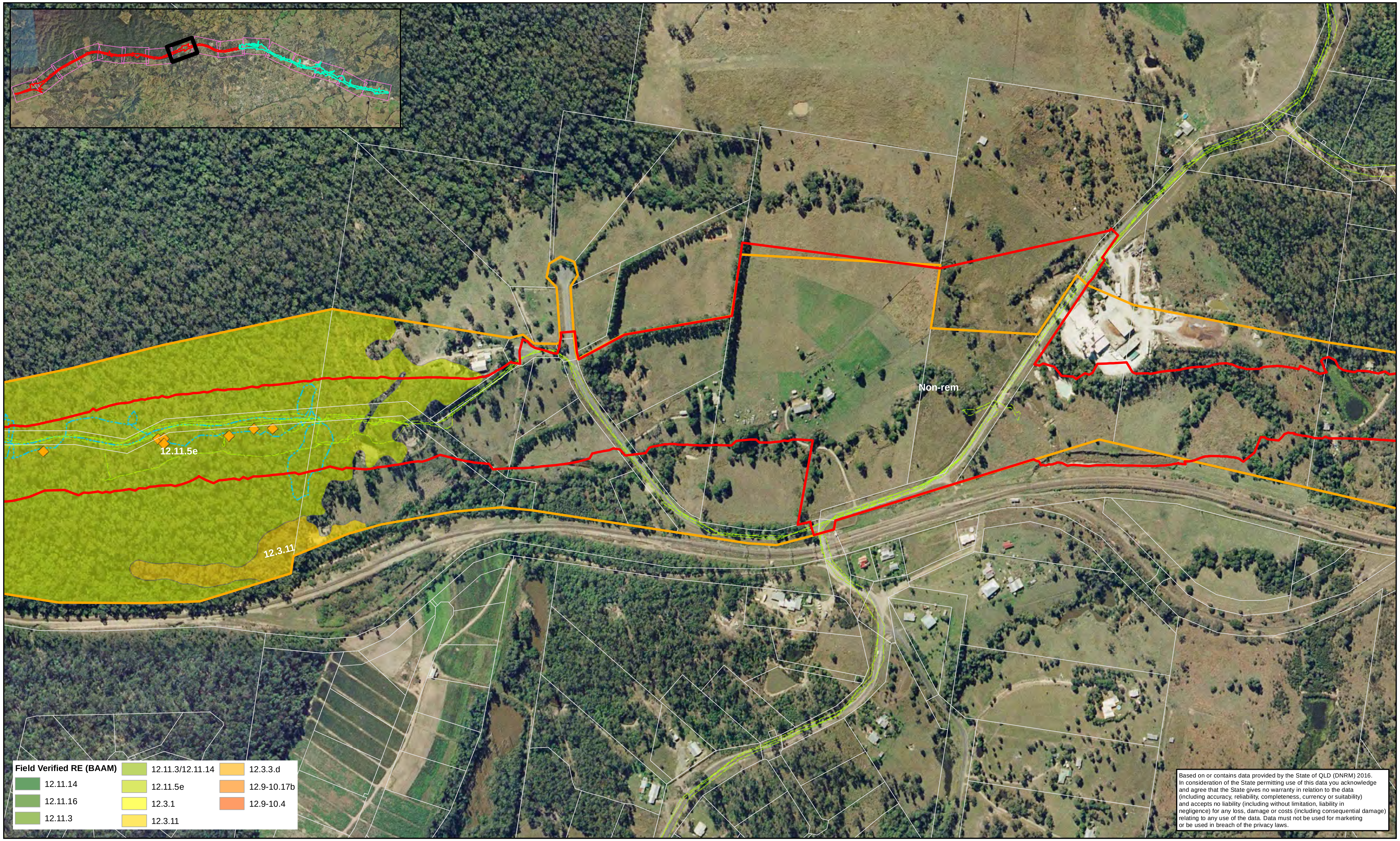
Survey Effort Mapping

Appendix B.8

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

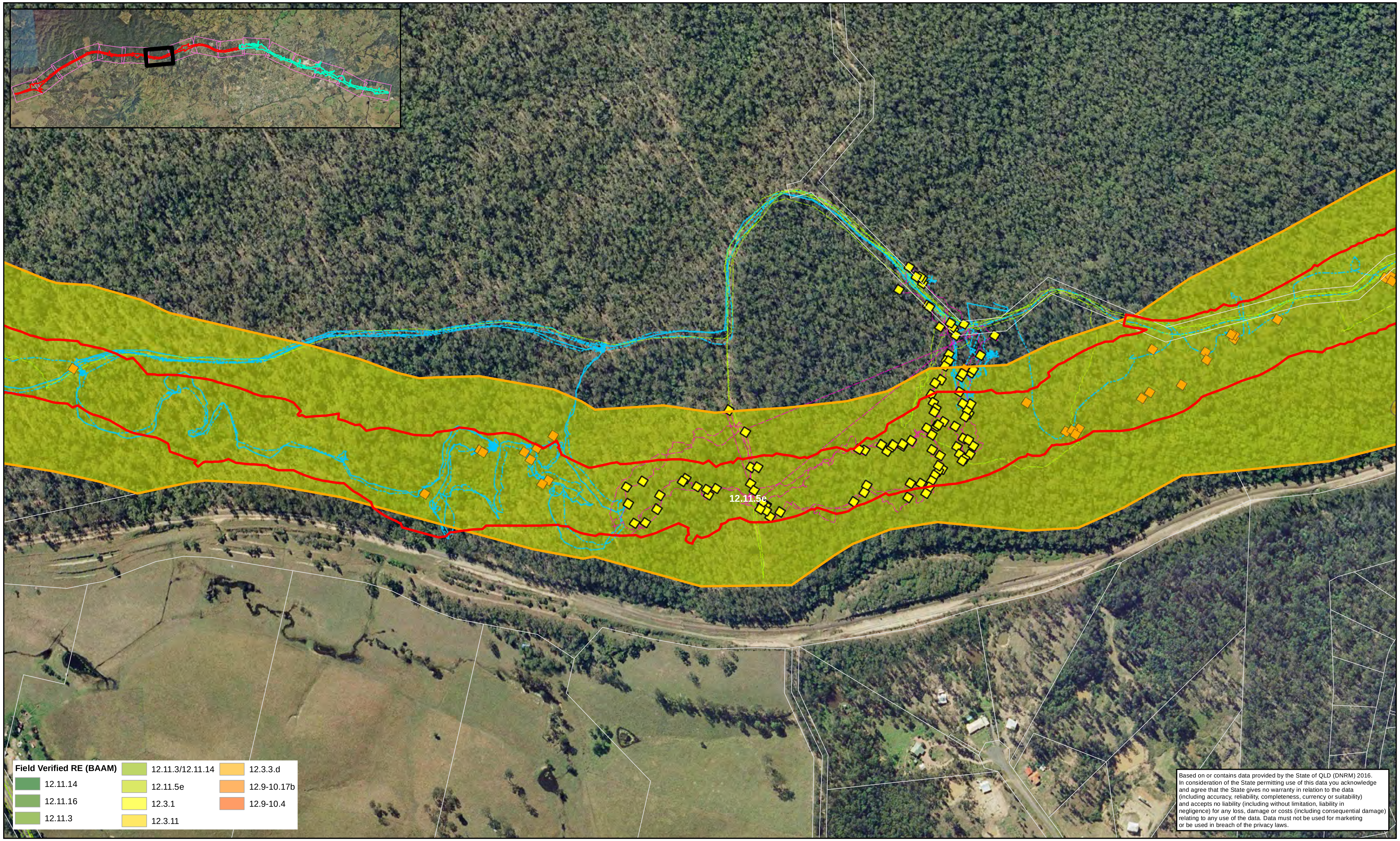
Survey Effort Mapping

Appendix B.9

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

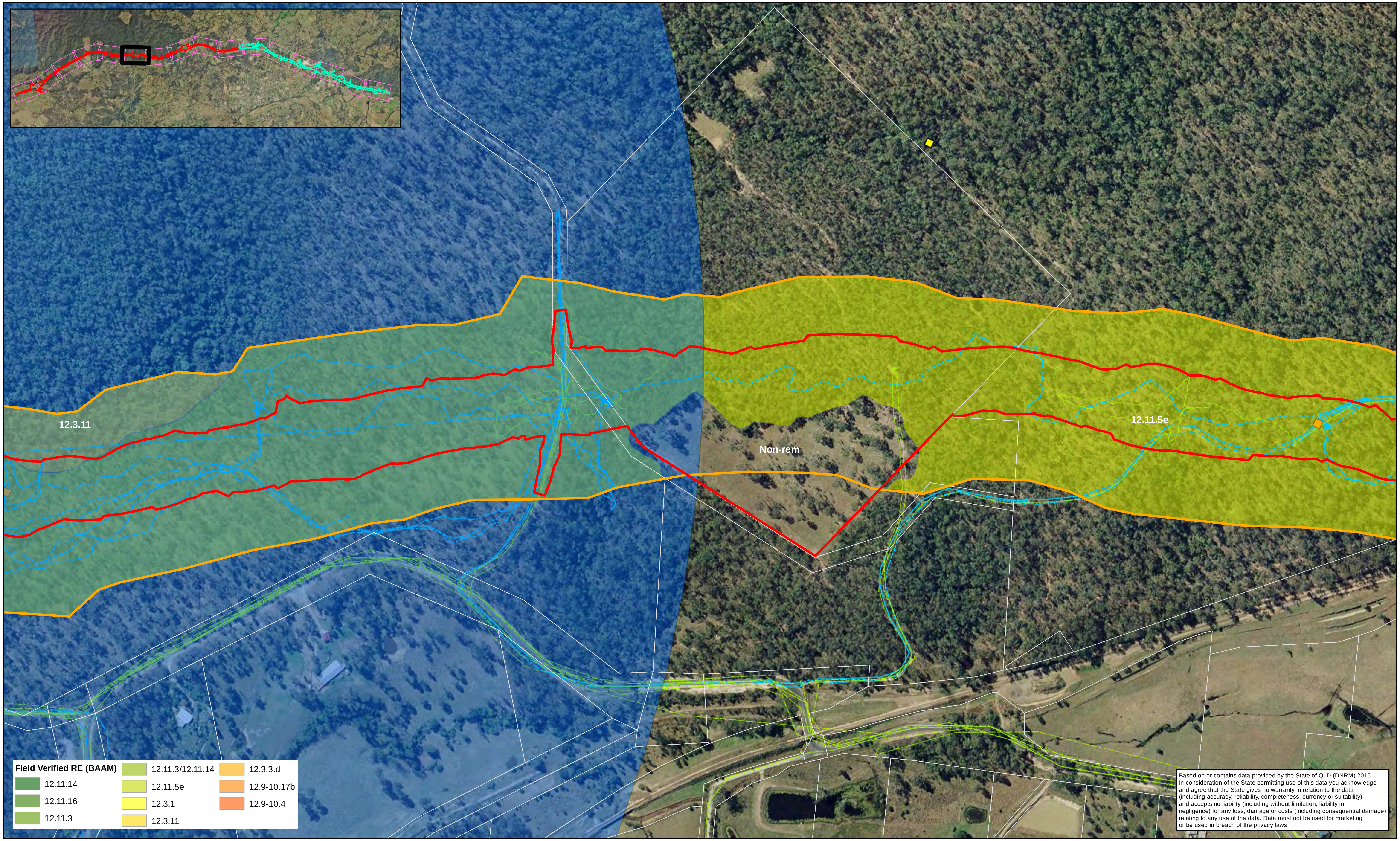
Survey Effort Mapping

Appendix B.10

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

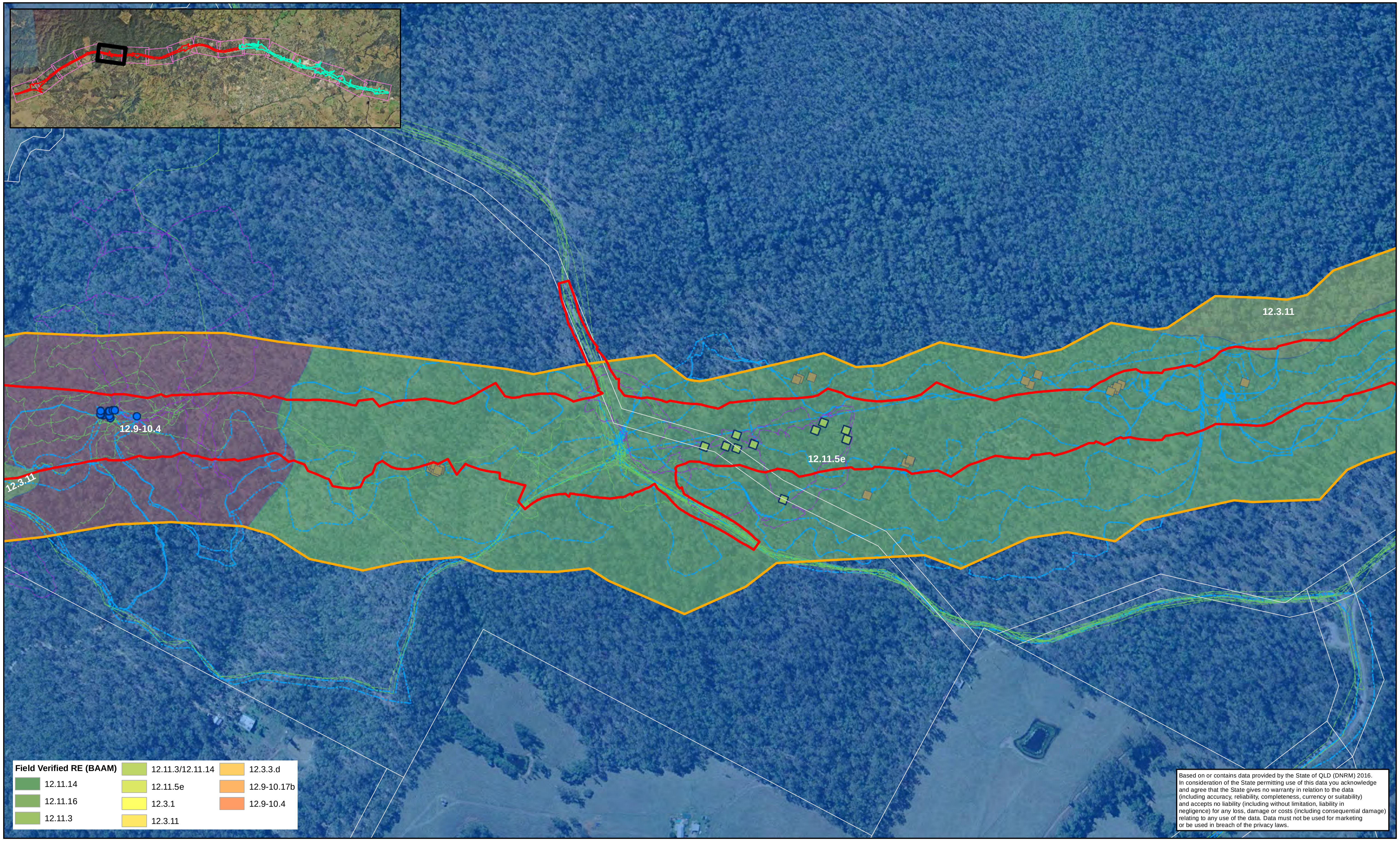
Survey Effort Mapping

Appendix B.11

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

Survey Effort Mapping

Appendix B.12

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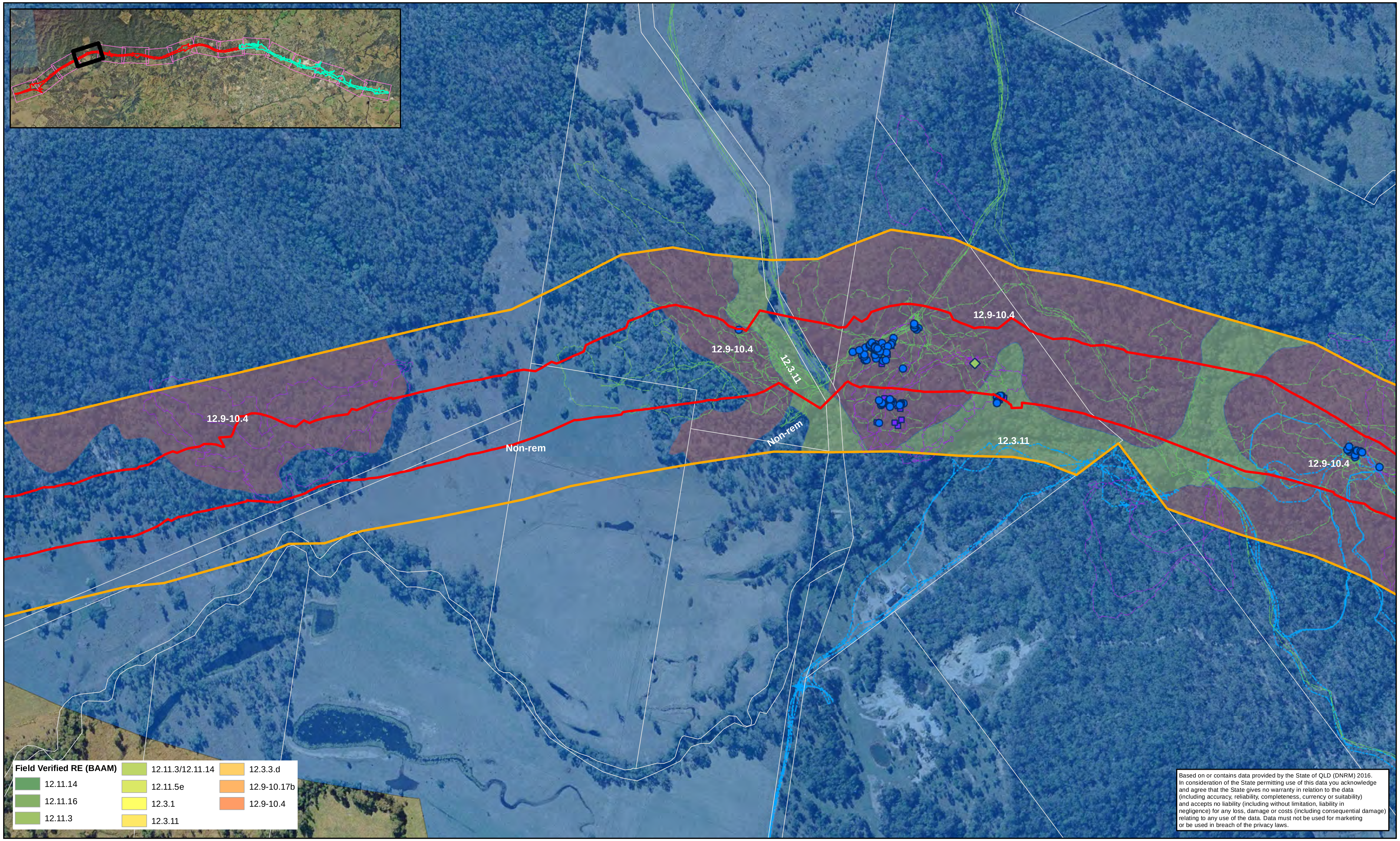
6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

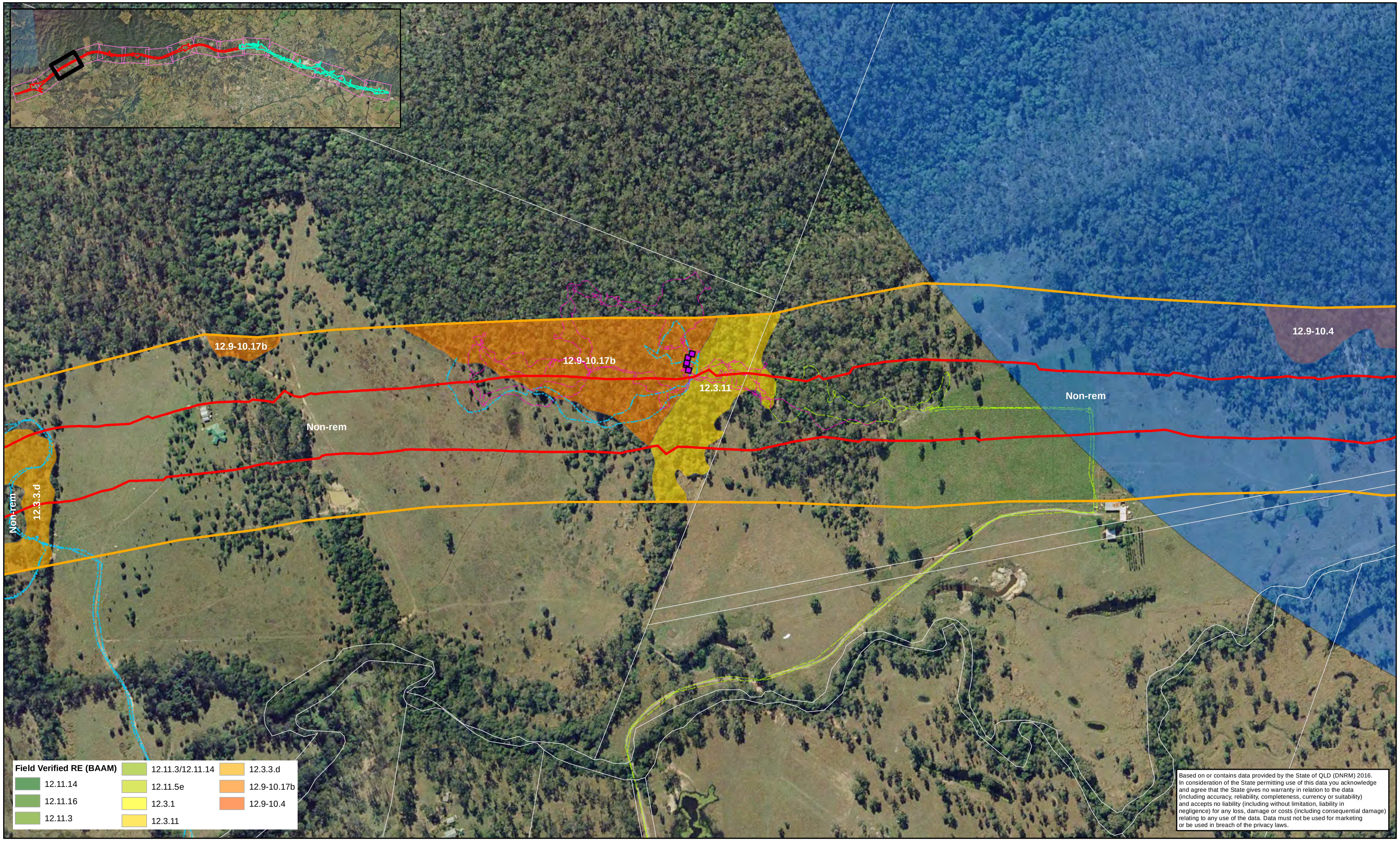
Survey Effort Mapping

Appendix B.13

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

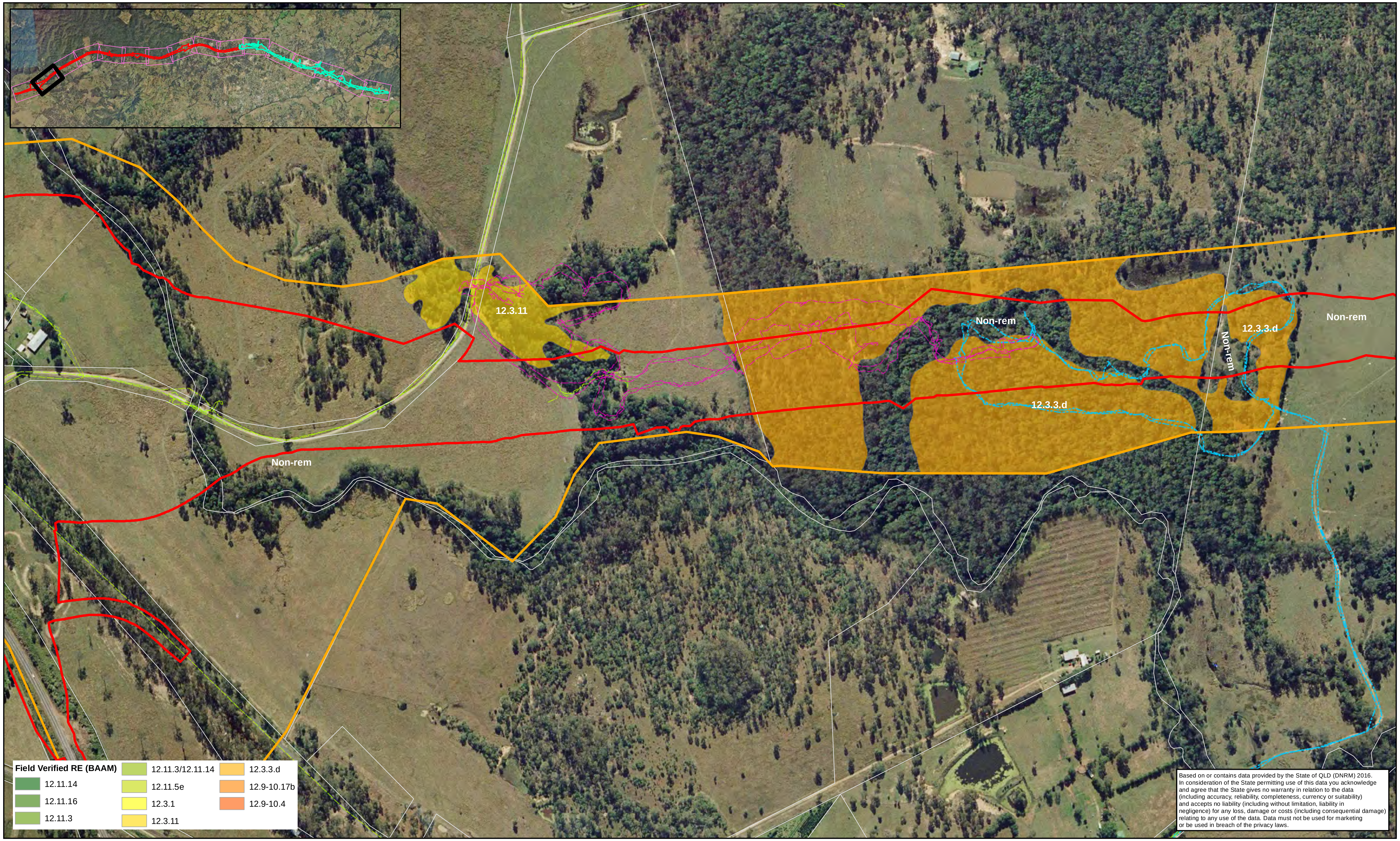
Survey Effort Mapping

Appendix B.14

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3027_AppendixB_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

Survey Effort Mapping

Appendix B.15

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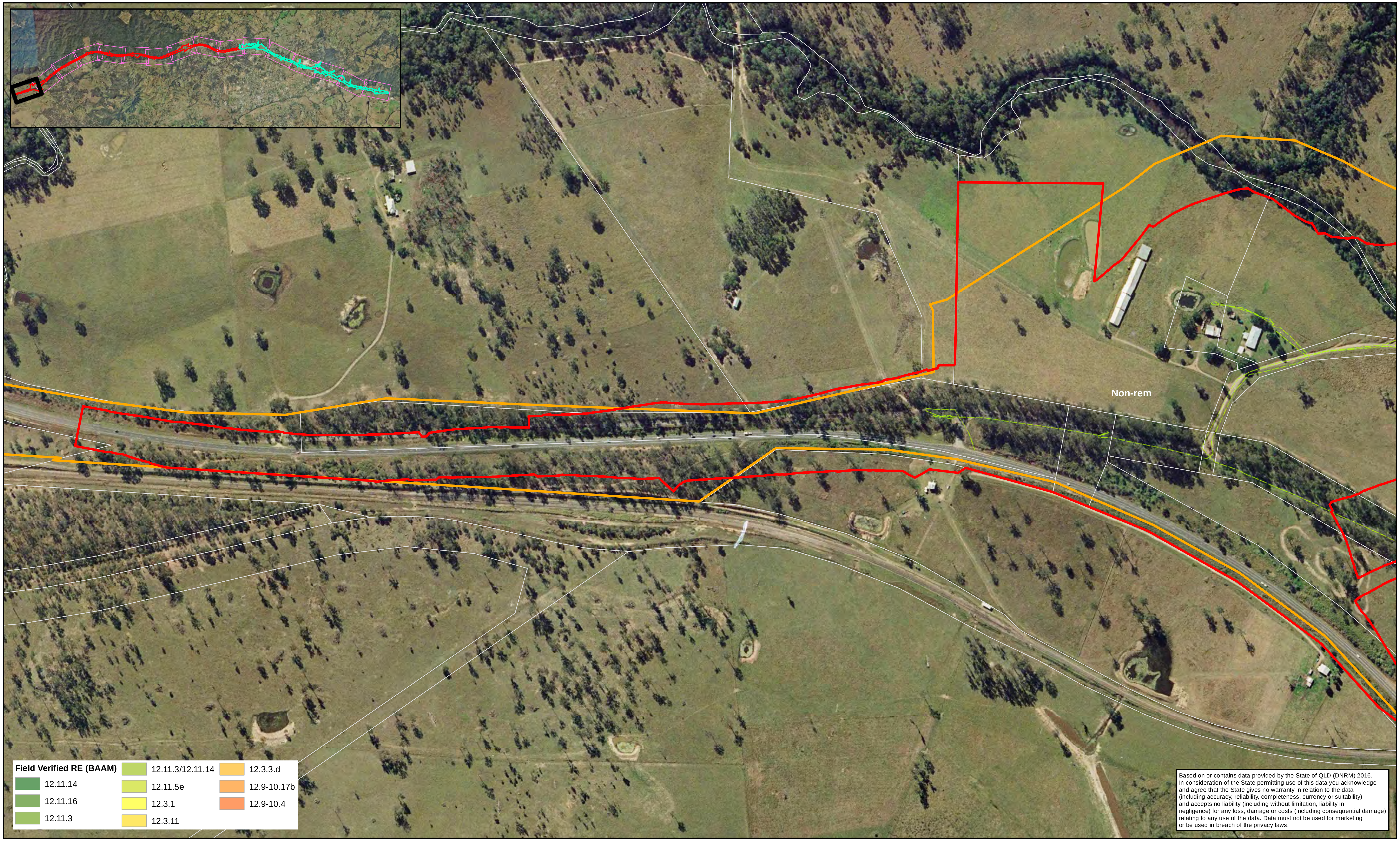
6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area
- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Flora High Risk Area
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)
- BAAM 2015 Survey Tracks
- BAAM 2016 Survey Tracks
- GHD 2016 Survey Tracks

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	30 Nov 2016

Survey Effort Mapping

Appendix B.16

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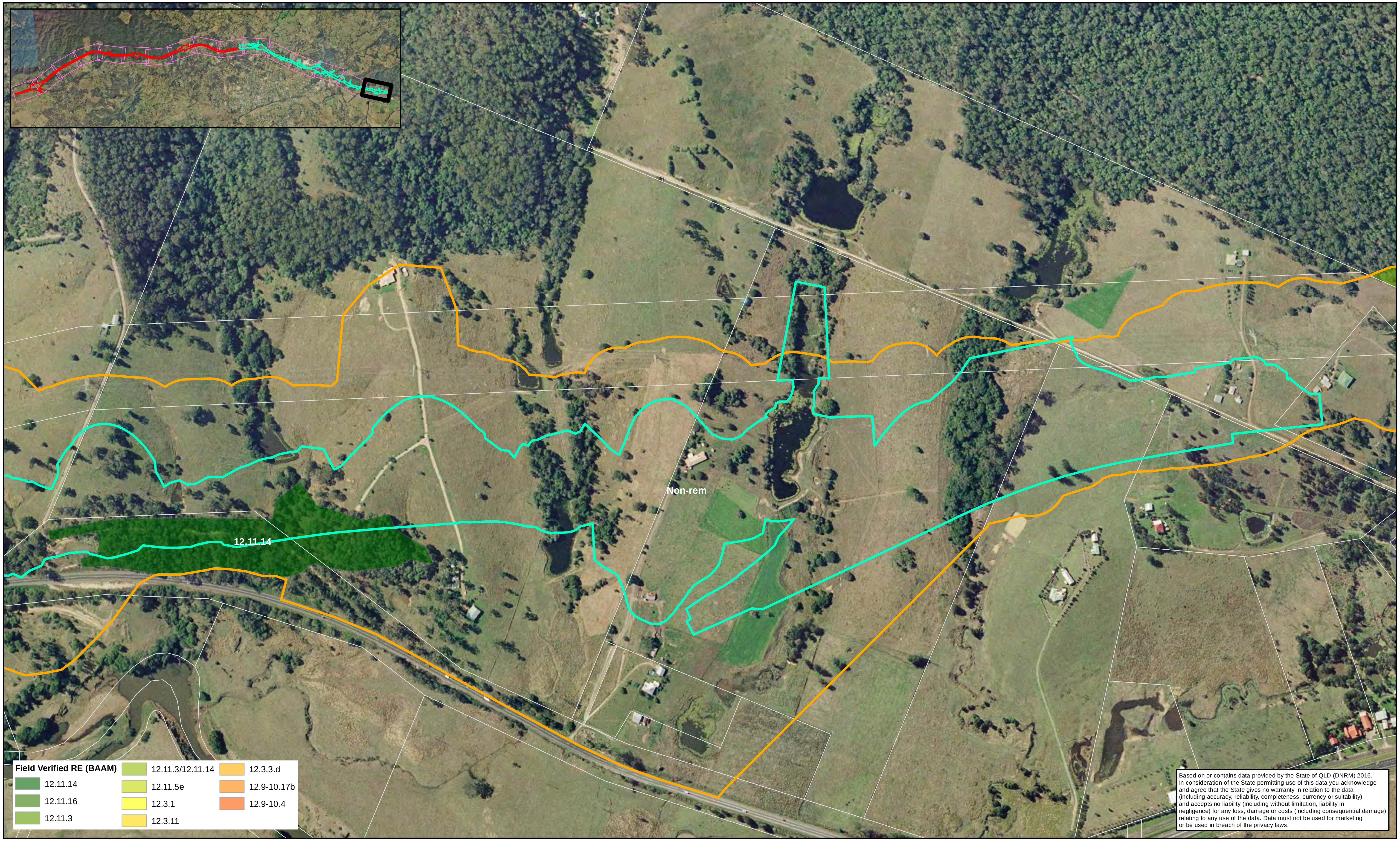
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Survey Area, Imagery (2014); DNRM: Cadastre (2015); DEHP: Flora High Risk Area (2014); GHD: Flora Survey Data (2016). GHD: Project Area (November 2016). Created by: SC

Appendix C – Extent of Occurrence Mapping



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

GHD

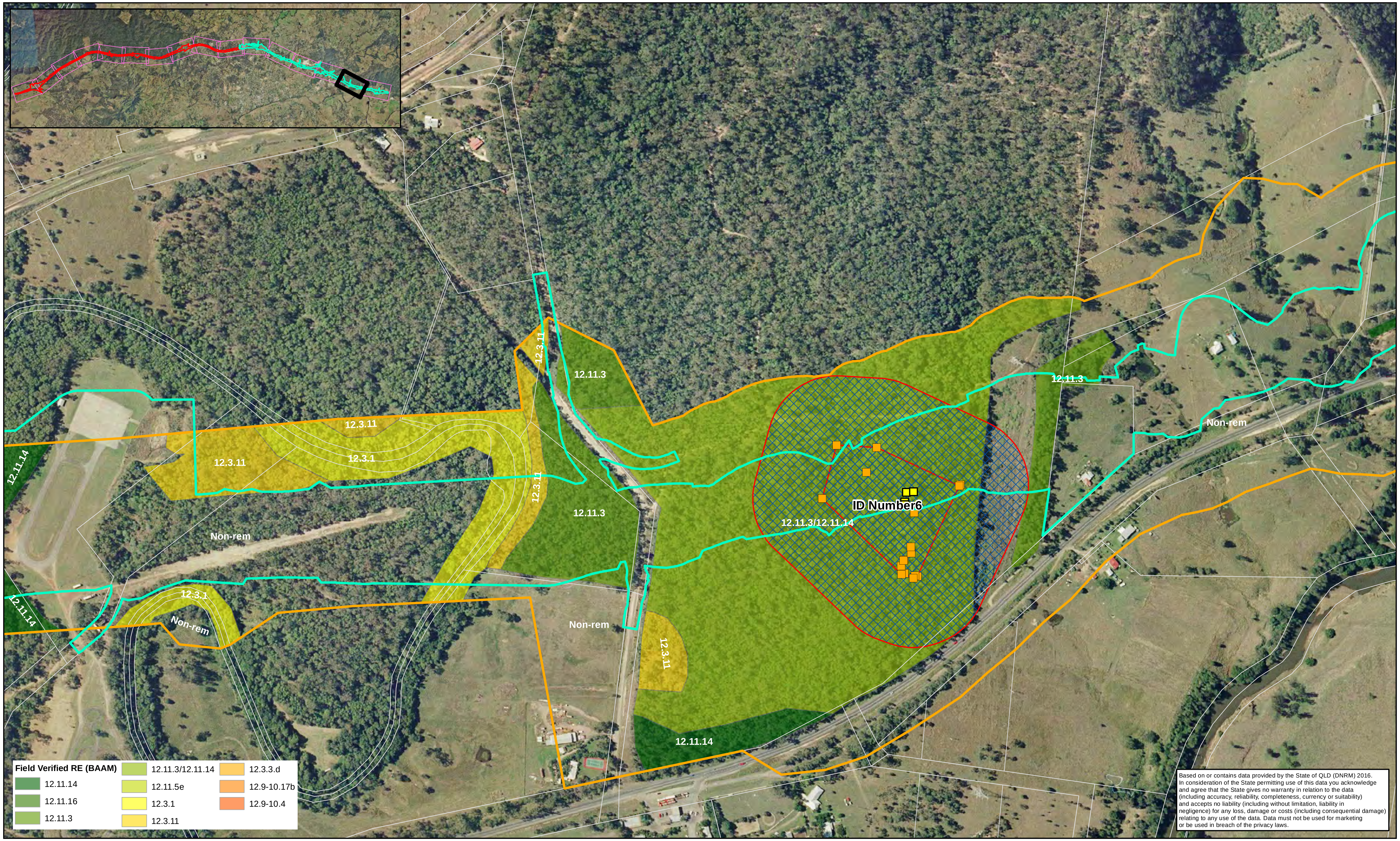
Extent of Occurence Mapping

Appendix C.1

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area
- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence
- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.2

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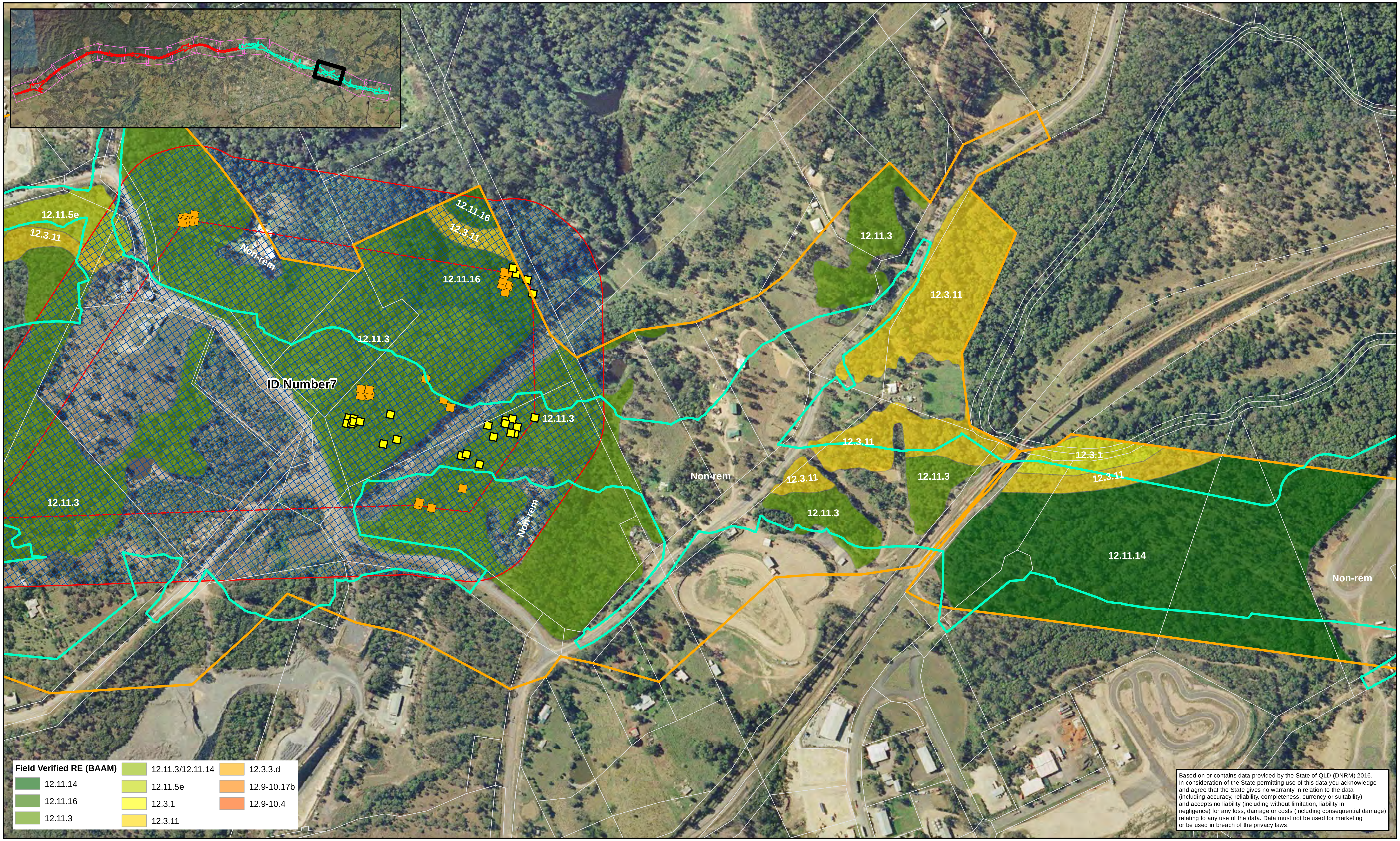
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

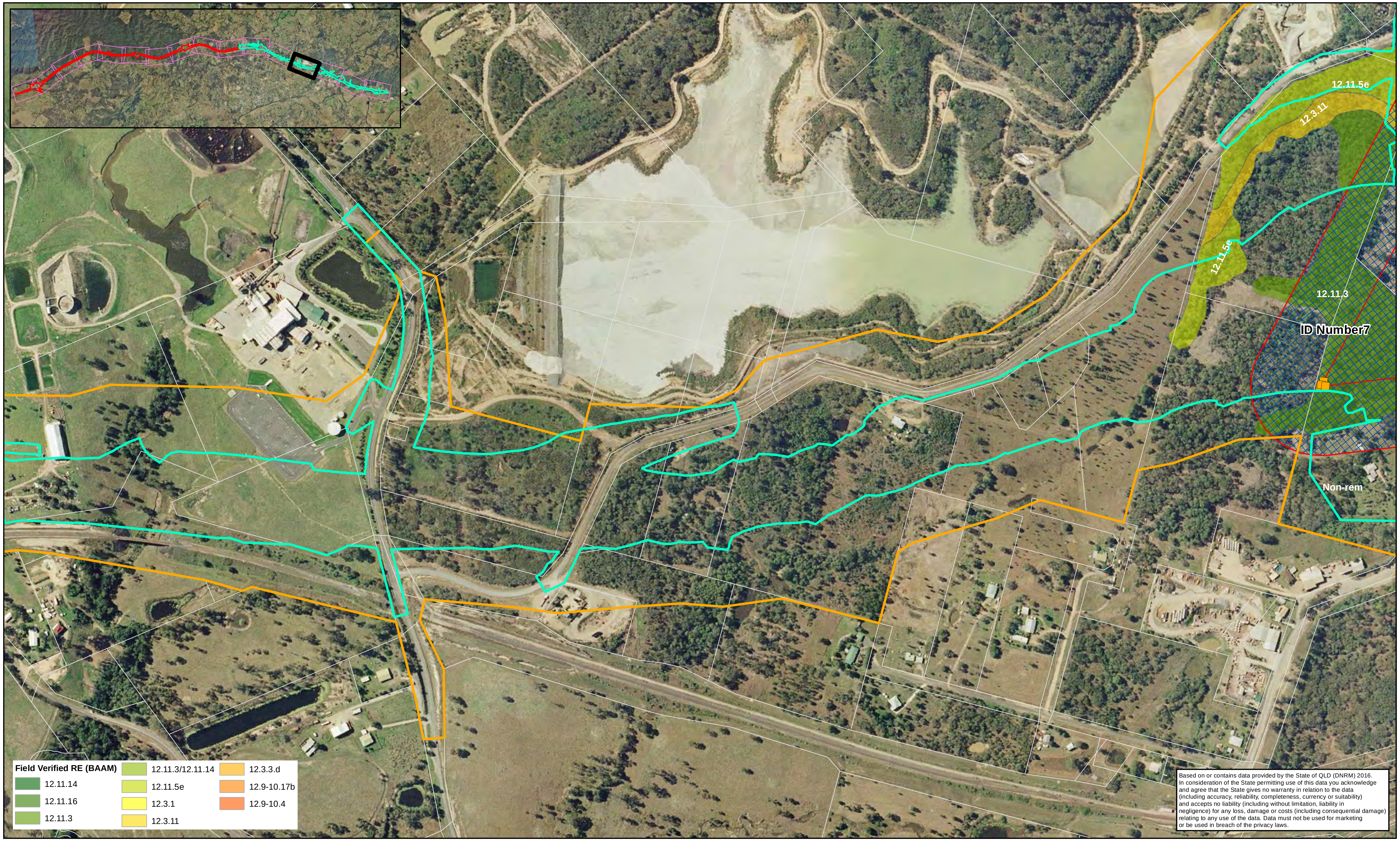
Extent of Occurence Mapping

Appendix C.3

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.4

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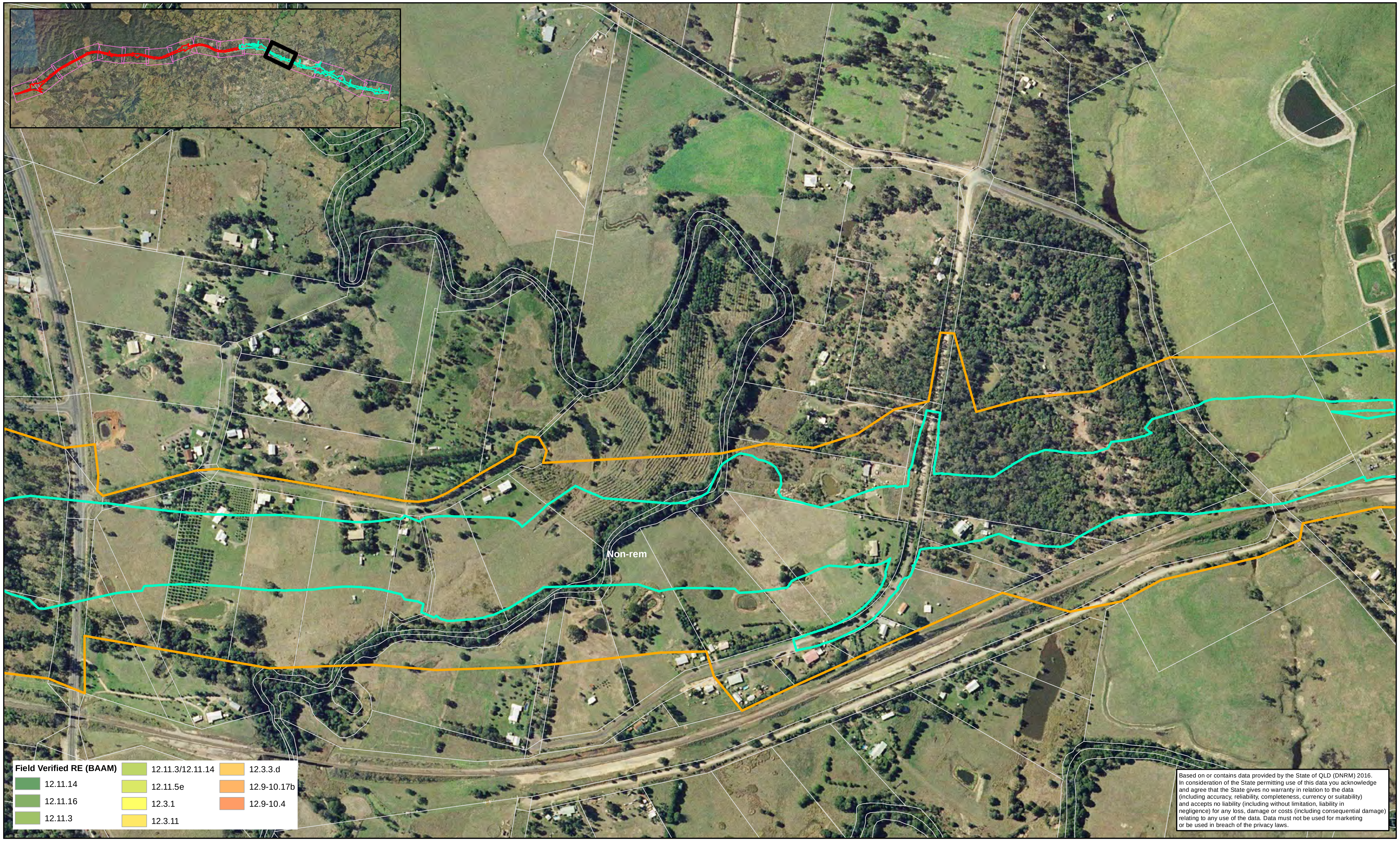
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.5

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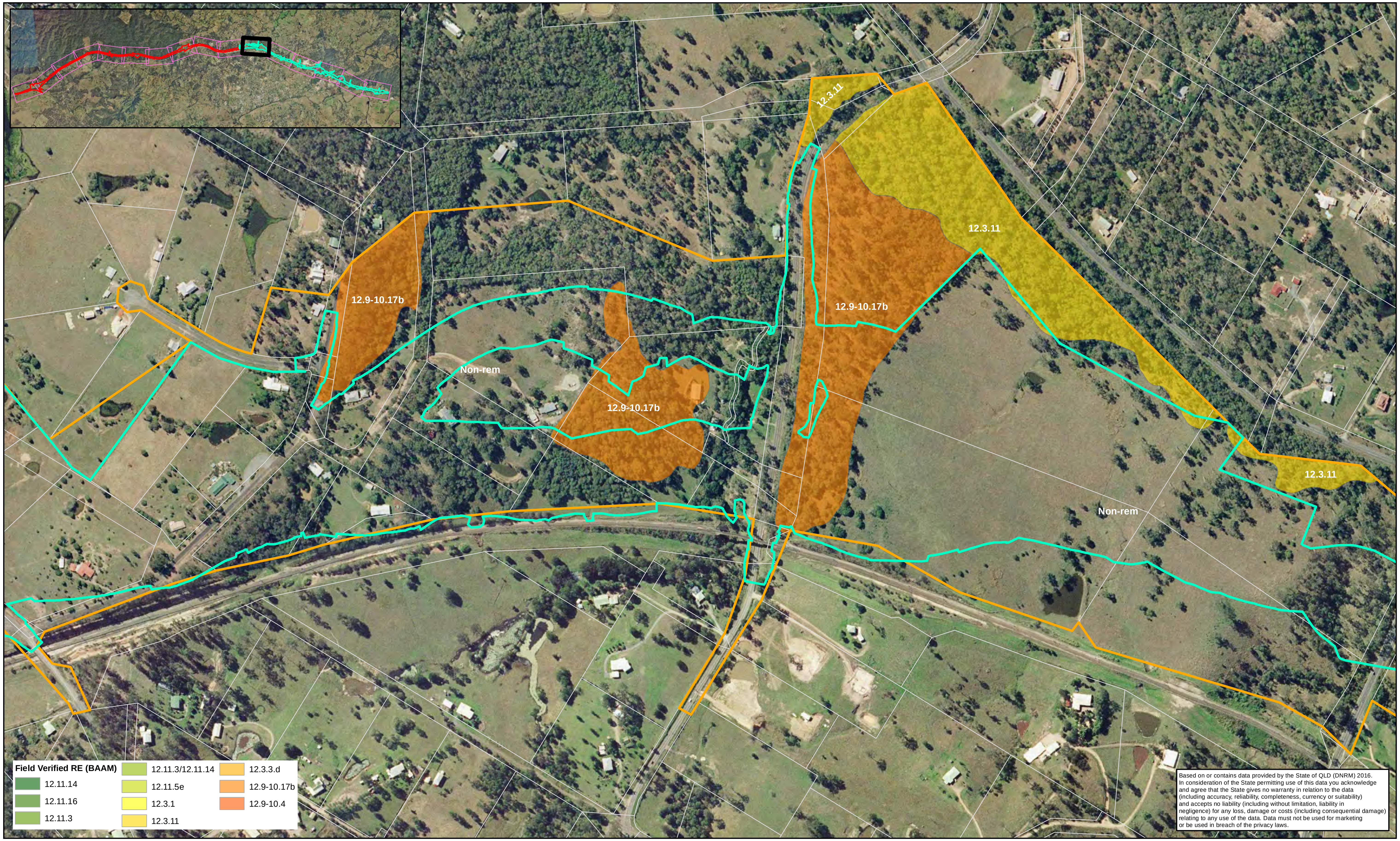
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

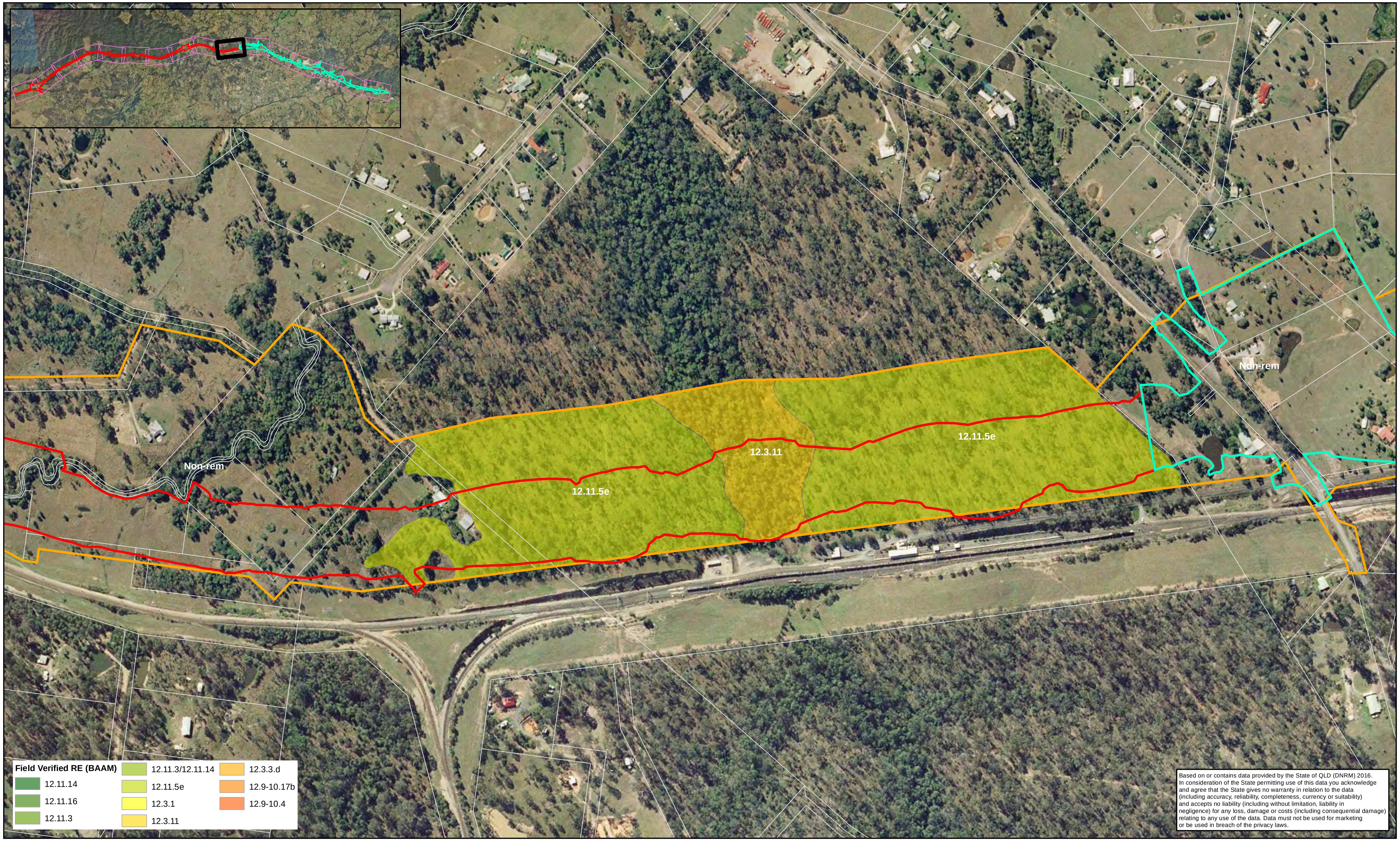
Extent of Occurence Mapping

Appendix C.6

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

0 25 50 100 150 200 250

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

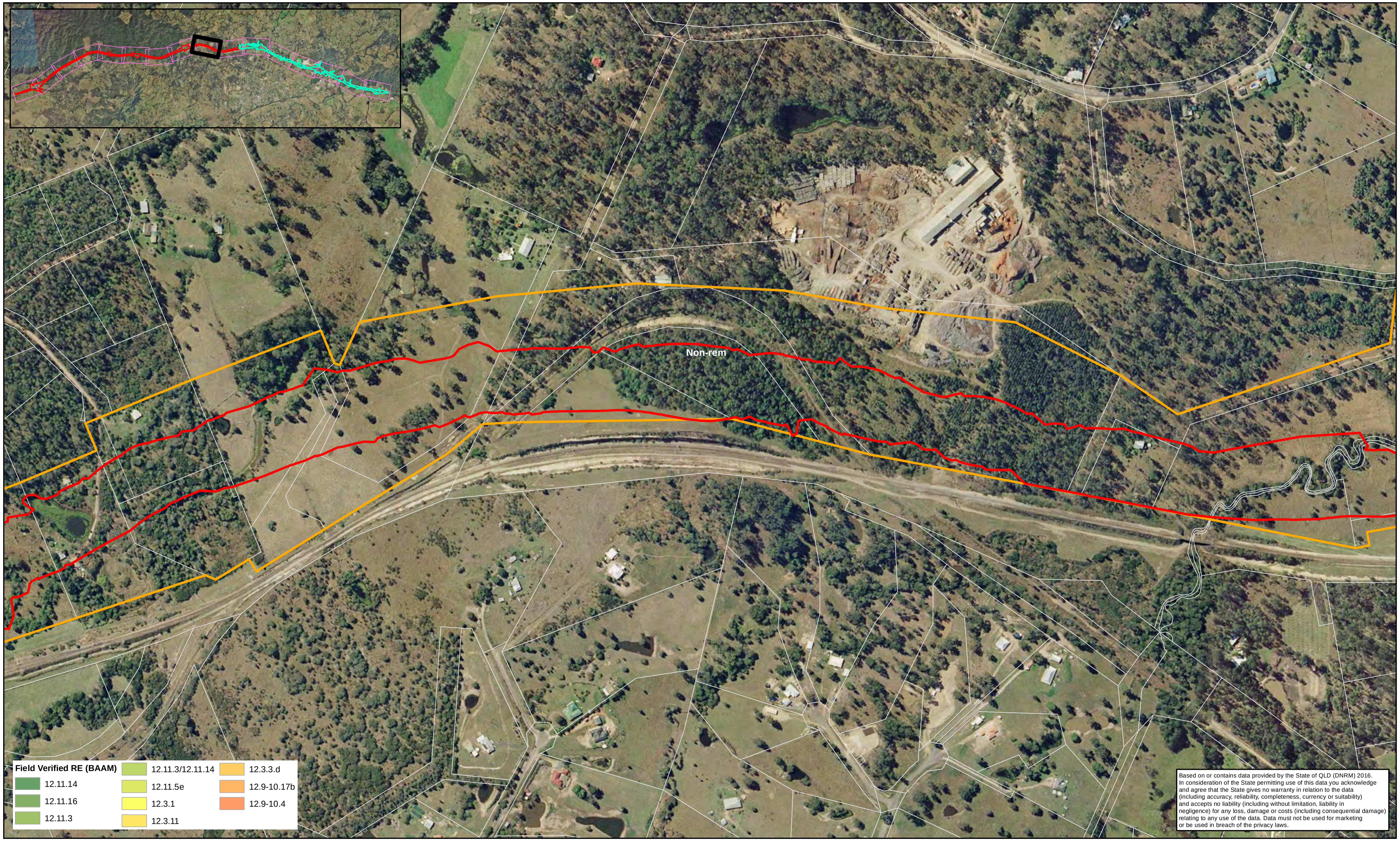
Extent of Occurence Mapping

Appendix C.7

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.8

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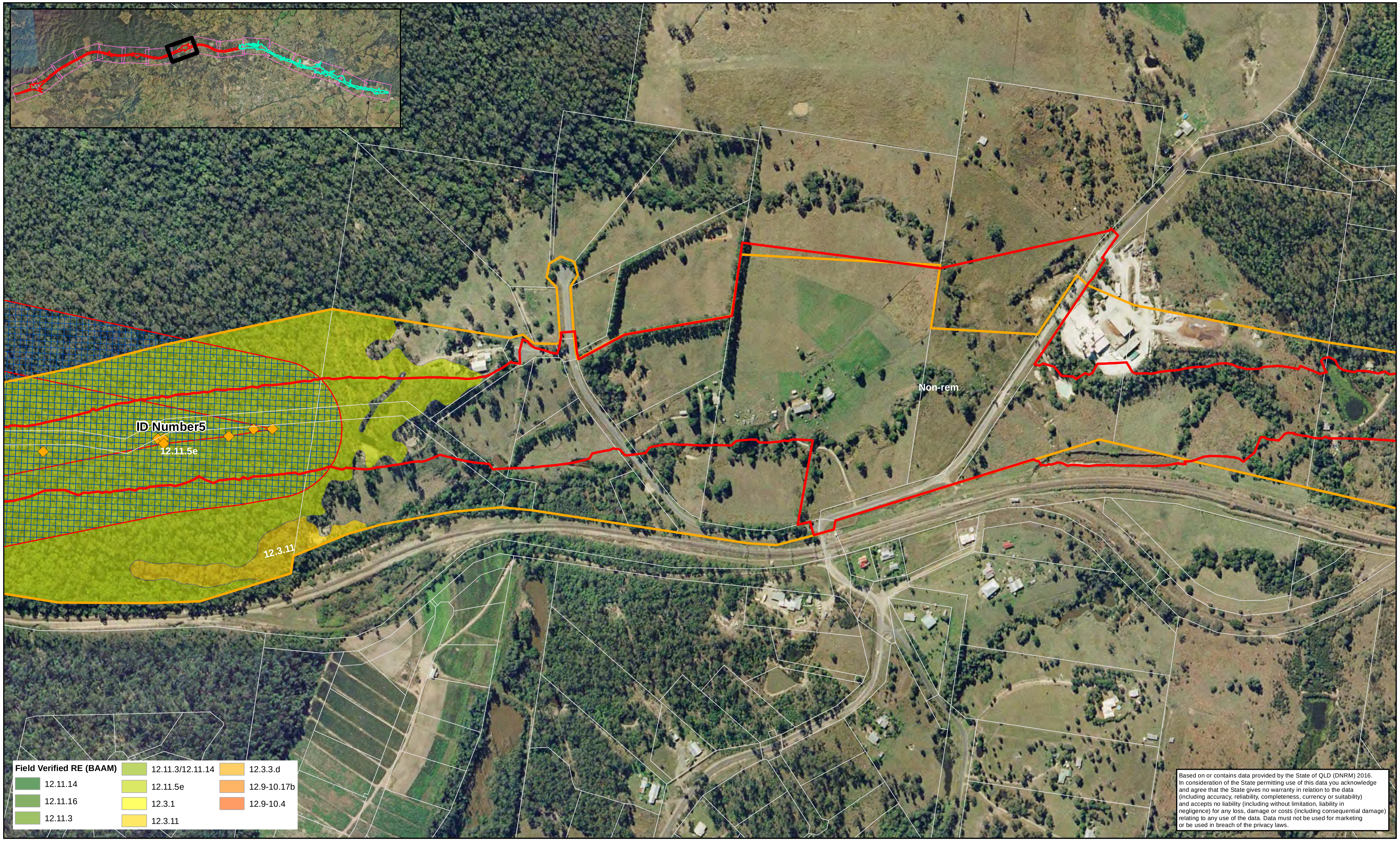
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.9

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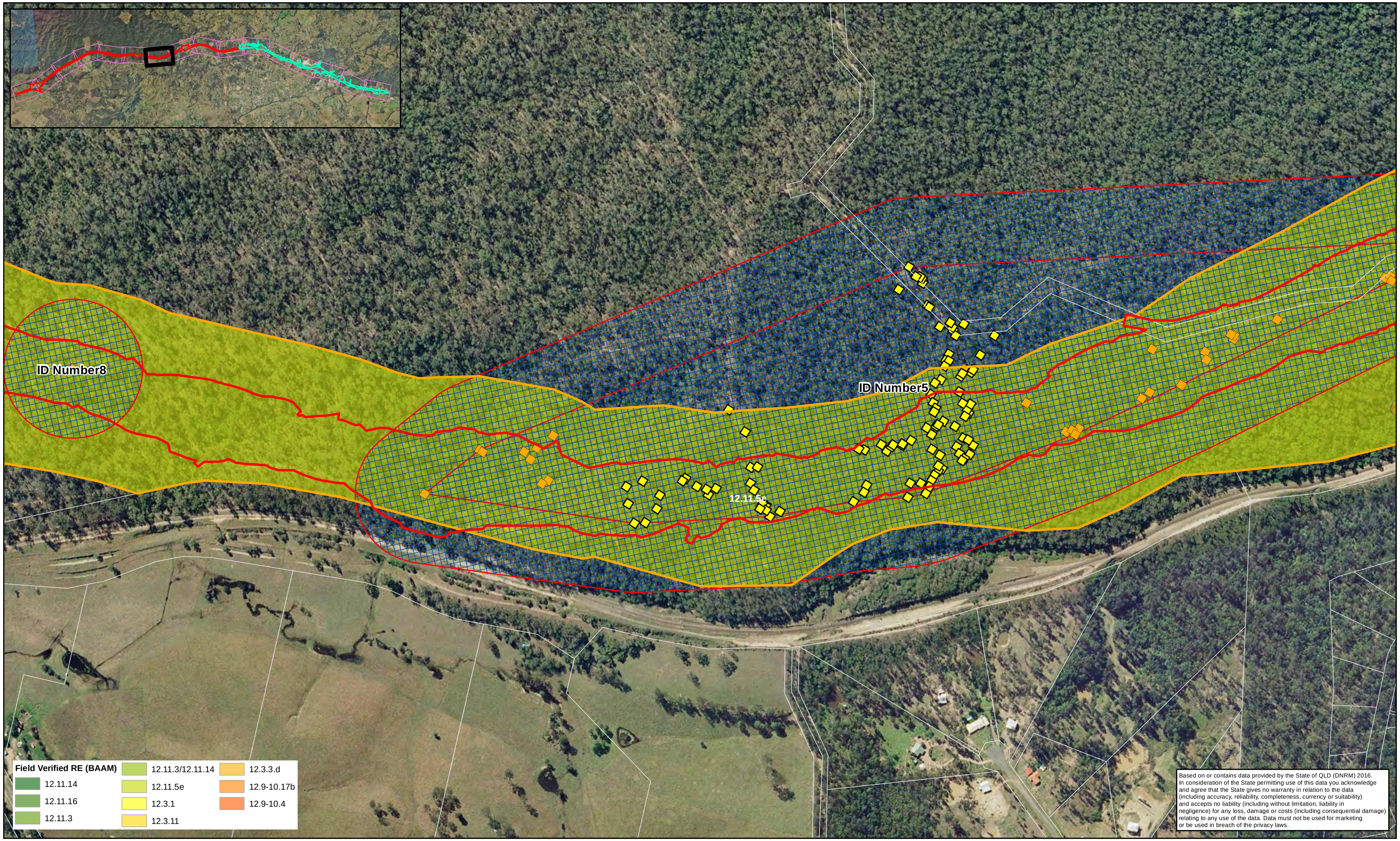
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

Contract 1
Contract 2
Survey Area

Cadastral Boundary
Macrozamia P2 Survey (BAAM 2015)
Macrozamia P3 Survey (BAAM 2015)
Marsdenia coronata (BAAM, 2016)

Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

Macrozamia pauli-guilielmi
Marsdenia coronata

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

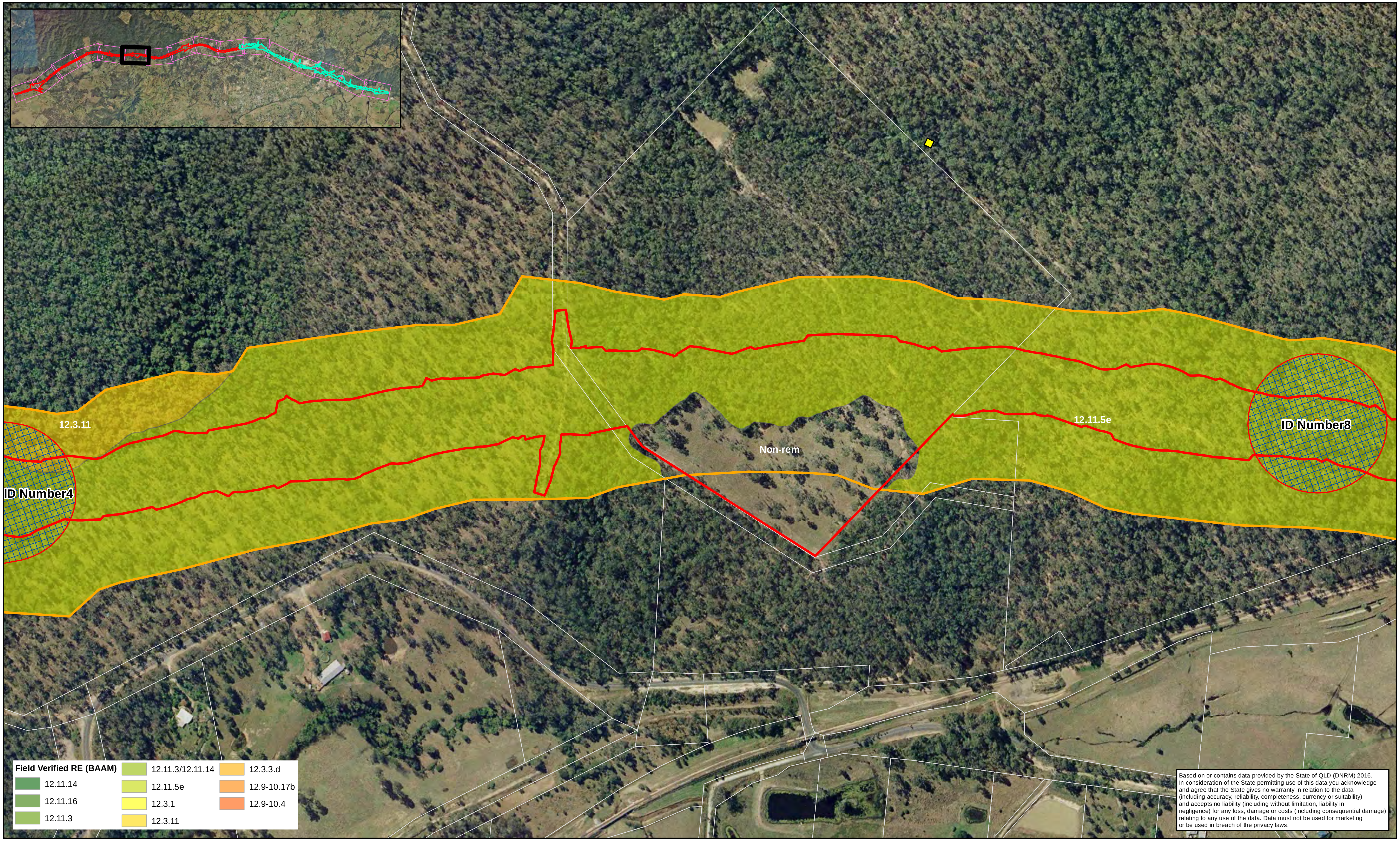
Extent of Occurence Mapping

Appendix C.10

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

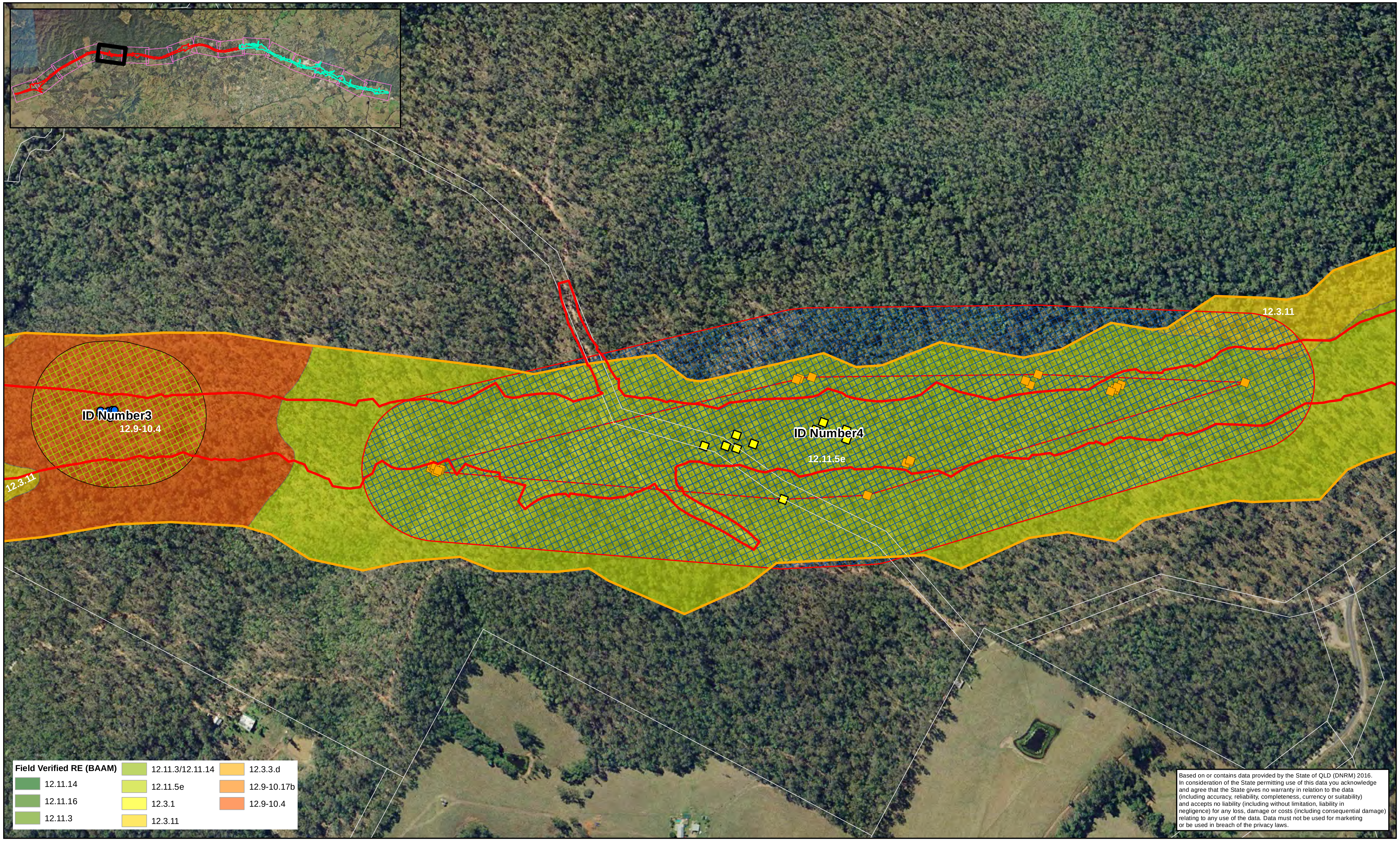
Extent of Occurence Mapping

Appendix C.11

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area
- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence
- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.12

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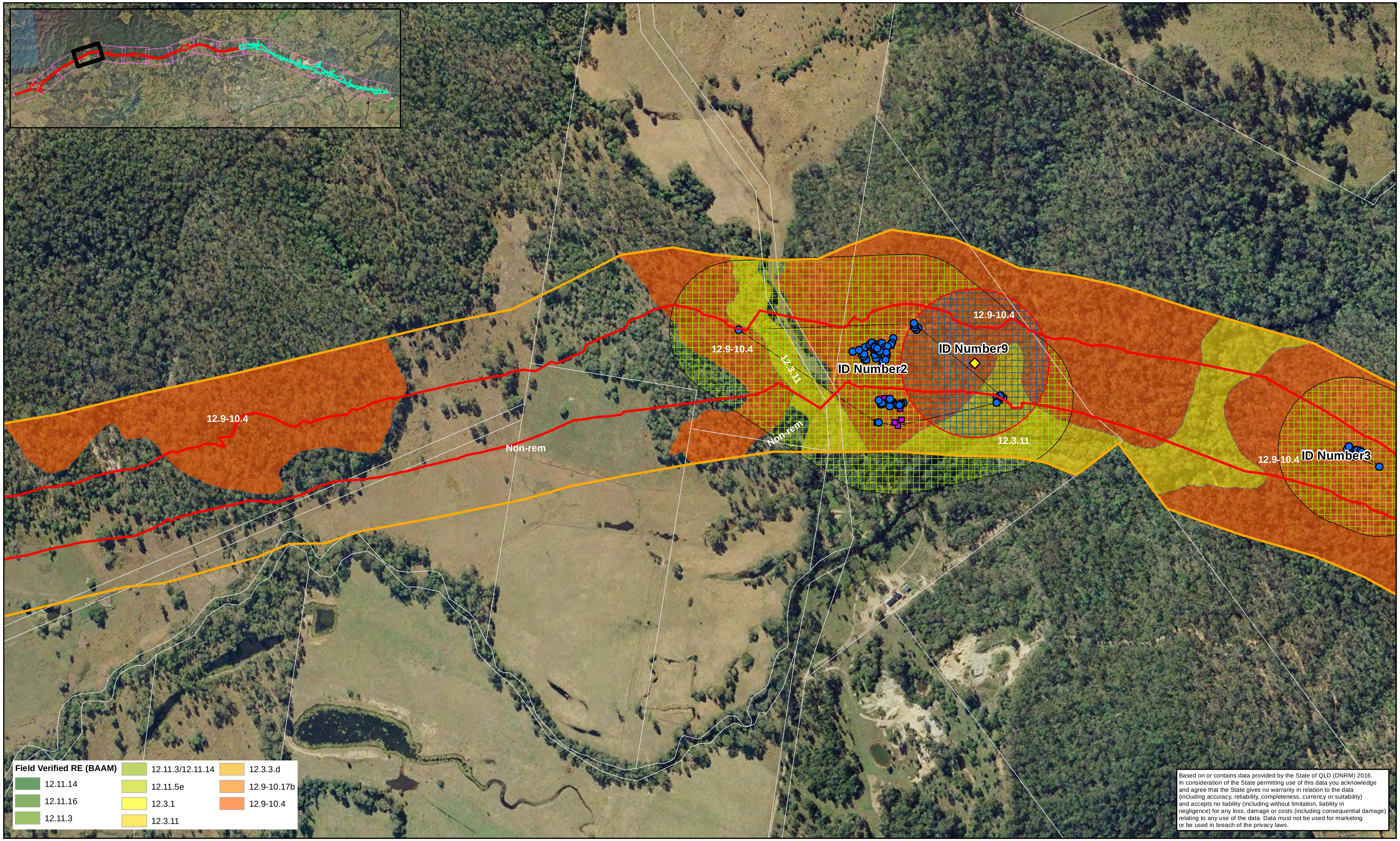
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

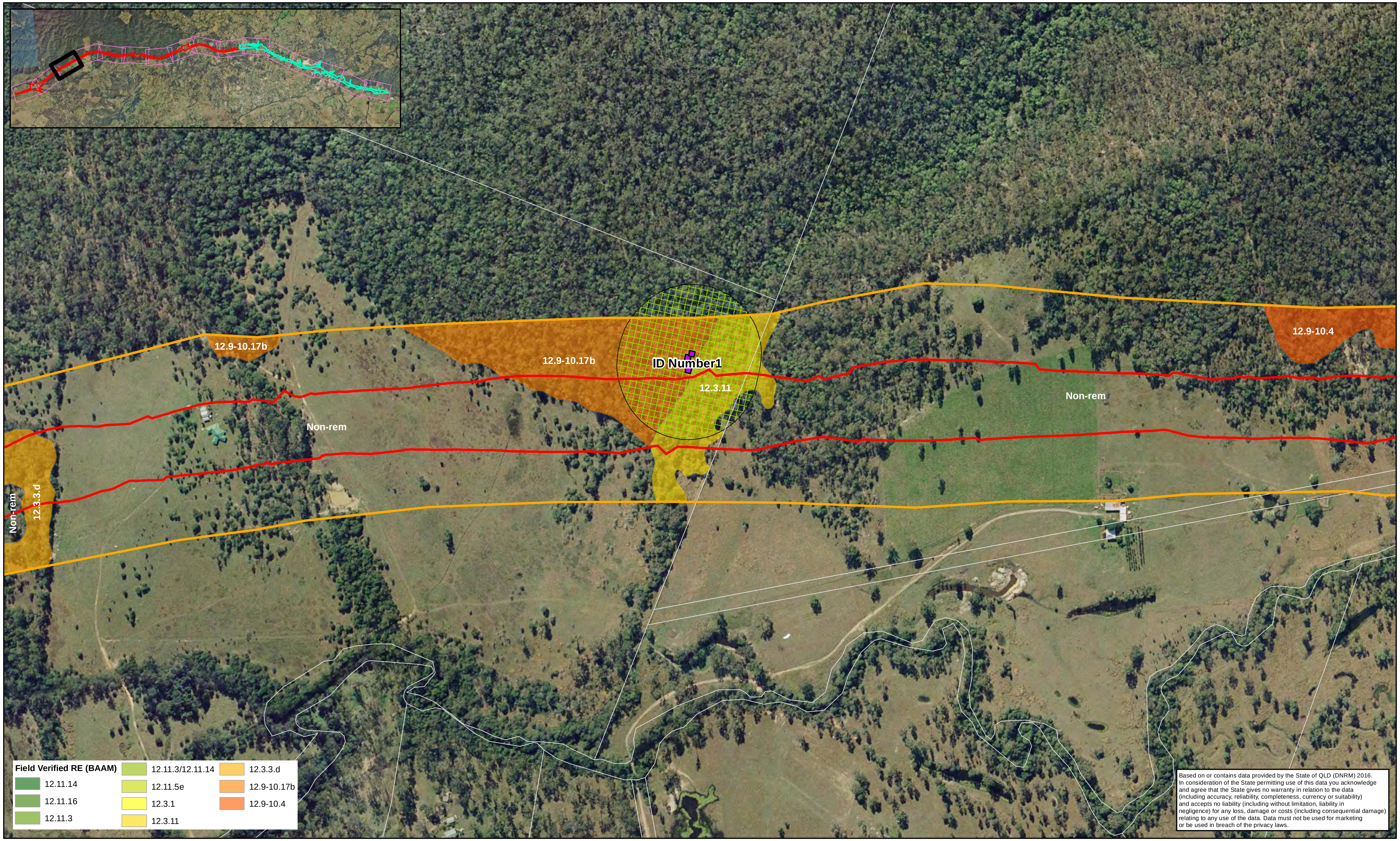
Extent of Occurence Mapping

Appendix C.13

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area
- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence
- Macrozamia pauli-guilielmi
- Marsdenia coronata

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.14

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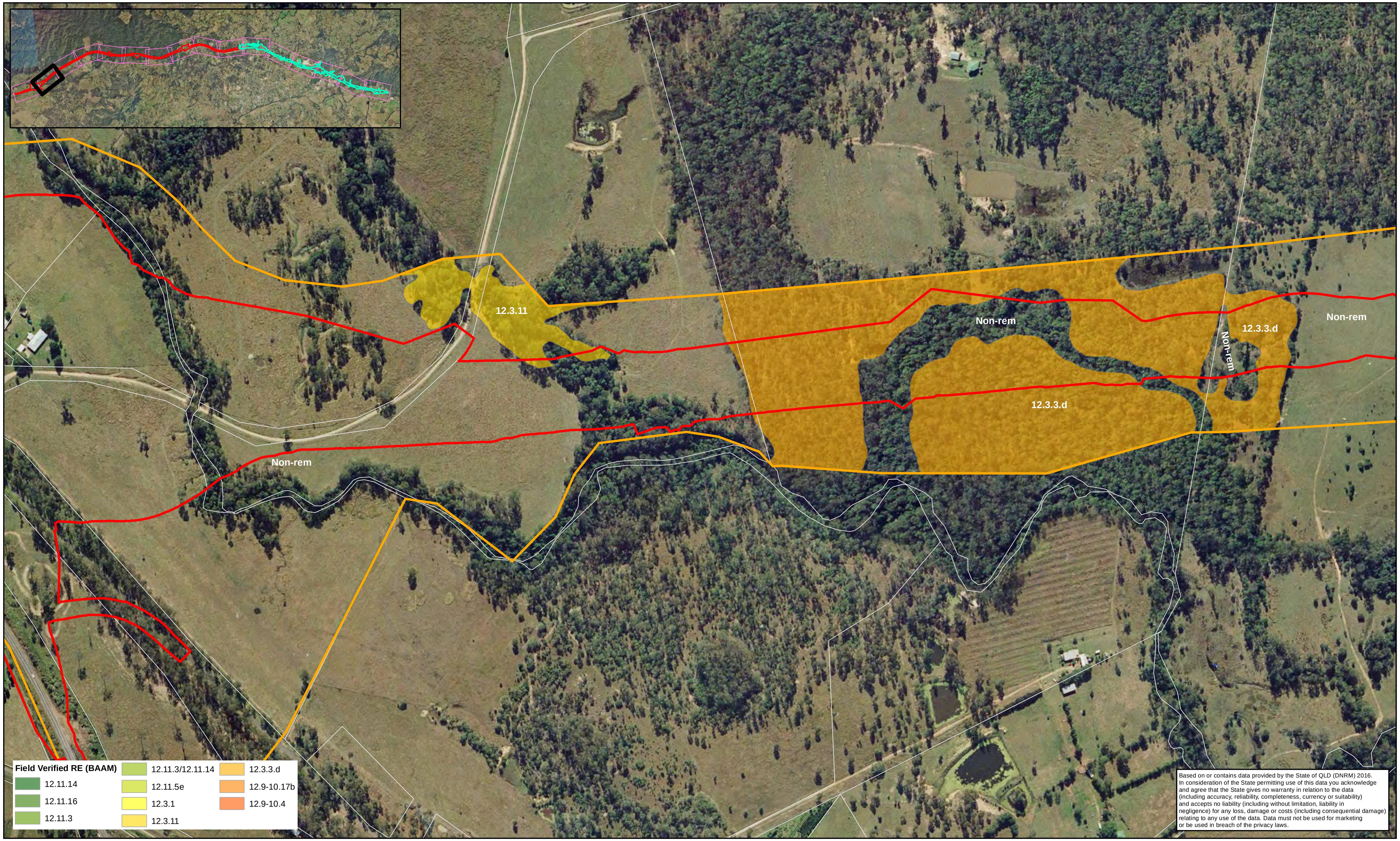
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

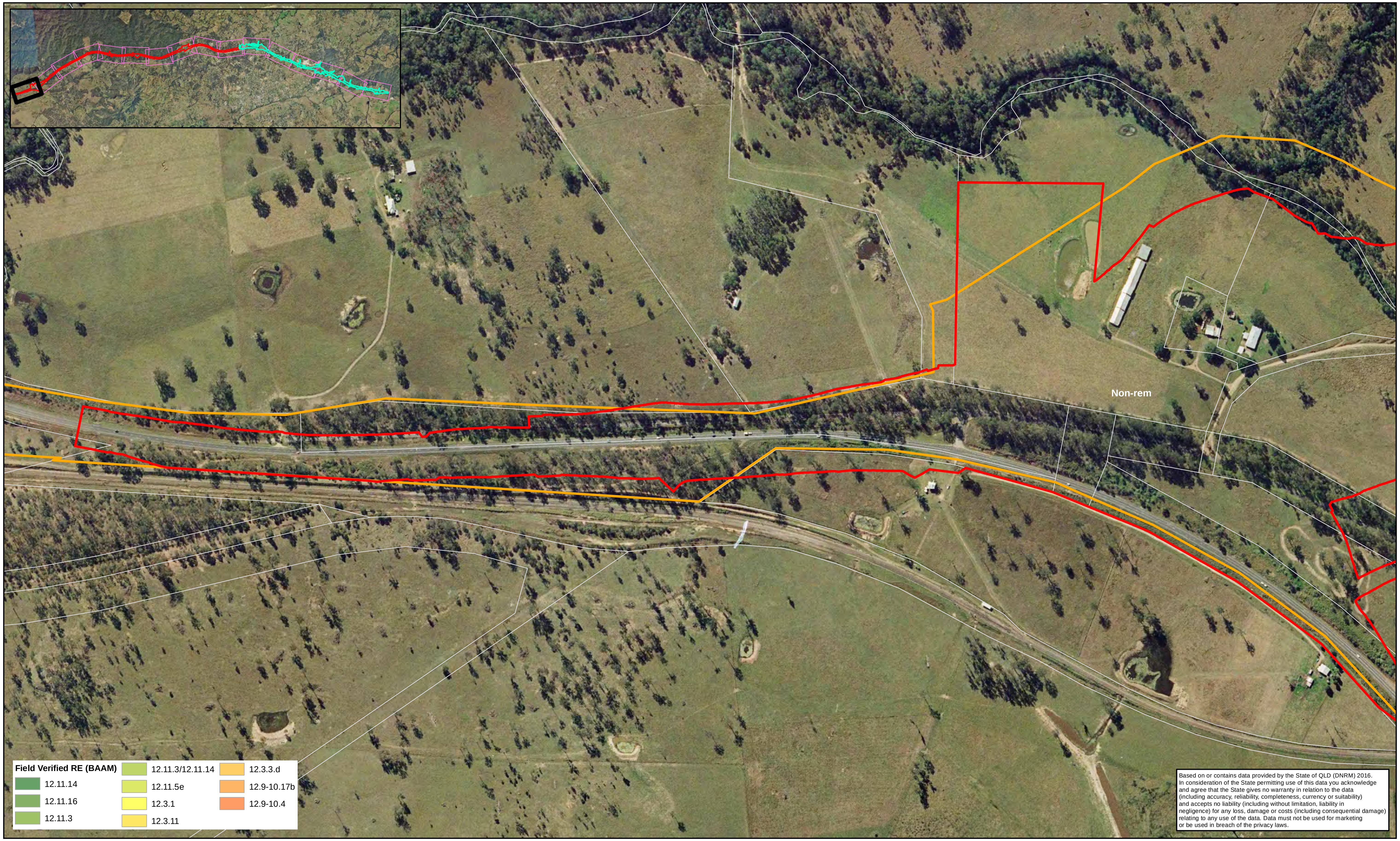
Extent of Occurence Mapping

Appendix C.15

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3028_AppendixC_Flora_A3_Rev0.mxd

Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area

- Cadastral Boundary
- Macrozamia P2 Survey (BAAM 2015)
- Macrozamia P3 Survey (BAAM 2015)
- Marsdenia coronata (BAAM, 2016)
- Marsdenia coronata (GHD, 2016)

Extent of Ocurrence

- Macrozamia pauli-guilielmi
- Marsdenia coronata

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Extent of Occurence Mapping

Appendix C.16

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Data source: TMR: BAAM Flora Survey data, Field Verified RE, Chainage, Alignment, Survey Area (2016), Imagery (2014); DNRM: Cadastre (2015); GHD: Project Area (November 2016), Extent of Occurence (2016), Flora Survey Data (2016). Created by: SC

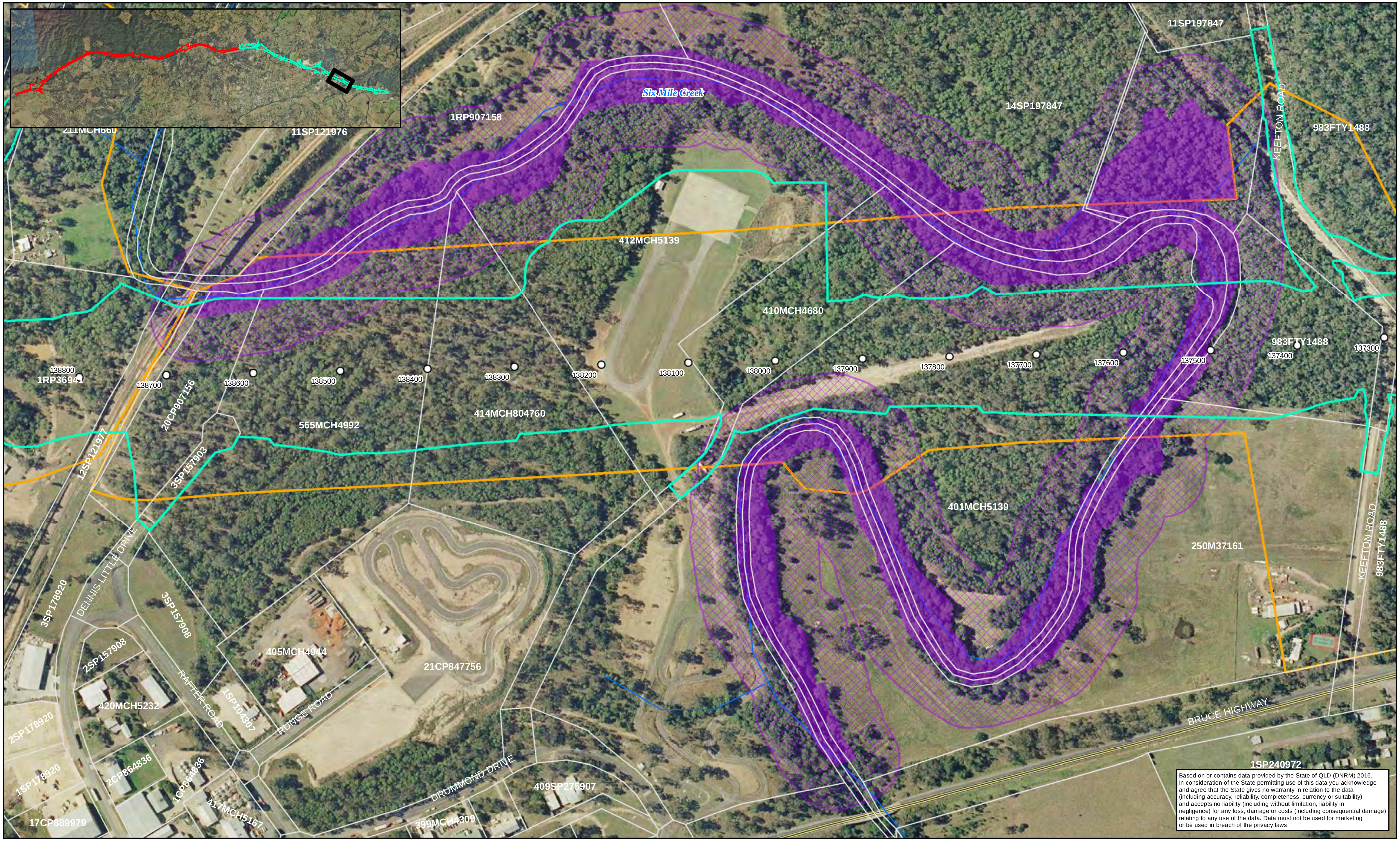
Appendix D – Lowland Rainforest of Subtropical Australia Threatened Ecological Community at Six Mile Creek Species List

Flora species identified within the riparian vegetation along Six Mile Creek

Scientific name	Common name	Included in Appendix A Characteristics Flora Species
Acacia bakeri	marblewood	Yes
Acmena smithii	lilly pilly	Yes
Acronychia oblongifolia		
Adiantum hispidulum		
Alocasia macrorhiza		
Alphitonia excelsa	soap ash	Yes
Aphananthe philippinensis	rough leaved elm	Yes
Arytera divaricata		
Arytera distylis	twin-leaved coogera	Yes
Atractocarpus chartaceus		Yes
Beilschmiedia elliptica		Yes
Breynia oblongifolia	coffee bush	Yes
Capparis arborea	brush caper berry	Yes
Castanospermum australe	black bean	Yes
*Celtis sinensis**		
Christella dentata		
Cissus antarctica	native grape vine	Yes
Cissus hypoglauca	giant water vine	Yes
Cleistanthus cunninghamiana	omega	Yes
Clerodendrum floribundum		Yes
Cordyline rubra	red-fruited palm lily	Yes
Cryptocarya laevigata		
Cryptocarya macdonaldii		
Cryptocarya obovata	pepperberry tree	Yes
Cryptocarya triplinervis		
Cupaniopsis serrata	smooth tuckeroo	Yes
Dioscorea transversa	native yam	Yes
*Dolichandra unguis-cati**	cats claw creeper	
Doodia aspera		
Doodia caudata		
Elaeocarpus grandis		Yes
Elattostachys nervosa	green tamarind	Yes
Embelia australiana		
Endiandra discolor		
Eustrephus latifolius	wombat berry	Yes
Ficus coronata	creek sandpaper fig	Yes
Ficus fraseri	sandpaper fig	Yes
Flindersia australis (edge)	native teak	Yes
Geitonoplesium cymosum		Yes
Gossia bidwillii		Yes
Guioa semiglauca		Yes
Hippocratea barbata		
Jagera pseudorhus	foambark	Yes
Lophostemon confertus	brushbox	Yes
Maclura cochinchinensis	cockspur thorn	Yes
Mallotus claoxyloides		
Mallotus philippensis	red kamala	Yes
Mischocarpus pyriformis		

Scientific name	Common name	Included in Appendix A Characteristics Flora Species
Morinda jasminoides		Yes
Neolitsea dealbata	white bolly gum	Yes
Parsonsia straminea	monkey rope	Yes
Pittosporum revolutum	hairy pittosporum	Yes
Polyscias elegans	silver basswood	Yes
Psychotria daphnoides		
Rhodamnia rubescens		Yes
Rhodomyrtus psidioides		
Ripogonum elseyanum		
Sloanea woollsii	yellow carabeen	Yes
Smilax australis	sarsaparilla	Yes
Stephania japonica var. discolor	snake vine	Yes
Streblus brunonianus	whalebone tere	
Syzygium australe	brush cherry	Yes
Syzygium crebrinerve	purple cherry	Yes
Syzygium francisii	giant watergum	Yes
Tabernaemontana pandacaqui	banana bush	Yes
Trophis scandens		
Waterhousea floribundum	weeping lilly pilly	Yes
Vitex lignum-vitae		

Appendix E – Maps Showing Lowland Rainforest of Subtropical Australia Threatened Ecological Community at Six Mile Creek and Woondum State Forest



Paper Size A3

0 50 100 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Highway
- Secondary Road
- Local Connector Road
- Street/Local Road
- Watercourse
- **Project Area**
  - Contract 1
  - Contract 2
- Survey Area
- Cadastral Boundary
- Surveyed TEC Extend (GHD, 2016)
- TEC 50m Buffer

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

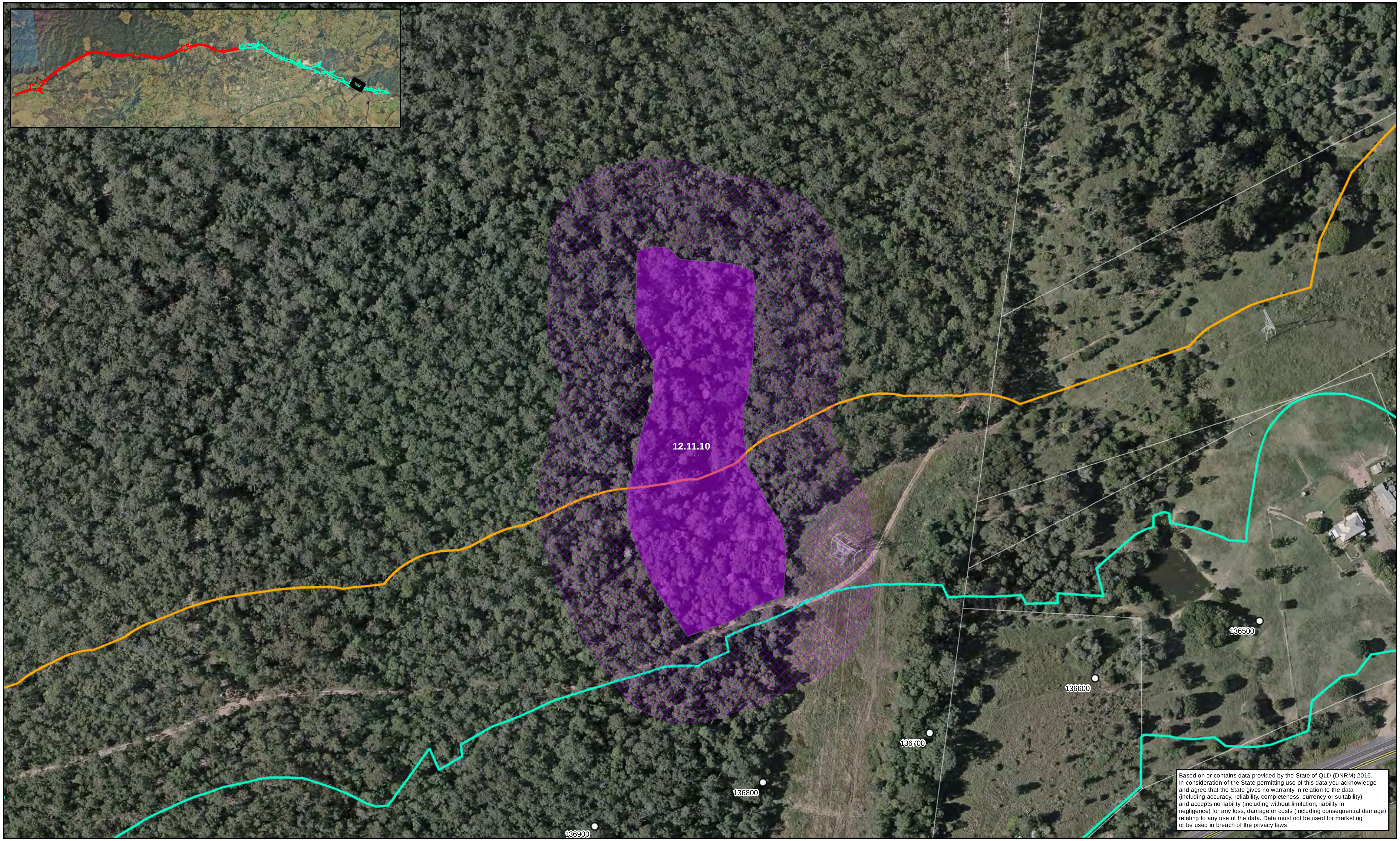
Lowland Rainforest of Subtropical Australia TEC at Six Mile Creek

Appendix E.1

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3022_AppendixE1_TEC_SixMileCreek_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: GHD: TEC, TEC 50m Buffer (2016); TMR: Imagery (2014), Field Verified RE (2016); DNRM: Cadastre (2016), Watercourses (2010), Road Retwork (2016). GHD: Project Area (November 2016). Created by: SC



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Project Area

- Contract 1
- Contract 2
- Survey Area
- Cadastral Boundary
- TEC (GHD 2016)
- TEC 50 m Buffer

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	01 Dec 2016

Lowland Rainforest of Subtropical Australia TEC at Woondum State Forest

Appendix E.2

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3023_AppendixE_TEC_Woondum_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: GHD: TEC, TEC 50m Buffer (2016), Project Area (November 2016). TMR: Imagery (2014), Survey Area (2016). DNRM: Cadastre (2016). Created by: sc

Appendix F – Lowland Rainforest of Subtropical Australia Threatened Ecological Community at Woondum State Forest Species List

Flora species from Appendix A of the TEC listing advice identified within Woondum State Forest

Scientific name	Common name
Acacia bakeri	marblewood
Ackama paniculata	soft corkwood
Actephila lindleyi	actephila
Alphitonia excelsa	red ash soapbush
Aphananthe philippinensis	rough leaved elm
Araucaria cunninghamii	hoop pine
Argyrodendron trifoliolatum	white booyong
Arytera distylis	twin-leaved coogera
Asplenium australasicum	bird's nest fern
Atractocarpus chartaceus	
Breynia oblongifolia	coffee bush
Bridelia exaltata	brush ironbark
Calamus muelleri	vine
Capparis arborea	brush caper berry
Cissus antarctica	native grape vine
Citrus australasica	finger lime
Cleistanthus cunninghamii	cleistanthus
Clerodendrum floribundum	
Cordyline rubra	red-fruited palm-lily
Cupaniopsis serrata	smooth tuckeroo
Dioscorea transversa	native yam
Diospyros mabacea	red-fruited ebony
Flindersia australis	native teak
Flindersia schottiana	bumpy ash
Flindersia xanthoxyla	long jack
Geitonoplesium cymosum	scrambling lily
Gossia bidwillii	
Grevillea hilliana	white yiel yiel
Grevillea robusta	silky oak
Guioa semiglauca	guioa
Jagera pseudorhus	foambark
Lophostemon confertus	brushbox
Mallotus discolor	
Mallotus philippensis	red kamala
Melicope micrococca	
Morinda jasminoides	
Notelaea longifolia	mock olive
Pentaceras australe	penta ash
Pittosporum multiflorum	orange thorn
Pittosporum revolutum	hairy pittosporum
Platycerium bifurcatum	elk horn
Polyscias elegans	celerywood
Sarcomelicope simplicifolia	
Smilax australis	sarsaparilla
Stephania japonica var. *discolor*	snake vine
Streblus pendulinus	whalebone tree
Tabernaemontana pandacaqui	banana bush
Triflorensia cameronii	Cameron's tarenna
Tinospora tinosporoides	arrow-head vine

GHD

4-6 Innovation Parkway, BIRTINYA QLD 4575
PO Box 1540, BUDDINA QLD 4575
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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	C. Vaughan	D. Willis		I Brodie C/- D. Caine		4/12/2016

Appendix G – *Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D* (ERM, 2016)

Bruce Highway (Cooroy to Curra) Project Section D

Terrestrial Fauna Survey Report (Final)

Department of Transport and Main Roads

May 2016

0331161

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Environmental Resources Management Australia Pty Ltd Quality System

Bruce Highway (Cooroy to Curra) Project Section D

Terrestrial Fauna Survey Report (Final)

Department of Transport and Main Roads

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EXECUTIVE SUMMARY

The Bruce Highway Cooroy to Curra Project aims to provide an upgrade and realignment to the existing 61 km section of the Bruce Highway between Cooroy and Curra. Section D of the Project involves creation of a predominately greenfield four lane dual carriageway from Woondum Road to Curra, with a total length of approximately 30 km.

A fauna survey of the alignment and a broader Survey Area was undertaken in summer 2016 to identify ecological values that may require specific management in the planning and delivery of Section D. The summer 2016 survey was designed to build upon ecological surveys previously undertaken in the alignment as part of the Review of Environmental Factors for Section D (Jacobs 2015). As the previous work described the general ecological values of the Survey Area, the summer 2016 assessment focussed on those values of conservation importance, specifically species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and/or Nature Conservation Act 1992 (NC Act).

Survey Method

The summer 2016 (Jan/Feb) survey program involved desktop review, development of a field survey program in consideration of available state and Commonwealth guidelines, and delivery of the field surveys over two survey periods in January and February 2016. Field survey methods included detailed threatened species habitat assessment, grey-headed flying fox (Pteropus poliocephalus) food plant surveys, koala (Phascolarctos cinereus) faecal pellet searches, call playback targeting selected species, tusked frog (Adelotus brevis) area searches and black-breasted button quail (Turnix Melanogaster) area searches. Data collated through field surveys and desktop review was evaluated to identify if the Survey Area contained suitable habitat for conservation significant species; habitat critical to the survival of an EPBC Act-listed threatened species; an 'important population' of an EPBC Act-listed vulnerable species; 'important habitat' for an EPBC Act-listed migratory species; or a 'breeding place' for any species protected under the NC Act.

Threatened Species

Signs of two EPBC Act and NC Act-listed threatened species, black-breasted button quail and koala, were recorded during the summer 2016 surveys. While the species were not directly sighted, koala faecal pellets and platelets associated with black-breasted button quail feeding were observed. The Survey Area is considered to provide habitat critical to the survival of black-breasted button quail and koala, based on definitions provided in Commonwealth Guidelines.

The NC Act-listed tusked frog was not recorded in the summer 2016 surveys, despite substantial survey effort and suitable survey conditions. However the species was recorded within the Survey Area during the Review of Environmental Factors (Jacobs 2015), and the Survey Area is likely to contain breeding places for the species.

In addition, other threatened species are considered likely or as having potential to occur in the Survey Area. The Survey Area is not considered to provide habitat critical to the survival of the threatened species likely or with potential to occur, and it is considered unlikely that the Survey Area will contain an important population of threatened species likely or with potential to occur.

Migratory and Special Least Concern Species

Five migratory species, the cattle egret (Ardea ibis), fork-tailed swift (Apus pacificus), rainbow bee-eater (Merops ornatus), spectacled monarch (Symposiarchus trivirgatus) and rufous fantail (Rhipidura ruficauda), have been recorded within the Survey Area and additional migratory species are considered to be likely or to have potential to occur. The Survey Area was not evaluated as providing important habitat, or being likely to support an ecologically significant proportion of any populations of these species.

Signs of the special least concern species, short-beaked echidna (Tachyglossus aculeatus), were recorded at 20 of the 45 habitat assessment sites, and it is likely the Survey Area contains breeding places for this species.

1 *INTRODUCTION*

The Bruce Highway Cooroy to Curra Project aims to provide an upgrade and realignment to the existing 61 km section of the Bruce Highway between Cooroy and Curra. Section D of the Project involves creation of a predominately greenfield four lane dual carriageway from Woondum Road to Curra, with a total length of approximately 30 km. Section D realigns the Bruce Highway from its existing position aligned immediately west of Gympie town centre, to be aligned approximately 4 km east of Gympie town centre.

The proposed road alignment has been divided into two segments for management:

- Section D1 extends from the south of Section D at Woondum Road, north to Sandy Creek Road; and
- Section D2 extends from Sandy Creek Road, north to Curra (*Figure 1*).

1.1 *BACKGROUND*

As part of the Review of Environmental Factors (REF) for Section D (Jacobs 2015), terrestrial ecology surveys were undertaken within the proposed alignment and a broader Survey Area in March 2015. The Survey Area for the assessment was based on the alignment at January 2015, and comprised a buffer of approximately 50 m to 100 m to the alignment, with some broader areas where the Survey Area followed lot boundaries (*Figure 1*).

The surveys:

- Recorded a number of species of conservation significance (i.e. species listed as migratory, threatened or special least concern under state or Commonwealth legislation) within the Survey Area;
- Assessed additional species of conservation significance as being likely, expected or having potential to occur in the Survey Area; and
- Mapped habitat for selected species of conservation significance that were known or assessed as likely to occur in the Survey Area.

To build on the information presented in the REF, fauna surveys were undertaken in January and February 2016 to target fauna species identified as known, likely and having potential to occur in the Survey Area.

1.2 *PURPOSE AND SCOPE OF THIS REPORT*

The purpose of this report is to provide information on conservation significant fauna species within the Survey Area to support the preparation of State and Federal approvals documentation (e.g. *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral and Species Management Program, which may be required under the *Nature Conservation (Wildlife Management) Regulation 2006*).

To achieve this, this report presents the findings of desk based investigations and field surveys undertaken in summer 2016.

Specifically, this report:

- Describes the fauna habitat types present within the Survey Area;
- Identifies the fauna species of conservation significance known, likely or with potential to occur within the Survey Area; and
- Evaluates the relative importance of habitat within the Survey Area to fauna species of conservation significance, in consideration of available State and Commonwealth guidelines.

1.3 *KEY TERMS*

The following key terms are used in this report.

Table 1.1 Key terms

Term	Description
Section D	Section D of the Bruce Highway Cooroy to Curra Project.
Alignment	The proposed alignment for Section D, as shown on *Figure 1*, Annex A.
Survey Area	An area encompassing and surrounding the Section D alignment, shown on *Figure 1*, Annex A as described in the REF (Jacobs 2015).
Section D1	The southern portion of Section D, as shown on *Figure 1*, Annex A.
Section D2	The northern portion of Section D, as shown on *Figure 1*, Annex A.
Species of conservation significance	Species listed as migratory, special least concern, vulnerable, endangered and/or critically endangered under the EPBC Act and/or NC Act.
Threatened species	Species listed as near threatened, vulnerable, endangered or critically endangered under the EPBC Act or NC Act.
Subject species	Species assessed during field surveys, refer *Section 2.1*.

2 METHOD

The survey program was designed to build on the work previously completed for the REF (Jacobs 2015). This report focusses on conservation significant species assessed in the REF as known, expected, likely or as having potential to occur. For the purposes of this report, these conservation significant species are identified as the 'subject species'.

The approach to the assessment involved a review of desk-based information to identify the species to be targeted during field surveys, and a review of available State and Commonwealth survey guidelines and relevant literature to determine appropriate survey techniques and survey effort (see Section 2.3). Based on this information, a survey program was designed, which responded to recommendations in survey guidelines, and targeted those species of conservation significance considered to have a greater likelihood of occurring within the Survey Area based on desktop review.

The field survey program was undertaken over two survey periods:

- Survey Period 1 (27 – 29 January and 4 February 2016); and
- Survey Period 2 (22 – 26 February 2016).

Each survey event was conducted by four field ecologists and involved both day and night surveys.

Following completion of field surveys, the data collected was reviewed, along with information presented in the REF, public databases and publicly available mapping products, to evaluate the relative importance of habitat within the Survey Area for species on conservation significance. This evaluation drew on the definitions and criteria presented in Commonwealth guidelines, so that the findings of this report can be used to inform future approvals documentation.

The following sections outline in further detail the process undertaken to identify subject species for the survey program, access publicly available databases and mapping products, deliver the field survey and undertake relevant analysis.

2.1 *SUBJECT SPECIES*

Confirmation of the subject species for the survey program was undertaken by reviewing the likelihood of occurrence assessment included in the REF, and identifying changes to the listing of species under the EPBC Act and NC Act since the ecological assessment for the REF was undertaken (early 2015). The review involved:

- Undertaking an updated search of the Protected Matters Search Tool to identify any changes in the EPBC Act-listed species relevant to the Survey Area; and

- Reviewing amendments to the listing of species in the Nature Conservation (Wildlife) Regulation 2015 and highlighting any species with listing changes that were identified in the database search results presented in the REF.

Changes to species listings relevant to the Survey Area are:

- EPBC Act: the Australian painted snipe (*Rostratula benghalensis*) is no longer listed as migratory, however continues to be listed as marine and, under the synonym *Rostratula australis*, as endangered

- NC Act: the conservation status of the common death adder (*Acanthophis antarcticus*), has changed from near threatened to vulnerable

These changes do not affect the subject species or survey design.

A list of subject species, including current conservation status, is shown in *Table 2.1*.

Table 2.1 Subject Species with likelihood of occurrence from REF

Common Name	Scientific Name	EPBC Act Status	NC Act Status
Known			
Cattle egret	*Ardea ibis*	M	S
Koala	*Phascolarctos cinereus*	V	V
Rainbow bee-eater	*Merops ornatus*	M	S
Rufous fantail	*Rhipidura ruficauda*	M	S
Tusked frog	*Adelotus brevis*	-	V
Expected to occur			
Black-breasted button-quail	*Turnix melanogaster*	V	V
Black-faced monarch	*Monarcha melanopsis*	M	S
Spectacled monarch	*Symposiarchus trivirgatus*	M	S
Likely to occur			
Eastern Great Egret	*Ardea modesta*	M	S
Fork-tailed Swift	*Apus pacificus*	M	S
Grey-headed flying-fox	*Pteropus poliocephalus*	V	-
Latham's Snipe	*Gallinago hardwickii*	M	S
Powerful Owl	*Ninox strenua*	-	V
Short-beaked Echidna	*Tachyglossus aculeatus*	-	S
White-throated Needletail	*Hirundapus caudacutus*	M	S
Potential to occur			
Australian Fritillary Butterfly	*Argyreus hyperbius inconstans*	-	E
Australian Reed-Warbler	*Acrocephalus australis*	M	S
Common Sandpiper	*Actitis hypoleucos*	M	S
Oriental Cuckoo	*Cuculus optatus*	M	S
Satin Flycatcher	*Myiagra cyanoleuca*	M	S
Low Potential to occur			
Australian Painted Snipe	*Rostratula australis*	E	V
Common Death Adder	*Acanthophis antarcticus*	-	V
Coxen's Fig-Parrot	*Cyclopsitta diophthalma coxeni*	E	E
Giant Barred Frog	*Mixophyes iteratus*	E	E
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	-	V
Northern Quoll	*Dasyurus hallucatus*	E	-
Red Goshawk	*Erythrotriorchis radiatus*	V	E
Richmond Birdwing Butterfly	*Ornithoptera richmondia*	-	V
Spotted-tailed Quoll (southern subspecies)	*Dasyurus maculatus maculatus*	V	V

E –Endangered, V – Vulnerable, S – Special Least Concern, M - Migratory

2.2 *DESKTOP REVIEW*

Database searches and a review of mapping products were undertaken to identify species previously recorded in the region surrounding the Survey Area, and the environmental characteristics of surrounding areas. The sources reviewed are described in *Table 2.2*.

Table 2.2 Desktop Review Sources

Source	Administering Body	Search Terms	Purpose
Wildlife Online Database	Department of Environment and Heritage Protection (DEHP)	All species records from all dates, within a search area of more than 10 km from the Survey Area.	To understand the flora and fauna species previously recorded in the region.
Formally Atlas of Living Australia Database (ALA)		All species records within a 10 km buffer to the Survey Area. The distribution of individual species records across Australia was also viewed in the online mapping tool.	To identify records of species of conservation significance from within 10 km of the Survey Area, their proximity to the Survey Area and dates of records.
Birdata	BirdLife Australia	All bird records within a 10 km buffer to the Survey Area.	To identify records of species of conservation significance from within 10 km of the Survey Area, their proximity to the Survey Area and dates of records.
Queensland Globe	Queensland Government	Review of mapping products related to: • Watercourses • Drainage lines • Soils and geology • Protected areas • Land tenure • Vegetation mapping • Drainage basins Mapping products accessed through Queensland Globe are cited throughout the report.	To understand the environmental characteristics of the Survey Area and surrounding region.

2.3 *FIELD SURVEY METHOD*

The field survey program was developed in consideration of guidance provided in relevant State and Commonwealth survey guidelines. This included consideration of:

- EPBC Act Referral Guidelines for the Vulnerable Koala (DoE 2014);

- Tusked Frog *Adelotus brevis* Targeted Species Survey Guidelines (Rowland 2013);
- EPBC Act Survey Guidelines for Australia's Threatened Bats (DEWHA 2010);
- EPBC Act Survey Guidelines for Threatened Birds (DEWHA 2010);
- Draft Referral Guideline for 14 Birds Listed as Migratory Species under the EPBC Act (Commonwealth of Australia 2015); and
- Survey guidance published in the Department of Environment Species Profile and Threats Database (DoE 2016).

The survey guidelines recommend survey approaches and timing for subject species as summarised in *Table* 2.3.

Table 2.3 Survey approaches and timing recommended in relevant guidelines

Species	Guideline	Recommended Survey Method	Recommended Timing
Koala (*Phascolarctos cinereus*)	EPBC Act Referral Guidelines for the Vulnerable Koala (DoE 2014) No available state guideline.	Vegetation stratification to inform design of faecal pellet surveys (either SAT or KRAM), in Survey Period 1 and detailed sighting surveys (strip transects) in Survey Period 2 to provide information on density, breeding, disease status etc.	January, in line with guideline recommendation, and detailed sighting surveys in February (not reliant on high levels of activity as identified in the guidelines)
Tusked frog (*Adelotus brevis*)	Tusked Frog *Adelotus brevis* Targeted Species Survey Guidelines (Rowland 2013)	Dip-net surveys Aural survey targeting suitable breeding habitat: 300m surveyed per 1000m of waterbody perimeter (spending at least 20 minutes per 100m) Call play-back: two playback sessions per 5ha, per survey period	Guideline requires September to February, 3 consecutive nights on two occasions. Proposed one survey in January, one in February following recent rainfall.

Species	Guideline	Recommended Survey Method	Recommended Timing
Grey-headed flying-fox (*Pteropus poliocephalus*)	EPBC Act Survey Guidelines for Australia's Threatened Bats (DEWHA 2010)	Daytime field surveys for camps/colonies (it is noted a colony exists close to Gympie township), vegetation community and food plant survey, nocturnal surveys - identify foraging extent	Presence depends on food resources, however the species is widespread throughout its range in Summer.
Black-breasted button-quail (*Turnix melanogaster*)	EPBC Act Survey Guidelines for Threatened Birds (DEWHA 2010) No specific guideline available for Queensland. General guidance provided in the Terrestrial Vertebrate Survey Guidelines of Queensland (DSITIA[1] 2014)	Area searches, platelet searches, call playback. Recommended effort is 15 person hours of land-based area searches, for areas less than 50ha, undertaken over three days.	No specific timing listed, however breeding occurs from September to February/March.
Powerful Owl (*Ninox strenua*)	No specific guideline available for Queensland. General guidance provided in the Terrestrial Vertebrate Survey Guidelines of Queensland (DSITIA 2014)	Call playback, searches for signs of owls (e.g. feathers, regurgitated pellets)	No specific timing listed, and will be undertaken during the two proposed survey events.
Short-beaked Echidna (*Tachyglossus aculeatus*)	No specific guideline available for Queensland. General guidance provided in the Terrestrial Vertebrate Survey Guidelines of Queensland (DSITIA 2014)	No specific method recommended – opportunistic surveys for signs and individuals.	No specific timing listed, and will be undertaken during the two proposed survey events.
Migratory species (black-faced monarch, spectacled monarch, rufous fantail)	Draft Referral guideline for 14 birds listed as migratory species under the EPBC Act (Commonwealth of Australia 2015)	Habitat assessment, presence of key features, visual and/or aural detection of individuals	Autumn or Spring

Species	Guideline	Recommended Survey Method	Recommended Timing
Migratory species (cattle egret, white-bellied sea-eagle, rainbow bee-eater)	Survey Guidelines published in the Department of Environment Species Profile and Threats Database	Habitat assessment, including nest searches, visual and/or aural detection of individuals	No specific timing listed.

Subject species identified in the REF as known, expected or likely to occur were targeted through species-specific techniques, such as call playback, area searches in suitable habitat and the koala Spot Assessment Technique (in accordance with the summary above). Subject species identified in the REF as having potential or low potential to occur were assessed in the field through detailed habitat assessment, to identify key habitat features of importance to those species, or signs (such as scats, tracks or trails) of those species. This approach was used to enable survey effort to be focussed on those species that are most likely to occur within the Survey Area (and therefore at higher risk of impact as a result of the Section D project), while still enabling an understanding of habitat value for species less likely to occur.

In total, 34 person days were spent in the field, encompassing 45 habitat assessment sites, 42 Spot Assessment Technique Sites and 35 call playback sessions. *Table 2.4* describes the survey techniques used, the considerations for site selection, and a summary of survey effort undertaken. *Table 2.5* summarises the survey effort for terrestrial habitat assessment and Spot Assessment Technique in each RE and are shown in *Figure 2* in Annex A.

Table 2.4 Description of survey techniques

Technique	Target Species	Description	Site Selection Considerations	Effort
Day Surveys				
Habitat Assessment	All subject species	Habitat assessment involved assessing and recording the following features using a standard, Program-specific proforma: • Context in the landscape (for example connectivity, elevation, proximity to water) • Condition (for example weeds and evidence of pest species, recruitment, erosion, evidence of disturbance) • Breeding and roosting habitat features (for example hollows (size and density), den sites, nests, shedding bark, caves) • Foraging resources (for example flowering tree species, other food trees, termite mounds, waterbodies) • Microhabitats present (for example woody debris, leaf litter, rocky outcrop) • Characteristics of any wetland features (for example, presence of aquatic vegetation, water depth, soil or substrate type) • Presence of specific vegetation types associated with threatened species, such as the Australia fritillary butterfly larval food plant *Viola betonicifolia* or Richmond birdwing butterfly larval host plant *Pararistolochia* vine • Signs of threatened species, such chewed cones of *Allocasuarina* species (indicating presence of glossy-black cockatoo), platelets, scats, track or scratches Representative photographs of each habitat assessment site, and any significant habitat features were taken.	Habitat assessment sites (focussing on all subject species, as well as breeding places for non-listed species) were selected by stratifying the Survey Area based on remnant status of vegetation and regional ecosystem type. For each stratified unit with over 5 ha within the Survey Area, at least three survey sites were selected. Considerations in site selection within each stratification unit included: • Spatial distribution across the length of the Survey Area; • Preference for locating survey sites within the alignment, where suitable habitat was available within the alignment; and • Accessibility.	45 terrestrial habitat assessments. 28 aquatic habitat assessments. Refer to *Table 2.4* for a summary of the number of terrestrial habitat assessment sites per regional ecosystem.

Technique	Target Species	Description	Site Selection Considerations	Effort
Grey-headed flying fox food plant survey	Grey-headed flying fox	Significant food tree presence was measured in conjunction with the Spot Assessment Technique method, by recording the species of each tree investigated. This data was used to understand the relative dominance of significant food trees within each regional ecosystem type. In addition, locations with high densities of significant food trees were recorded, including within native vegetation communities and orchards.	As per habitat assessment site stratification.	Relative dominance of significant food trees measured at 42 sites.
Spot Assessment Technique	Koala	The Spot Assessment Technique was undertaken, as recommended in the EPBC Act Referral Guidelines for the Vulnerable Koala (DoE 2013). This technique involved faecal pellet searches of a 100 cm radius around thirty trees at each Spot Assessment Technique site. The method applied was varied from that described in Phillips and Callaghan (2011), by randomly selecting the centre tree (from a randomly generated location) and searching under both potential food and shelter trees (i.e. not limited to trees of the Eucalyptus, Corymbia, Angophora or Lophostemon genera), based on evidence presented in Woosnam-Merchez et al. (2012). Based on the number of trees with pellets recorded, koala relative density was considered according to Ellis et al. (2013).	As per habitat assessment site stratification.	42 Spot Assessment Technique surveys.

Technique	Target Species	Description	Site Selection Considerations	Effort
Black-breasted Button Quail area search and point survey	Black-breasted Button Quail	A thorough area search of the mapped BBBQ habitat mapped in the REF was undertaken on three occasions. The area was searched systematically by walking throughout the habitat patch and stopping where habitat features or signs warranted further investigation. The aim of the survey was to record flushed birds or detection of birds through hearing foraging or scratching were recorded. The locations of platelets observed during the area search were recorded. In addition, a dawn point survey was undertaken on one occasion, in which four observers sat quietly for 45 minutes at separate locations in suitable BBBQ habitat, with the aim of directly observing individuals.	• Habitat assessment sites located within areas of suitable habitat (i.e. notophyll vine forest). • Area searches undertaken in areas of suitable habitat.	2.5 hours with two ecologists on 4 February (five person hours) 2 hours with four ecologists on 25 February (8 person hours) 1.25 hours with four ecologists on 26 February (5 person hours)
Night Surveys				
Call playback	Powerful Owl	Vocalisations of the powerful owl were broadcast over a loud speaker. The process followed these steps: • listening for unsolicited calls for at least two minutes prior to broadcast • broadcasting call for two minutes • listening for calls or appearance of the species for three minutes • broadcasting call for two minutes • listening for five minutes • broadcasting the call for two minutes • listening for two minutes	• Habitat assessment undertaken at all habitat assessment sites. • Targeted survey sites located in areas mapped in the REF as containing suitable nest trees. • Survey sites located at least 3 km apart to avoid repeat counts of the same owl from multiple sites. • Additional call playback undertaken at tusked frog sites, where suitable habitat was present.	Call playback undertaken at 13 sites.

Technique	Target Species	Description	Site Selection Considerations	Effort
		• following completion of broadcasting, spotlighting around the broadcast site, to identify any individuals that may have been attracted but did not vocalise.		
Call playback	Tusked frog	Calls of tusked frog were broadcast through a speaker. The following process was followed: • listening for unsolicited calls for at least two minutes prior to broadcast • broadcasting call for three minutes • listening for calls for an additional two minutes	• Watercourses within tusked frog habitat shown in the REF. • Other watercourses, drainage lines or dams observed during day surveys. • Each mapped patch of habitat targeted, with a density of sites of at least two sites per 5 ha, as recommended Rowland (2013).	Call playback undertaken twice at 16 sites, and once at an additional three sites (35 call playback sessions in total). This is equivalent to more than 2.5 call play back sites per survey period per 5 ha tusked frog habitat. For larger sites, call playback was undertaken at multiple locations during the area search.
Aural/ thorough waterbody survey	Tusked frog	Two field personnel walked through areas of suitable breeding habitat, listening for calls of the species and actively searching for frogs and tadpoles. Searches for adult tusked frogs focussed on low vegetation, debris, and cavities and crevices within or near water. Transects were walked at a pace of at least 20 minutes per 100 m. Transects were collocated with call playback surveys, with an average of a 60 m transect at each call playback site, however extended transects were undertaken in areas of higher habitat quality.		In total, frog surveys (incorporating area searches and call playback) were conducted over 39 person hours.

Technique	Target Species	Description	Site Selection Considerations	Effort
Day and Night				
Incidental Observations	All species	Incidental observations of conservation significant species detected during surveys or while travelling through the Survey Area were recorded. Details including number of individuals, sex, adults/juvenile status and geographic coordinates of the observation were recorded.	NA	NA

Table 2.5 Representation of Terrestrial Habitat Assessment and Spot Assessment Technique within Regional Ecosystems

Regional Ecosystem	Short Description	Extent within Survey Area	Number of Habitat Assessment Sites	Number of Spot Assessment Technique Sites
Remnant Vegetation				
12.9-10.4	*Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks	34 ha	7	7
12.9-10.17b	*Corymbia citriodora* subsp. *variegata* mixed open forest to woodland.	17 ha	3	3
12.11.5e	*Corymbia citriodora* subsp. *variegata* woodland usually including *Eucalyptus siderophloia* or *E. crebra* (sub coastal ranges), *E. propinqua* and *E. acmenoides* or *E. carnea*.	168 ha	7	7
12.11.14	*Eucalyptus crebra, E. tereticornis, Corymbia intermedia* woodland on metamorphics +/- interbedded volcanics (SEVT)	17 ha	4	4
12.11.16	*Eucalyptus cloeziana* open forest on metamorphics +/- interbedded volcanics	3 ha	1	1
12.3.1	Gallery rainforest (notophyll vine forest) on alluvial plains	5 ha		
12.11.3	*Eucalyptus siderophloia, E. propinqua* +/- *E. microcorys, Lophostemon confertus, Corymbia intermedia, E. acmenoides* open forest on metamorphics +/- interbedded volcanics	40 ha	8	8
12.3.11	*Eucalyptus tereticornis +/- Eucalyptus siderophloia, Corymbia intermedia* open forest on alluvial plains usually near coast	39 ha	5	5
12.3.3.d	Floodplain (other than floodplain wetlands). *Eucalyptus moluccana* woodland.	16 ha	3	3
12.11.3/12.11.14	See component descriptions above.	23 ha	3	2
Non-remnant Vegetation				
Native Regrowth Vegetation	Including areas mapped as High Value Regrowth and Mature Regrowth.	235 ha	4	2
Total			**45**	**42**

2.4 ANALYSIS

Data collected through the survey program was interpreted in consideration of available literature and desktop information to evaluate the likelihood of each species occurring within the Survey Area, if the Survey Area contained:

- suitable habitat for subject species, as described in the Species Profiles and Threats Database, survey guidelines and other available sources (e.g. REF);
- habitat critical to the survival of an EPBC Act-listed threatened species;
- an 'important population' of an EPBC Act-listed vulnerable species;
- 'important habitat' for an EPBC Act-listed migratory species; or
- a 'breeding place' for any species protected under the NC Act.

Refer to table *Table 2.7* for the criteria used in these evaluations.

The criteria used to assess likelihood of occurrence are presented in *Table 2.6*. No likelihood of occurrence criteria were provided in the REF, and so the following has been developed for this assessment to provide transparency and consistency in the likelihood rankings, particularly as new data (from field surveys) will be used to describe likelihood of occurrence. It is important to note, that given the analysis described here and the criteria applied, the likelihood of occurrence for some species in this report may differ for equivalent species reported in the REF. This approach provides a more robust and consistent assessment, less reliant on subjective analysis.

Table 2.6 Likelihood of Occurrence Definitions

Likelihood Ranking	Definition
Known	• The species has been recorded (directly by DTMR-commissioned surveys or from database records) within the Survey Area in the past 10 years
Likely	• The species has been recorded within 10 km of the Survey Area in the past 10 years; and • The site contains suitable habitat for the species
Potential	• The Survey Area is within the species current known distribution, but the species has not been recorded within 10 km of the Survey Area; and • The site contains suitable habitat for the species
Unlikely	• The site is not within the species known distribution; and/or • Suitable habitat is not present at the site

Table 2.7 Criteria used for habitat and breeding place evaluations

Term	Definition	Applicable Subject Species	Source
Habitat Critical To The Survival Of A Species			
Habitat critical to the survival of a species	Areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators) • to maintain genetic diversity and long term evolutionary development, or • for the reintroduction of populations or recovery of the species or ecological community. Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	EPBC Act-listed Threatened Species	SIG 1.1
Habitat critical to the survival of a species	Habitat receiving a score of five or more using the Koala Habitat Assessment Tool presented in the Koala Referral Guidelines.	Koala	EPBC Act Referral Guidelines for the vulnerable koala (Commonwealth of Australia 2014)
Important Population			
Important population	An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source 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.	Species listed as vulnerable under the EPBC Act	SIG 1.1

Term	Definition	Applicable Subject Species	Source
Important Habitat			
Important Habitat (for migratory species)	Internationally important habitat is habitat that regularly supports: • 1 per cent of the individuals in a population of one species or subspecies of waterbird; or • a total abundance of at least 20 000 waterbirds. Nationally important habitat is habitat that regularly supports: • 0.1 per cent of the flyway population of a single species of migratory shorebird; or • 2000 migratory shorebirds; or • 15 migratory shorebird species.	Common sandpiper	EPBC Act Policy Statement 3.21
Important Habitat (for migratory species)	Important habitat for Latham's Snipe is considered: • areas that have previously been identified as internationally important for the species; or • areas that support at least 18 individuals of the species.	Latham's snipe	EPBC Act Policy Statement 3.21
Important Habitat (for migratory species)	An area of 'important habitat' for a migratory species is: • habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; and/or • habitat that is of critical importance to the species at particular life-cycle stages; and/or • habitat utilised by a migratory species which is at the limit of the species range; and/or • habitat within an area where the species is declining.	All other migratory subject species	SIG 1.1
Important Habitat (for migratory species)	Additional description of habitat types considered to be important habitat is provided for selected species in the Referral Guidelines for 14 Birds Listed As Migratory Species Under the EPBC Act.	White-throated needletail Fork-tailed swift Oriental Cuckoo Black-faced monarch Spectacled monarch Satin flycatcher Rufous fantail	Referral Guidelines for 14 Birds Listed As Migratory Species Under the EPBC Act

Term	Definition	Applicable Subject Species	Source
Breeding Place			
Breeding Place	***breeding place***, of an animal, means a bower, burrow, cave, hollow, nest or other thing that is commonly used by the animal to incubate or rear the animal's offspring.	Species protected under the NC Act	Nature Conservation (Wildlife Management) Regulation 2006

3 ECOLOGICAL CHARACTERISTICS OF THE SURVEY AREA

3.1 REGIONAL CONTEXT

The Survey Area is located in the South East Queensland Bioregion (IBRA), in the Mary River Catchment. The Mary River Catchment is bound by mountain ranges in the northwest, west and south (Pointon and Collins 2000). The eastern portion of the catchment, in which the Survey Area is located, contains level to gently undulating terrain along the Mary River and its tributaries (Pointon and Collins 2000). Major tributaries entering the Mary River from the west include Munna Creek, Wide Bay Creek, Widgee Creek, Amamoor Creek, Kandanga Creek and Yabba Creek (Pointon and Collins 2000). Major tributaries entering from the east include Tinana Creek, Six Mile Creek and Obi Obi Creek (Pointon and Collins 2000). The Survey Area intersects one of these creeks, Six Mile Creek.

The region has warm summers (mean lows of 20°C and mean highs of 31°C) and mild winters (mean lows of 6°C and mean highs of 20°C) (BoM 2016). Gympie has mean rainfall of 1127 mm per year, with higher rainfall in summer (maximum mean monthly rainfall of 168 mm in February) and lower rainfall in winter (minimum mean monthly rainfall of 41mm in August) (BoM 2016).

3.2 ABIOTIC CHARACTERISTICS OF THE SURVEY AREA

Table 3.1 describes the land use, connectivity, watercourses, soils and topography of the Survey Area.

Table 3.1 Abiotic characteristics of the Survey Area

Characteristics	Description
Land Use	The main land uses within Section D include grazing, production forestry and rural residential (Queensland Government 2015). Other land uses include nature conservation and manufacturing and industrial (Queensland Government 2015). Approximately 1 km of Section D1 passes through Woondum State Forest, and approximately 6 km of Section D2 passes through Curra State Forest.
Connectivity	The southern portion of section D1 from Woondum State Forest to East Deep Creek Road has poor connectivity to surrounding woodland and forest communities within Woondum State Forest and freehold land, as well as Woondum National Park located 7 km east of Section D1. This part of the Survey Area is located within a Regional Statewide Ecological Corridor, mapped within the Biodiversity Planning and Assessment mapping. The central portion of the alignment (the northern portion of Section D1 and southern portion of Section D2) contains fragments of remnant and regrowth woodland within a mosaic of agricultural and residential land uses. This portion of the alignment has little connectivity to intact

Characteristics	Description
	vegetation. The northern portion of Section D2 is located on the western edge of a large intact area of remnant vegetation, including remnant vegetation within Curra State Forest and on freehold land. Curra State Forest contains 4830 ha of remnant vegetation, and is connected via remnant vegetation on freehold land, to other State Forest areas extending north to Maryborough and east to the coast. *Figure 1*, Annex A shows the regional context of the Survey Area.
Topography and soils	The Survey Area is located in hilly terrain, with elevations of 50 to 110 m. The Atlas of Australian Soils maps the Survey Area as containing the following broad landforms and soil types: *Section D1 and D2* • Generally low hilly terrain on shales with gentle to moderate side slopes, with a general soil type of shallow bleached loams (Map Code Fu8); • Hilly to low hilly terrain on phyllites-convex hills with moderate side slopes small slopes fans and relatively narrow stream valleys, with a general soil type of hard pedal red duplex soils (Map Code Pc2); *Section D2 Only* • Hilly to steep hilly lands on shales and cherts, narrow ridge crests with moderate to steep side slopes, with a general soil type of shallow bleached loams (Map Code Fu6); • Hilly to steep hilly land with bleached sands (Map Code Cd7); and • Low rounded hilly terrain-gentle side slopes to shallow relatively broad valleys with a general soil type of hard pedal mottled-yellow duplex soils (Map Code Tb69).
Watercourses	The Survey Area is intersected by three permanent watercourses. These are: • Six Mile Creek, located in Section D1, is a fifth order watercourse which drains to the Mary River. The alignment crosses Six Mile Creek approximately 2 km upstream of the confluence with the Mary River. • Deep Creek, located in Section D1, is a fifth order watercourse. The alignment crosses Deep Creek approximately 3 km overland from its confluence with the Mary River. • Curra Creek, located in Section D2 is a fourth order watercourse, located approximately 13 km overland from its confluence with the Mary River. The alignment also crosses a number of lower order ephemeral waterways and drainage lines.

3.3 *BROAD HABITAT TYPES*

The following tables (3.2-3.7) provide a summary of the overarching habitat types present within the Survey Area. Approximately 60% of the Survey Area contains native habitat types (i.e. native woodland and forest communities) while the remaining 40% contains cleared areas, such as grazing land and residential properties. A selection of representative photographs are captured in the tables.

Table 3.2 Eucalypt Communities on Sedimentary and Metamorphic Rock

Habitat Type	**Eucalypt Communities on Sedimentary and Metamorphic Rock**
Overview:	This is the most widespread native habitat type in the Survey Area, covering 442 ha, and comprises woodland and open forest communities mapped on sedimentary and metamorphic rocks (Land Zones 9-10 and 11).
Vegetation Description:	Vegetation within this habitat type typically comprises: • A canopy of mixed eucalypt species, most commonly *Corymbia citriodora, Corymbia intermedia, Lophostemon suaveolens, Eucalyptus acmenoides* and *Eucalyptus propinqua.* • A subcanopy of *Lophostemon suaveolens* and Acacia species was commonly present. *Alphitonia excelsa* and *Lophostemon confertus* were also present at many sites. • A variable midstorey, with some areas containing dense regrowth of Acacia or overstorey regeneration and some areas lacking a midstorey. Dense infestations of *Lantana camara* were common in this habitat type. • In areas with a more open midstorey, ground cover was often grassy. Common ground cover species included kangaroo grass (*Themeda triandra*), hairy panic (*Panicum effusum*) and blady grass (*Imperata cylindrical*).
Sheltering Resources:	Common sheltering resources in this habitat type included • Coarse woody debris present at all sites, including fallen timber with hollows or fissures, present at 87% of sites; • Dead trees with fissures or small hollows; • Deep bark at the base of shedding Eucalypts; • Leaf litter (an average ground cover of 40%); • Small and medium sized hollows. Small hollows (with an opening less than 10 cm) were present at two thirds of sites. Medium hollows (with an opening of 10 – 20 cm) were present at half the sites surveys. Other, less common, sheltering resources included: • Large hollows (greater than 20 cm), present at approximately one quarter of sites surveyed. • Rock features, present at approximately one third of sites. This typically consisted of scattered small surface rocks, and rock piles were uncommon. • At one location, in the north of the alignment, large boulders were abundant on the slopes of a gully. These boulders may provide sheltering resources for reptiles and small mammals.

Habitat Type	Eucalypt Communities on Sedimentary and Metamorphic Rock
Foraging Resources:	Foraging resources include: • seeding grass cover (86%); • flowering eucalyptus (88%); • insects, which were abundant at the majority of sites; and • termite mounds (80%). Other foraging resources include: • flowering mistletoe (28%); and • Fleshy fruiting plants (16%);
Disturbance:	*Noise Disturbance* • Section D1 is located in suburban areas, and as such noise disturbances from nearby roads, houses and industrial areas was common throughout. • Section D2 passes through Curra State Forest and rural residential land and has less noise disturbance, with the exception of the southern portion of the alignment within Curra State Forest, which is aligned with the rail line. *Invasive Weeds* • Invasive weeds were present at the majority (94%) of sites. • Lantana (Lantana camara) was the most prevalent weed, present at most sites surveyed. • Other common weeds included Cat's claw creeper (Macfadyena unguis-cati), common prickly pear (Opuntia stricta), pasture grasses, blue billy goat weed (Ageratum houstonianum), corky passion vine (Passiflora suberosa) and Cadagahi (*Eucalyptus torelliana*). *Other disturbances* • Pig diggings were present to the south of the Curra Creek crossing (PD9). • At one site near Curra State Forest (PD35) trees had been ringbarked. • Approximately 60% of sites had signs of past fire.
Signs of fauna:	Common signs of fauna in this habitat type included macropod scats, scratches on tree trunks (such as those made by possums and goannas), bandicoot diggings and burrows. Other signs of note include short-beaked echidna (*Tachyglossus aculeatus*) diggings and the remains (bones and tail) of a sugar glider (*Petaurus breviceps*). Fauna were also directly observed, including common frog species heard calling, bearded dragons (*Pogona barbata*) and a range of bird species. Refer to Annex D for a full list of species recorded.
Fauna breeding places:	Signs of fauna breeding were present at 57% of the sites surveyed. These included: • Birds nests in trees; • Nest holes in arboreal termitaria; and • Brush turkey nests. Sheltering resources described above, such as tree hollows and clusters of fallen timber provide suitable breeding habitat for a range of species, including birds, reptiles and small mammals.

Habitat Type	Eucalypt Communities on Sedimentary and Metamorphic Rock
Representative Photographs	
1. Percentages in brackets, e.g. (50%), refer to the proportion of sites surveyed that had a habitat feature.	

Table 3.3 Eucalypt Communities On Alluvial Soils

Habitat Type	Eucalypt Communities On Alluvial Soils
Overview:	This habitat type is present in lower parts of the Survey Area, typically along creeklines, and covers 124 ha within the Survey Area. Waterbodies were present within this habitat type, and are described separately in *Section 3.4*
Vegetation Description:	Vegetation within this habitat type typically comprises: • A canopy typically dominated by *Eucalyptus tereticornis* with *Lophostemon suaveolens* or *Eucalyptus mollucana* with *Lophostemon suaveolens.* Other canopy species present included *Eucalyptus propinqua, Corymbia intermedia, Corymbia citriodora* and *Eucalyptus crebra* and *Melaleuca salicina*. • A subcanopy of *Acacia leiocalyx*, *Alphitonia excelsa* and regeneration of canopy species. At one site, *Melaleuca quinquenervia* formed a subcanopy. • At some locations, a mid-storey of lantana was present. • The understorey of this habitat type typically comprised grasses (commonly kangaroo grass *Themeda triandra* and hairy panic *Panicum effusim*), lomandra species and low *Carissa ovata* shrubs. At some sites, the invasive weed Cat's claw creeper formed a dense mat.
Sheltering Resources:	Sheltering resources in this habitat type included: • Small tree hollows (45%)1 • Dense leaf litter and bark at the base of trees, from shedding bark and banked up flood debris • Coarse woody debris (85%), including hollow logs (54%) Less common sheltering resources included: • Dense ground cover and shrub cover. • Medium (33%) and large (25%) tree hollows. • Rock features were uncommon, however one site, immediately north

Habitat Type	Eucalypt Communities On Alluvial Soils
	of Curra State Forest (PD8), contained large boulders.
Foraging Resources:	Foraging resources in this habitat type included: • Seeding grass and lomandra species (82%) • Flowering eucalypts (91%) and mistletoe (45%) • Insects, including termite mounds (38%).
Disturbance:	Common disturbances within this habitat type included: • Weed invasion. The most prevalent weed species were Lantana (*Lantana camara*) (67%), and cat's claw creeper (*Macfadyena unguis-cati*) (27%). At some sites, these infestations were extensive. • Noise disturbance from nearby houses, roads, train line and industrial properties (60%). Less common disturbances included: • Low levels of litter. • Domestic (cows, horses and dogs) and feral (rabbit) fauna species. Cows and horses were present at two sites, signs of rabbits present at one site and domestic dogs were heard from nearby properties.
Signs of fauna:	Common signs of fauna in this habitat type included macropod scats, ringtail possum scats, scratches on tree trunks from arboreal fauna and bandicoot diggings. Other fauna signs include occasional short-beaked echidna (*Tachyglossus aculeatus*) diggings and chewed figs. Fauna observed directly include numerous skinks sheltering in leaf litter, red-necked wallaby (*Macropus rufogriseus*), long-nosed bandicoot (*Perameles nasuta*) and numerous bird and frog species (refer Annex D for a full species list).
Fauna breeding places:	Fauna breeding signs included bird nests in trees and arboreal termite mounds, present at 38% of sites. Juvenile fauna, including juvenile long-nosed bandicoots (*Perameles nasuta*) and lace monitors (*Varanus varius*) also indicate breeding within the surrounding area. Sheltering resources described above, such as tree hollows and clusters of fallen timber provide suitable breeding habitat for a range of species, including birds, reptiles and small mammals.
Representative Photographs	

1. Percentages in brackets, e.g. (50%), refer to the proportion of sites surveyed that had a habitat feature.

Table 3.4 Vine Forest

Habitat Type	Vine Forest
Overview:	This habitat type is limited to an area in the south of D1, at Woondum State Forest, and riparian areas of Six Mile Creek, with a total of 32 ha within the Survey Area. Within Woondum State Forest, this habitat type intergrades with *Eucalyptus propinqua* woodland. At Six Mile Creek this habitat type is limited to the lower creek bank, with upper banks typically containing *Corymbia intermedia* and *Lophostemon suaveolens*.
Vegetation Description:	• At Six Mile Creek, the canopy is dominated by *Waterhousea floribunda* and *Castanospermum australe,* with *Ficus coronata* also present. At Woondum State Forest, the canopy is dominated by *Eucalyptus propinqua*. • The sub-canopy consists of a range of rainforest species, including *Cryptocarya triplinervis, Aphananthe philippinensis* and *Streblus brunonianus.* • The shrub layer is sparse, to medium density, and contains *Atractocarpus chartaceus* and *Phyllanthus microcladus.* • Ground layer is typically open, with deep leaf litter, and *Lomandra hystrix,* however along much of Six Mile Creek, this habitat type is densely infested with cat's claw creeper.
Sheltering Resources:	Sheltering resources in this habitat type included deep leaf litter and coarse woody debris. Hollow logs, surface rock and rock slabs were present at Six Mile Creek, however were uncommon in Woondum State Forest. No tree hollows were recorded in this habitat type.
Foraging Resources:	Foraging resources in this habitat type included fleshy fruiting plants, such as *Ficus coronata*, flowering Eucalypts and insects. Areas of Woondum State Forest also contained termite mounds.
Disturbance:	The main disturbance in this habitat type is weed infestation. Riparian vegetation at Six Mile Creek is severely impacted by cat's claw creeper, and lantana occurs within vine forest in Woondum State Forest. Distant noise from the Bruce Highway to the west of the Survey Area can be heard throughout this habitat type.
Signs of fauna:	Signs of fauna in this habitat type included: • Bandicoot diggings; • Black-breasted button quail platelets, recorded throughout Woondum State Forest (refer *Section 4.1.1*); and • Echidna feeding signs in termite mounds. Fauna observed directly included microbats and common ringtail possums (*Pseudocheirus peregrinus*) seen while spotlighting, as well as a range of bird species, including migratory rainforest and wet forest species, Rufous fantail (*Rhipidura rufifrons*), spectacled monarch (*Symposiarchus trivirgatus*) (refer Annex D).
Fauna breeding places:	Fauna breeding signs in this habitat type included a brush turkey nest and juvenile birds present. Sheltering resources described above may provide suitable breeding places for some species.

Habitat Type	Vine Forest
Representative Photographs	 

Table 3.5 Cleared areas (with isolated trees)

Habitat Type	Cleared Areas
Overview:	This habitat type encompasses cleared areas of the Survey Area, with a total area of 393 ha within the Survey Area. This habitat type mostly contains land used for cattle grazing, as well as cleared areas in residential properties.
Vegetation Description:	Vegetation within this habitat type includes: • Cleared paddocks with pasture grasses and scattered native or non-native trees; • Cultivated gardens; and • Areas of native vegetation regrowth which is not high value regrowth, and typically comprises shrubs or stands of dense young acacia.
Sheltering Resources:	Sheltering resources in this habitat type include: • Dense pasture grasses; • Hollows or fissures in dead trees in paddocks; • Dense stands of shrubs or acacia regrowth; • Occasional small stands of trees; and • Disused buildings, such as sheds.
Foraging Resources:	Foraging resources in this habitat type include: • Seeding grass cover; • Insects; and • Fruiting and flowering plants in gardens
Disturbance:	This habitat type includes disturbed areas which have been predominately cleared of native vegetation. This habitat type includes grazing land and residential uses.
Signs of fauna:	Common bird species were observed in this habitat type.
Fauna breeding places:	Bird nests were recorded in this habitat type. Isolated trees, as well as open areas in paddocks, may provide suitable breeding habitat for a range of fauna species.

Habitat Type	Cleared Areas
Photographs showing regrowth vegetation and scattered trees	

3.4 *AQUATIC HABITAT FEATURES*

Within the broad habitat types described in *Section 3.3*, there are two broad types of aquatic habitat features: waterways (including permanent and ephemeral waterways) and dams, described in *Table 3.6* and *Table 3.7* respectively.

Table 3.6 Waterways

Habitat Type	Creeks
Overview:	Three permanent waterways are present at the Survey Area, Six Mile Creek, Curra Creek and Deep Creek. In addition, numerous ephemeral waterways are also present throughout the Survey Area. During Survey Period 1, the ephemeral waterways investigated were typically dry, or contained only still pools. Survey Period 2 was undertaken following heavy rain and most ephemeral waterways investigated held water or had a slow flow. The permanent waterways were typically deep (>1 m) with a slow to medium flow, while ephemeral creeks were not observed to be more than 0.5 m deep, with the exception of deeper pools at some locations, and were still or slow flowing. Water clarity was typically turbid and some creeks were tannin-stained.
Habitat features:	• Most of the streams investigated had a diversity of habitat types, including deeper pools, shallower sections with faster flow and riffles. • Numerous waterways contained moderate or dense fringing vegetation, such as lomandra, rushes, sedges and grasses. • Only one stream contained emergent vegetation, and no streams contained submerged or floating vegetation. • Instream sheltering resources such as logs and rocks were common at the majority of waterways, and some waterways also contained rock shelves or boulders.
Disturbance:	Disturbances at waterways included: • Minor erosion from cattle crossings; • Cat's claw creeper infestations on bank; and • Litter, such as discarded tyres, within streams, however this was not common.

Habitat Type	Creeks
Signs of fauna:	Reptile species directly observed within and near waterways include the eastern water dragon (*Intellagama lesueurii*), southern spotted velvet gecko (*Oedura tryoni*) and keelback snake (*Tropidonophis mairii*). Numerous frog species were recorded around waterways, including great barred frog (*Mixophyes fasciolatus*), green tree frog (*Litoria caerulea*), dainty green tree frog (*Litoria gracilenta*), Peron's tree frog (*Litoria peronii*), striped marsh frog (*Limnodynastes peronii*), wilcox's frog (*Litoria wilcoxii*) and eastern dwarf tree frog (*Litoria fallax*). Refer to Annex D for a full species list.
Fauna breeding places:	Waterways are likely to contain breeding places for a range of species.
Representative Photographs	

Table 3.7 Dams

Habitat Type	Dams
Overview:	Numerous dams are present within paddocks and residential properties within the Survey Area.
Habitat features:	The dams surveyed were typically turbid with moderate to dense fringing vegetation. Some floating macrophytes were also present.
Disturbance:	The dams are constructed, rather than naturally occurring waterbodies. Water within the dams was turbid, and some non-native vegetation was present fringing the dams.
Signs of fauna:	Common frog species were present at the edges of dams, including dusky toadlet (*Uperoleia fusca*), striped marsh frog (*Limnodynastes peronii*) and eastern dwarf tree frog (*Litoria fallax*). Refer to Annex D for a full species list. Bird species were also recorded surrounding dams.
Fauna breeding	Dams and surrounding areas are likely to provide breeding habitat for a

Habitat Type	Dams
places:	range of fauna species.
Representative Photographs	 

4 FAUNA SPECIES OF CONSERVATION SIGNIFICANCE

Following the desktop investigations and field surveys, and in accordance with the likelihood of occurrence criteria detailed in this report, fauna species of conservation significance known, likely or with potential to occur in the Study Area have been identified. Relevant information for each species is contained in detailed species profiles in *Annex E.* This section provides a summary of what is contained in the detailed species profiles.

For preparation of documentation to meet State and Federal regulatory requirements, reference should be made to the information in the species profiles in *Annex E.* The information contained in the species profiles includes:

- general information on the conservation status, distribution, habitat preferences and, where relevant, population estimates of each species;
- records of the species from field surveys (including Summer 2016 field surveys, and field surveys undertaken for the REF), and database records for the species from the surrounding area;
- suitability of habitat within the Survey Area, including a description of breeding, foraging and dispersal habitats, where relevant;
- the revised likelihood of occurrence assessment, based on summer 2016 field surveys and current database searches;
- evaluation of the likelihood of breeding places being present within the Survey Area, based on species' known breeding habitat requirements and habitat features identified through field surveys; and
- a conclusion of the key findings of the species, separated for Section D1 and D2, to assist in understanding the ecological value of each section of the alignment for species of conservation significance.

For species listed under the EPBC Act, the following items were also evaluated, in light of field survey findings and available information on species ecology and biology, as required by the SIG 1.1 (DoE 2013):

- whether habitat present at the Survey Area is habitat critical to the survival of species; and
- whether the Survey Area contains important populations of a species.

In summary, three threatened species, the black-breasted button quail, koala and tusked frog have been recorded, and therefore are known to occur, within the Survey Area. While the black-breasted button quail and koala were not directly sighted, koala faecal pellets and platelets associated with black-breasted button quail feeding were observed. In accordance with definitions contained within regulatory guidelines, the Survey Area is considered to provide habitat critical to the survival of these species.

The tusked frog is also known to occur in the Survey Area as it was recorded during field surveys for the REF (Jacobs 2016), and the Survey Area is likely to contain breeding places for the species.

Additional threatened species are considered likely, or with potential to occur in the Survey Area. The Survey Area is not considered to provide habitat critical to the survival of these species, and no species were evaluated as having an important population within the Survey Area.

4.1 CONSERVATION SIGNIFICANT SPECIES KNOWN TO OCCUR WITHIN THE SURVEY AREA

Three conservation significant species, the black-breasted button quail, koala and tusked frog have been recorded, and therefore are known to occur, within the Survey Area.

Black-Breasted Button-Quail (Turnix Melanogaster)

The black breasted button quail is known to occur in Section D1, and unlikely to occur in Section D2, as noted in the table below.

Species	**Black-Breasted Button-Quail (*Turnix Melanogaster*)**	
Conservation Status	*EPBC Act:* Vulnerable *NC Act:* Vulnerable *Back on Track:* Critical priority (Regional)	
Records	*Field* No individuals were directly observed during 2016 summer field surveys, however, fresh feeding platelets were observed in vine thicket and surrounding eucalypt woodland with lantana in the understorey in Woondum State Forest (refer *Figure 5* in Annex A). Vegetation in this area within the footprint includes *E. propinqua* dominated woodland with areas of vine forest on gentle slopes. Platelets were also observed at this location during field surveys for the REF (Jacobs 2015).	*Databases:* Wildnet: two records within 10 km of the alignment: Six Mile Creek Reserve (2006) < 1 km west of the alignment, Mothar Mountain State Forest 393 (1997) 7.5 km south east of the alignment. ALA: 3 records within 10 km of the alignment: 2 records as above and one Queensland Museum specimen collected from <3 km west of the alignment.
Habitat Suitability	Known habitat in the southern portion of D1 in Woondum State Forest with fresh feeding platelets observed. SEVT and surrounding eucalypt woodland with lantana in the understorey, including *E. propinqua* dominated woodland with areas of vine forest on gentle slopes (refer *Figure 5* in Annex A). No suitable habitat (vine thicket, vine forest, elements of these in understorey or acacia thickets) was observed within D2.	
Likelihood of occurrence	*Likelihood from REF* Expected to occur	*Revised Likelihood* Known to occur

Species	Black-Breasted Button-Quail (*Turnix Melanogaster*)	
Likelihood of Breeding Places	The species is considered sedentary and a high density of fresh feeding platelets was observed during the summer 2016 field surveys and the REF surveys. It is therefore likely that breeding occurs within the suitable habitat in the Survey Area, and in suitable habitat outside the Survey Area.	
Evaluation of Habitat Critical to the Survival of the Species	Fresh feeding platelets were observed in vine thicket and surrounding eucalypt woodland with lantana in the understorey in Woondum SF within the proposed footprint (D1). The vine thicket habitat type and surrounding eucalypt woodland in the Survey Area is regarded as habitat critical to the survival of the species. It is recognised foraging habitat (based on field observations) and due to the sedentary nature of the species, it is also likely to be breeding habitat.	
Importance of Population	In 1997, the national recovery plan for Black-breasted Button-Quail described key subpopulations included the Yarraman-Nanango, Jimna-Conondale Range and Great Sandy regions subpopulations due to their size and habitat protected within State-owned tenure. Other important subpopulations were those at the Palm Grove National Park and the Barakula State Forest area because they appeared to be the last remnant populations within an area where the species was formerly widespread. The key sub-populations listed in the recovery plan do not include the population detected within the Survey Area. This population is not located near the limit of the species range and no genetic information for this population is published (or was collected).	
Conclusion	*Section D1* Species known to occur (previous records in area and fresh feeding platelets observed during field surveys) within suitable SEVT and adjacent eucalypt woodland habitat in the Survey Area (refer *Figure 5* in Annex A).	*Section D2* Unlikely to occur as suitable habitat is not present within this portion of the footprint and REF and summer 2016 field surveys failed to identify signs or individuals.

Koala (Phascolarctos cinereus)

While most eucalypt forests and woodlands that occur in the Survey Area contained tree species used by koalas, findings from the summer 2016 field surveys indicated that koalas are present at very low densities. Based on work published by Ellis et al. (2013), where the proportion of trees with pellets was plotted against known koala density, koala density in the survey area is estimated to be about 0.02 koalas/ha. When compared with koala densities in other parts of the south-east Queensland Bioregion, that are typically in the range of 0.2-0.6 koalas/ha, this is considered to be very low (it is recognised that densities of this order are predominately associated with populations in the southeast corner of the Bioregion).

While koala densities are considered to be very low, field observations and data collected using the SAT indicates variable use of koala habitat in the Survey Area. For the purposes of this assessment, koala habitat within the Survey Area has been divided into four habitat groups:

- *Generally unsuitable habitat* – water bodies, predominately cleared areas, or mature regrowth vegetation not containing recognised koala food tree species;

- *Regrowth habitat* – mature regrowth vegetation containing recognised koala food tree species;

- *Remnant habitat with less frequent detection of koalas or signs* – mapped remnant Regional Ecosystems where koala pellets were recorded at greater than 50% of SAT locations; and

- *Remnant habitats with more frequent detection of koalas or signs* – mapped remnant Regional Ecosystems where koala pellets were recorded at less than 50% of SAT locations.

It must be noted that caution should be afforded the interpretation of these habitat categories, as the categories should not be misconstrued as a hierarchy of koala habitat value. While it is safe to assume the *generally unsuitable habitat* category is of lesser value than the other categories, determining value for comparative purposes should consider other parameters such as patch size, wider landscape connectivity, previous landuse, neighbouring koala populations, survey design limitations etc. These have not been considered in this assessment. Despite this, what is clear is that the limited frequency of observed koala evidence indicates a very low abundance of koalas in the Survey Area. This needs to be considered during the development of future project documentation.

Species	**Koala (*Phascolarctos cinereus*)**		
Conservation Status	*EPBC Act:* *NC Act:* *Back on Track:*	Vulnerable Vulnerable -	
Records	*Field:* Koala scats were found at 12 of 41 sites searched using the modified SAT, as described in *Section 2.3*. Site locations are shown in *Figure 4* in Annex A. The scats were found within large patches of remnant vegetation in association with State Forest areas (Curra SF in the north and Woondum SF in the south) and the East Deep Creek and Mothar Mountain area just north of Woondum SF. During the surveys, koala scats were found beneath 2% of		*Databases* ALA: One record within 10 km of the alignment: Gympie National Park (2013) included in Wildnet above. In addition, based on experience undertaking field surveys in the region, it is understood there are numerous additional records of the species within 5 km of the Survey Area which are not available through database searches.

Species	Koala (*Phascolarctos cinereus*)	
	searched trees (28 of 1230 trees), indicating that koalas use the area but are likely to occur at very low densities (about 0.02 koalas/ha). Signs of koala were also detected during field surveys for the REF.	
Habitat Suitability	While most eucalypt forests and woodlands in the Survey Area contained tree species used by koalas, findings from summer 2016 field surveys indicated that koalas are present at very low densities (estimated at about 0.02 koalas/ha). This may indicate that these more extensive vegetated areas are more suitable and important habitat to koalas compared to other areas along the alignment. Based on the results of the SAT, habitat within the Survey Area has been divided into four habitat categories: • Generally unsuitable habitat • Regrowth habitat • Remnant habitat with less frequent detection of koalas or signs • Remnant habitats with more frequent detection of koalas or signs These habitat types and the locations of koala faecal pellets detected are shown in *Figure 4* Annex A.	
Likelihood of occurrence	*Likelihood from REF* Known to occur	*Revised Likelihood* Known to occur
Likelihood of Breeding Places	Established adults are fairly sedentary and there have been records of koalas within the Survey Area and surrounds. It is therefore likely that breeding occurs within habitat within the Survey Area.	
Evaluation of Habitat Critical to the Survival of the Species	The koala habitat assessment tool provided in the EPBC Act referral guidelines for the vulnerable koala (Department of the Environment 2014a) was used and yielded a habitat score of eight. The referral guidelines state that habitat which receives a score of five or more is considered habitat critical to the survival of the koala. Therefore, the Survey Area is considered to contain habitat critical to the survival of the koala.	
Importance of Population	During the summer 2016 surveys, koala scats were found beneath 2% of searched trees (28 of 1230 trees), indicating that koalas use the area but are likely to occur in very low densities. The genetic and disease status of the koalas present in the Survey Area is not known and no evidence of breeding was gathered during the 2016 summer surveys.	
Conclusion	*Section D1* Species known to occur at very low densities (previous records in area and suitable habitat and scats observed during summer 2016 field surveys) within forest and woodland communities dominated by eucalypt species within the Survey Area. Of particular note are the areas associated with Woondum State Forest (including residential land adjoining the southern extent of Woondum State Forest) and the area surrounding Penny Road.	*Section D2* Species known to occur at very low densities (previous records in area and suitable habitat and scats observed during summer 2016 field surveys) within forest and woodland communities dominated by eucalypt species within the Survey Area. Faecal pellets were found in the south of Curra State Forest, and in freehold land in vegetation contiguous with Curra State Forest.

Tusked frog (Adelotus brevis)

The tusked frog was observed from two locations during field surveys for the REF. Despite significant duplicate survey effort in suitable habitats in Summer 2016, the species was not recorded, indicating that there is likely to be seasonal variability in abundance. As a result of previous survey effort and confirmed presence, in combination with suitable habitat, the species is considered known to occur in both Sections D1 and D2.

<table>
<tr><th>Species</th><th colspan="3">Tusked frog (Adelotus brevis)</th></tr>
<tr><td>Conservation Status</td><td>EPBC Act:
NC Act:
Back on Track:</td><td colspan="2">-
Vulnerable
Critical Priority (Regional), Medium Priority (State)</td></tr>
<tr><td>Records</td><td colspan="2">Field:
The species was recorded at two locations in the north of Section D2 during field surveys for the REF (refer Figure 5 in Annex A).
The species was not observed directly or indirectly during Summer 2016 surveys, despite significant duplicate survey effort. Conditions were considered conducive to amphibian activity with numerous other least concern amphibian species observed during the same survey period. Despite no direct or indirect observations, most night survey sites were considered likely habitat, including pools and slow moving waterways with overhanging ledges, rocks or logs.</td><td>Databases
ALA: 1 record since 2010 (inclusive) in Bollier (approximately 17 km south of the alignment).
Wildlife Online: One record within 10 km of the alignment.</td></tr>
<tr><td>Habitat Suitability</td><td colspan="3">This species was recorded at two locations during the 2015 surveys for the REF and are expected to occur in wetlands and slow moving waterways within the footprint. These two locations were again re-surveyed in January 2016 and February 2016 and no direct or indirect observations were reported although other least concern amphibian species were observed.
Figure 5 in Annex A shows suitable breeding habitat for Adelotis brevis, based on a 25 m buffer to the stream centreline, within habitat mapped within the REF. The 25 m buffer was applied as the species is recognised as occur within or beside streams, and only occasionally more distant from streams (Curtis and Dennis 2012). Waterways within mature regrowth were not added to the mapped habitat, as it was considered unlikely these would provide the level of habitat complexity found in the remnant vegetation.</td></tr>
<tr><td>Likelihood of occurrence</td><td colspan="2">Likelihood from REF
Known to Occur</td><td>Revised Likelihood
Known to Occur</td></tr>
<tr><td>Likelihood of Breeding Places</td><td colspan="3">There are wetlands and slow moving waterways with overhanging ledges, rocks or logs present within the footprint (Refer Figure 5 Annex A). Breeding places are likely to occur given records of the species within the vicinity and the presence suitable breeding habitat.</td></tr>
</table>

Species	Tusked frog (*Adelotus brevis*)	
Conclusion	*Section D1* Species known to occur within the Survey Area, as there are previous records of the species approximately 3 km to the west of Section D1 and suitable habitat observed during field surveys, within and adjacent to waterways in regional ecosystems associated with moist forest and dense undergrowth habitats.	*Section D2* The species has been recorded at two locations in Section D2 (Refer *Figure 5* in Annex A) and additional suitable habitat is present in Section D2 within and adjacent to waterways in regional ecosystems associated with moist forest and dense undergrowth habitats.

4.2 CONSERVATION SIGNIFICANT SPECIES LIKELY TO OCCUR WITHIN THE SURVEY AREA

Powerful Owl (Ninox Strenua)

Powerful owl records are known from within 10km of the Survey Area, and suitable foraging and breeding habitat have been observed eucalypt forests and woodlands of Curra and Woondum State Forests. Breeding places for the species was recorded during field surveys, but are generally restricted to previously unlogged gullies and riparian vegetation within the Survey Area.

Species	Powerful Owl (*Ninox strenua*)	
Conservation Status	*EPBC Act:* *NC Act:* *Back on Track:*	- Vulnerable Critical Priority (Regional), Medium Priority (State)
Records	*Field*: The species was not recorded during field surveys. Large trees with potential nesting hollows were observed at two sample locations in Curra State Forest, and two sample locations in Woondum State Forest. Signs and direct observations of prey species such as possums, gliders and flying foxes were observed within Curra State Forest and Woondum State Forest, as well as on freehold land within the Survey Area.	*Databases:* ALA: Three records since 2010 (inclusive) in Gympie National Park and Bella Creek areas. The two records in Gympie National Park are less than 10 km from the nearest point on the alignment (approximately 7 km and 8.5 km), while Bella Creek is approximately 28 km from the nearest point on the alignment (D1 southern end). Wildlife Online: 12 records within 10 km of alignment. The two closest wildlife online records are the same records reported in Gympie National Park on ALA (ie. 7 km and 8.5 km from alignment).
Habitat Suitability	This species is known to persist in native commercial timber estates where it forages in logged or regenerating areas and roosts in unlogged areas such as gullies where large trees with hollows still remain (Curtis and Dennis 2012). Some areas within the Survey Area remain connected to extensive areas of native forest which has been and is currently selectively harvested for commercial timber. These areas include Curra State Forest and Woondum	

Species	Powerful Owl (*Ninox strenua*)	
	State Forest. There are few large, well-positioned hollows in both living and dead trees within the Survey Area (*Figure 5* in Annex A). The large, well-positioned hollows are restricted to gullies where previous and current native timber harvesting has been restricted. Indirect and direct observations of prey species such as possums, gliders and flying foxes were observed within Curra State Forest and Woondum State Forest within the Survey Area.	
Likelihood of occurrence	*Likelihood from REF* Likely to occur	*Revised Likelihood* Likely to occur
Likelihood of Breeding Places	Powerful owls have large home ranges and have previously been recorded within 10 km of the alignment. The gully areas within Curra and Woondum State Forest with large hollows are considered likely breeding areas within the Survey Area, given the previous records within 10 km of the alignment, large home range, connectivity to extensive native forest, appropriate size and position of hollows and surrounding suitable foraging habitat. Adjacent selectively logged areas and rural bushland areas are considered suitable foraging habitat given the direct and indirect observations of prey species such as possums, gliders and flying foxes.	
Conclusion	*Section D1* Species likely to occur (previous records within 10 km and suitable breeding and foraging habitat observed during field surveys) within Survey Area.	*Section D2* Species likely to occur (previous records within 10 km and suitable breeding and foraging habitat observed during field surveys) within Survey Area.

Grey-Headed Flying-Fox (Pteropus poliocephalus)

The grey-headed flying fox is known to occur in the greater Gympie region, with confirmed presence at three separate roost sites in the region (but outside of the Survey Area). However, as the species is known to forage up to 25km from roost sites, it is likely that the species would forage in the Survey Area, particularly when eucalypt dominated forests and woodlands are flowering. As the species is highly mobile and the foraging habitat within the Survey Area is small in comparison to continuous habitat adjacent to the Survey Area and in the wider landscape, the foraging habitat within the Survey Area is not likely to be regarded as habitat critical to the survival of the species.

Species	Grey-headed flying-fox (*Pteropus poliocephalus*)	
Conservation Status	*EPBC Act:* Vulnerable *NC Act:* - *Back on Track:* Critical priority (Regional)	
Records	*Field:* No roost sites were detected during the survey. Flying fox species were observed during summer 2016 field surveys but species identity was unconfirmed. The REF reported a record of grey-headed flying-fox in Curra State Forest, approximately 500 m north east of the Survey Area.	*Databases:* Wildnet: 39 records within 10 km of the alignment: 38 records at Gympie township, Widgee Crossing (2004-2011) 5 km west of the alignment, 1 record at Hill Street Camp (2004) 1.7 km west of the alignment ALA: as above 2012-2015 monitoring program: Known camps for this species within the region are in the Goomboorian, Gympie township, Kandanga and Cooran areas (DoE 2015) (refer *Figure 1* in Annex A).
Habitat Suitability	Suitable foraging habitat occurs throughout the Survey Area – eucalypts will flower at different times throughout the year. Fleshy fruiting trees were also recorded. There are no historical (2012-2015) roost sites within the Survey Area (DoE 2015).	
Likelihood of occurrence	*Likelihood from REF* Expected to occur	*Revised Likelihood* Likely to occur
Likelihood of Breeding Places	There are no historical (2012-2015) roost sites within the Survey Area (DoE 2016), where breeding occurs, but likely to breed at the roosts identified in *Figure 1* in Annex A and use the Survey Area for foraging.	
Evaluation of Habitat Critical to the Survival of the Species	While habitat used for foraging is located within the Survey Area, this species is highly mobile and the foraging habitat within the Survey Area is small in comparison to the patches of continuous habitat adjacent and in the wider landscape. Therefore, the foraging habitat within the Survey Area is not likely to be regarded as habitat critical to the survival of the species.	
Importance of Population	The national population is spatially structured into colonies of one single interbreeding population (DoE 2016). The individuals that camp within the region and use the foraging habitat within the Survey Area are therefore a part of a larger population and are not a separate sub-population that are a key source of genetics for breeding or dispersal. The alignment is not near the limit of the species range.	
Conclusion	*Section D1* Species likely to occur within remnant vegetation throughout Survey Area. There are previous records of the species within 10 km of the Survey Area, and there are roosting colonies at Goomboorian, Gympie township, Kandanga and Cooran areas.	*Section D2* Species likely to occur within remnant vegetation throughout Survey Area. There are previous records of the species within 10 km of the Survey Area, and there are roosting colonies at Goomboorian, Gympie township, Kandanga and Cooran areas.

4.3 CONSERVATION SIGNIFICANT SPECIES WITH POTENTIAL TO OCCUR WITHIN THE SURVEY AREA

The species profiles in *Annex E* contain detailed information for those conservation significant species with potential to occur with the Survey Area. As a result of field surveys, there is no evidence to suggest that important populations for the species with potential to occur exist in the Survey Area. The majority of species were identified in the REF (Jacobs 2015) as low potential to occur, and the likelihood of occurrence has been updated to potential to occur in the Survey Area based on the criteria outlined in Section 2.4. The conservation significant species with potential to occur in the Survey Area are:

- Australian Painted Snipe *(Rostratula australis)*
- Coxen's Fig-Parrot *(Cyclopsitta diophthalma coxeni)*
- Red Goshawk *(Erythrotriorchis radiatus)*
- Spotted-Tailed Quoll (Sthn Subspecies) *(Dasyurus maculatus maculatus)*
- Common Death Adder (*Acanthophis antarcticus)*
- Giant Barred Frog *(Mixophyes iteratus)*

For conservation significant species that were identified in the REF (Jacobs 2015) with low potential to occur in the Survey Area that have now been updated to unlikely to occur in the Survey Area (based on field surveys and the criteria in Section 2.4) are:

- Glossy Black-Cockatoo *(Calyptorhynchus lathami)*
- Northern Quoll *(Dasyurus hallucatus)*
- Richmond Birdwing Butterfly *(Ornithoptera richmondia)*
- Australian Fritillary Butterfly *(Argyreus Hyperbius Inconstans)*

4.4 MIGRATORY AND SPECIAL LEAST CONCERN SPECIES

An assessment was also undertaken for migratory and special least concern species and information is provided in the species profiles in *Annex E*. The species profiles outline:

- general information on the species conservation status, distribution, habitat preferences and, where relevant, population estimates;
- records of the species from field surveys (including Summer 2016 field surveys, and field surveys undertaken for the REF), and database records of the species from the surrounding area;

- suitability of habitat within the Survey Area, including description of breeding, foraging and dispersal habitats, where relevant;
- the revised likelihood of occurrence assessment, based on summer 2016 field surveys and current database searches;
- evaluation of the likelihood of breeding places being present within the Survey Area, based on species' known breeding habitat requirements and habitat features identified through field surveys;
- for migratory species, an evaluation of the likelihood of the Survey Area supporting an ecologically significant proportion of a population, or important habitat for these species; and
- a conclusion of the key findings of the species, separated for Section D1 and D2, to assist in understanding the ecological value of each section of the alignment for migratory and special least concern species.

In summary, four migratory species (cattle egret, fork-tailed swift, rainbow bee-eater and spectacled monarch) and the echidna have been recorded within the Survey Area. The Survey Area was not assessed as providing important habitat, or being likely to support an ecologically significant proportion of any populations of these species. The Survey Area is considered likely to contain breeding places for some migratory species and the echidna (listed as special least concern). Detailed information is contained within the species profiles in *Annex E.*

5 *CONCLUSIONS*

The Survey Area defined for Section D of the Bruce Highway Cooroy to Curra Project contains ecological values which require specific consideration for project approvals and development of supporting documentation, and will require specific management through design and construction of Section D. These include:

- The EPBC Act-listed threatened species koala and black-breasted button quail. Signs of these species were recorded within the Survey Area, and habitat within the Survey Area was evaluated as habitat critical to the survival of these species, based on Commonwealth guidelines.

- Known and potential habitat for EPBC Act-listed migratory species, although this habitat is unlikely to be important habitat for these species.

- Likely breeding places for tusked frog, powerful owl (vulnerable under the NC Act) and echidna (special least concern under the NC Act) in the Survey Area.

- Potential foraging, dispersal and breeding habitat for other conservation significant species listed under the EPBC Act and NC Act.

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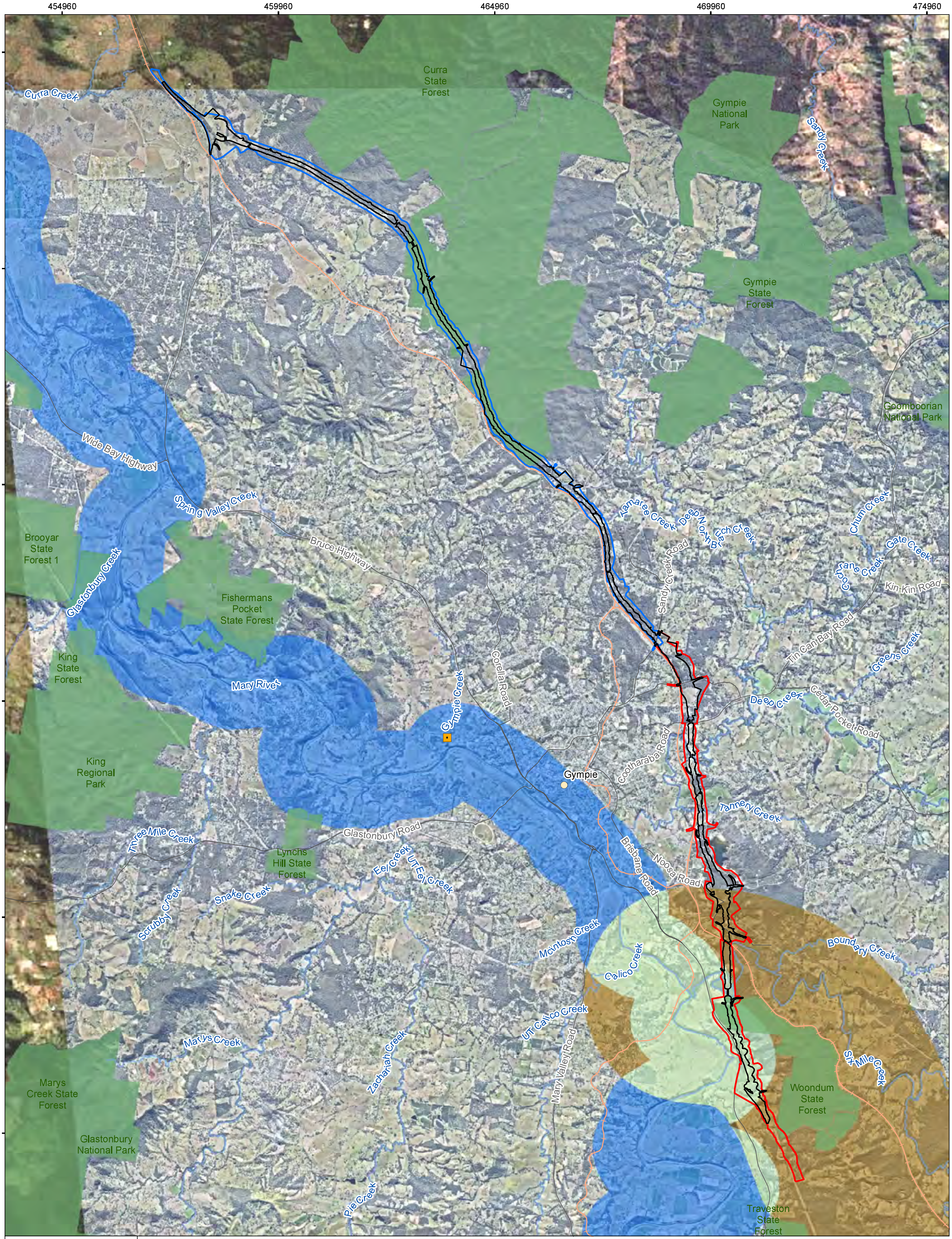
Annex A

Figures



Legend

- Project Footprint (Proposed)
- Road
- Railway
- Watercourse
- Protected Area
- Grey-headed Flying Fox Camp >50,000 individuals (2015)

Survey Area:

- D1
- D2

State or Regional Corridor:

- Terrestrial
- Riparian
- Riparian/Terrestrial

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Statewide or Regional Corridor - DEHP QLD Statewide Corridor Buffers v1.2
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Grey-headed Flying Fox Camp - DOE Interactive Flying-fox Web Viewer

N

0 1 2 3 Km
1:80,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G001_R0.mxd		
Date:	24/03/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

Figure 1: Survey Area Location

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

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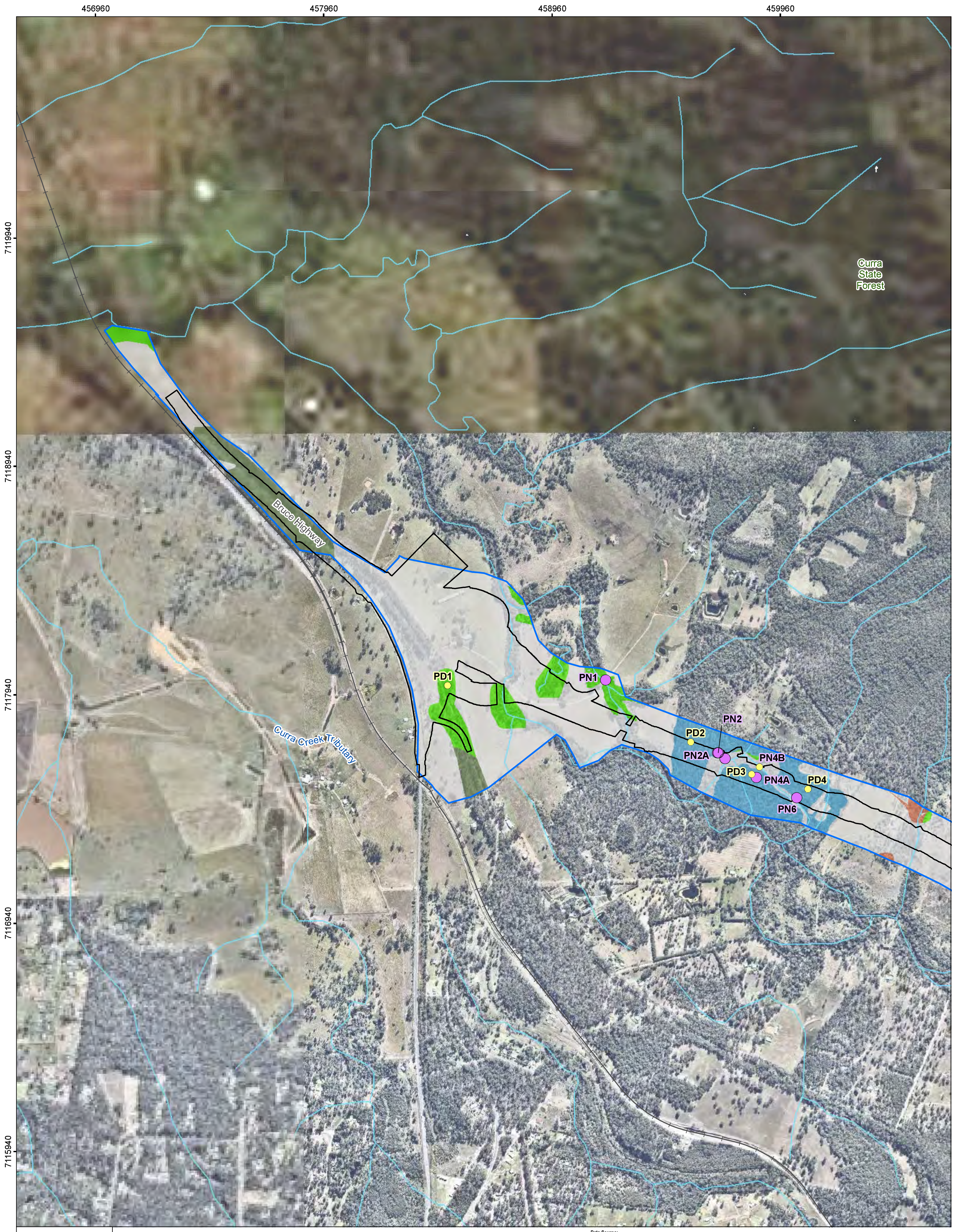

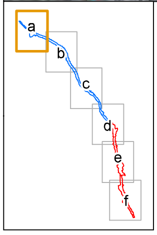

Legend

- Project Footprint (Proposed)
- Railway
- Watercourse

Survey Area:

- D1
- D2

Survey Location:

- Day
- Night

Habitat Assessment and SAT

Habitat Assessment

Regional Ecosystem:

- 12.3.11
- 12.3.3d
- 12.9-10.17b
- 12.9-10.3
- Non-rem

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Regional Ecosystem - DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

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GDA 1994 MGA Zone 56

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Drawn by:	TC	Reviewed by:	DD

Figure 2a: Survey Methods

Project: Bruce Highway (Cooroy to Curra)
Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

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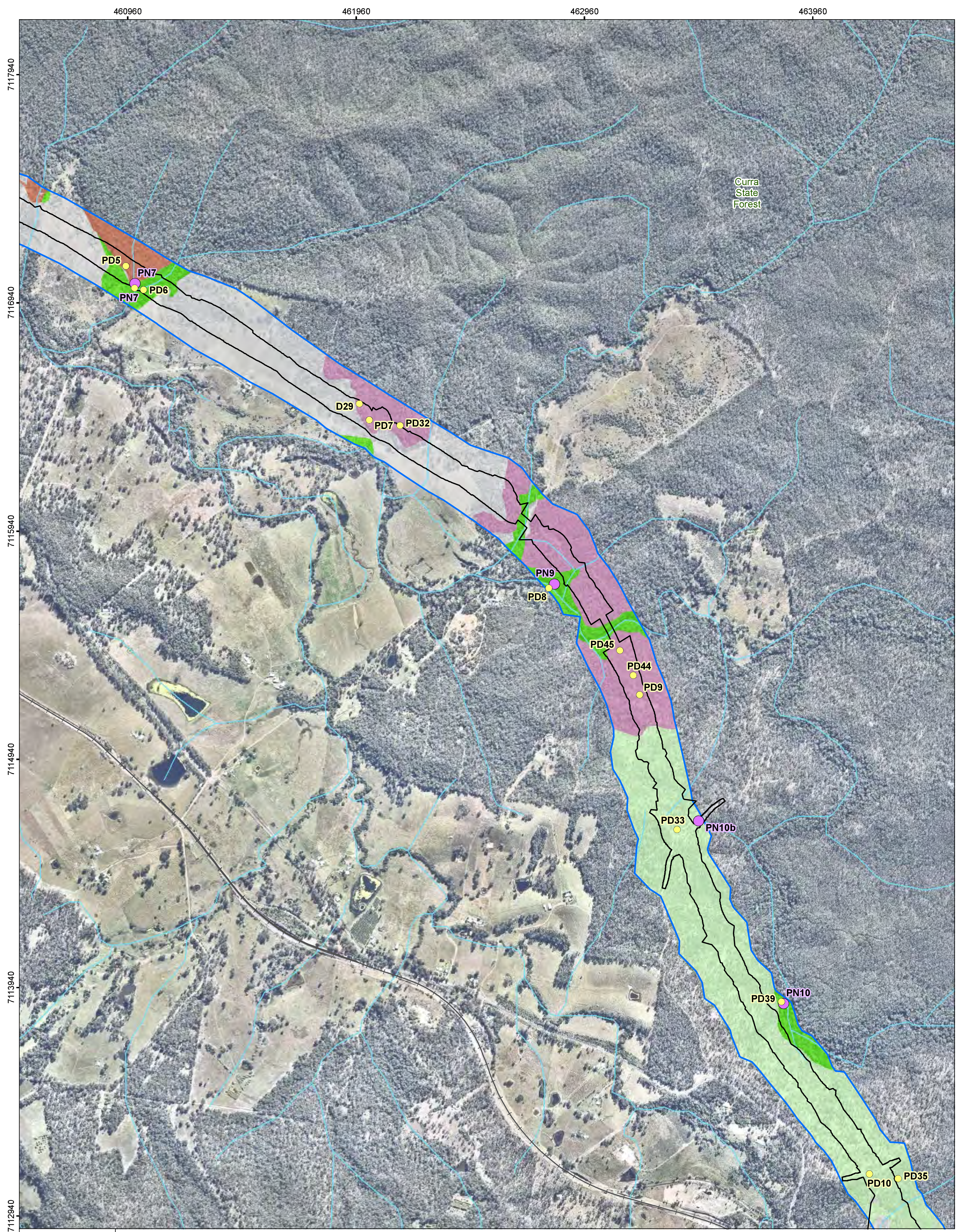
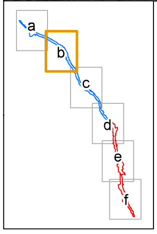




Legend

Project Footprint (Proposed)
Railway
Watercourse

Survey Area:
D1
D2

Survey Location:
Day
Night

Habitat Assessment and SAT
Habitat Assessment

Regional Ecosystem:
12.11.5e
12.3.11
12.9-10.17b
12.9-10.4
Non-rem

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Regional Ecosystem - DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N
0 100 200 300 m
1:15,000

GDA 1994 MGA Zone 56

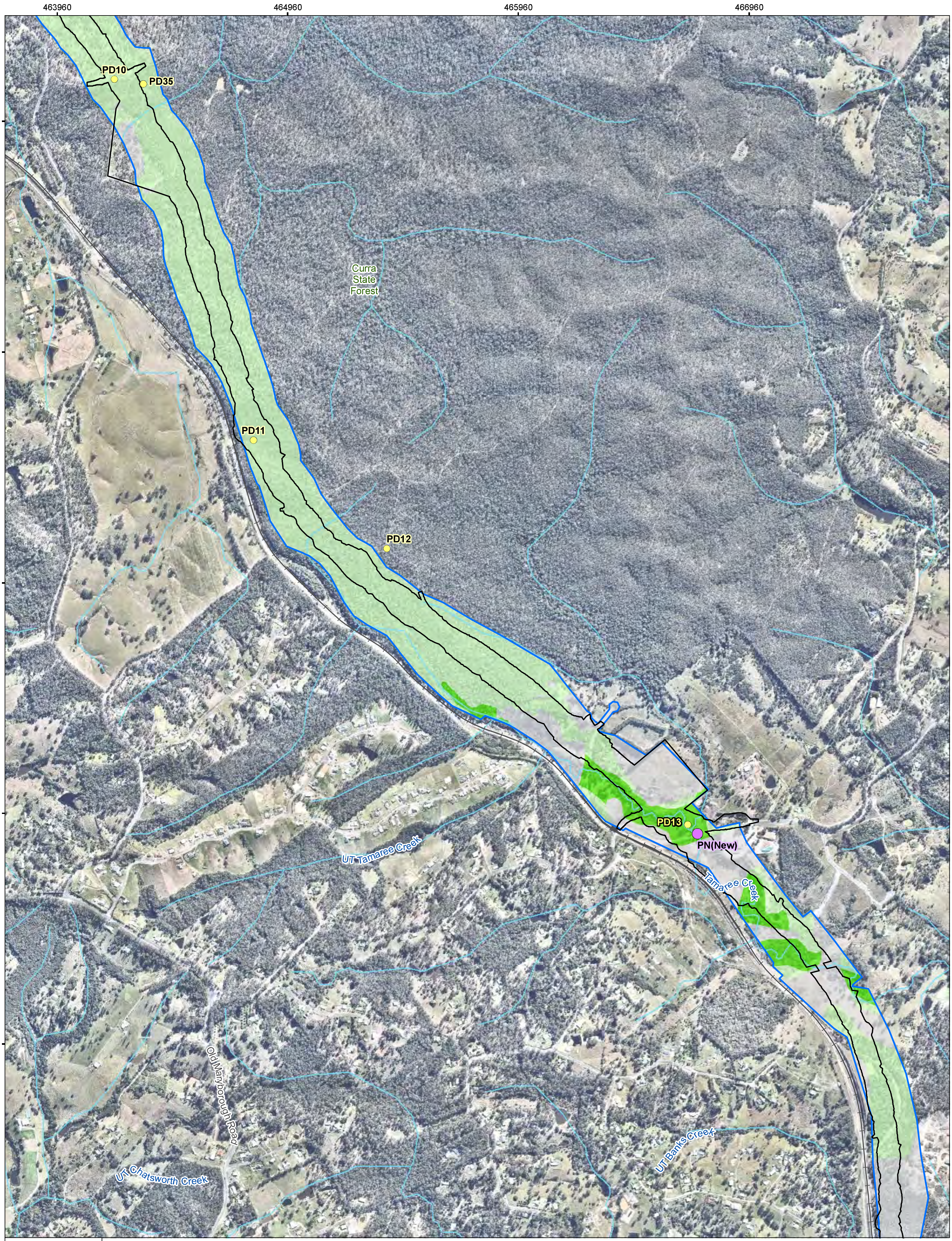
Drawing No:	0331161b_TFSR_G002_R2.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

Figure 2b: Survey Methods

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ



a
b
c
d
e
f

Legend

Project Footprint (Proposed)
Railway
Watercourse

Survey Area:
D1
D2

Survey Location:
Day
Night

Habitat Assessment and SAT
Habitat Assessment

Regional Ecosystem:
12.11.5e
12.3.11
Non-rem

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Regional Ecosystem - DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N
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GDA 1994 MGA Zone 56

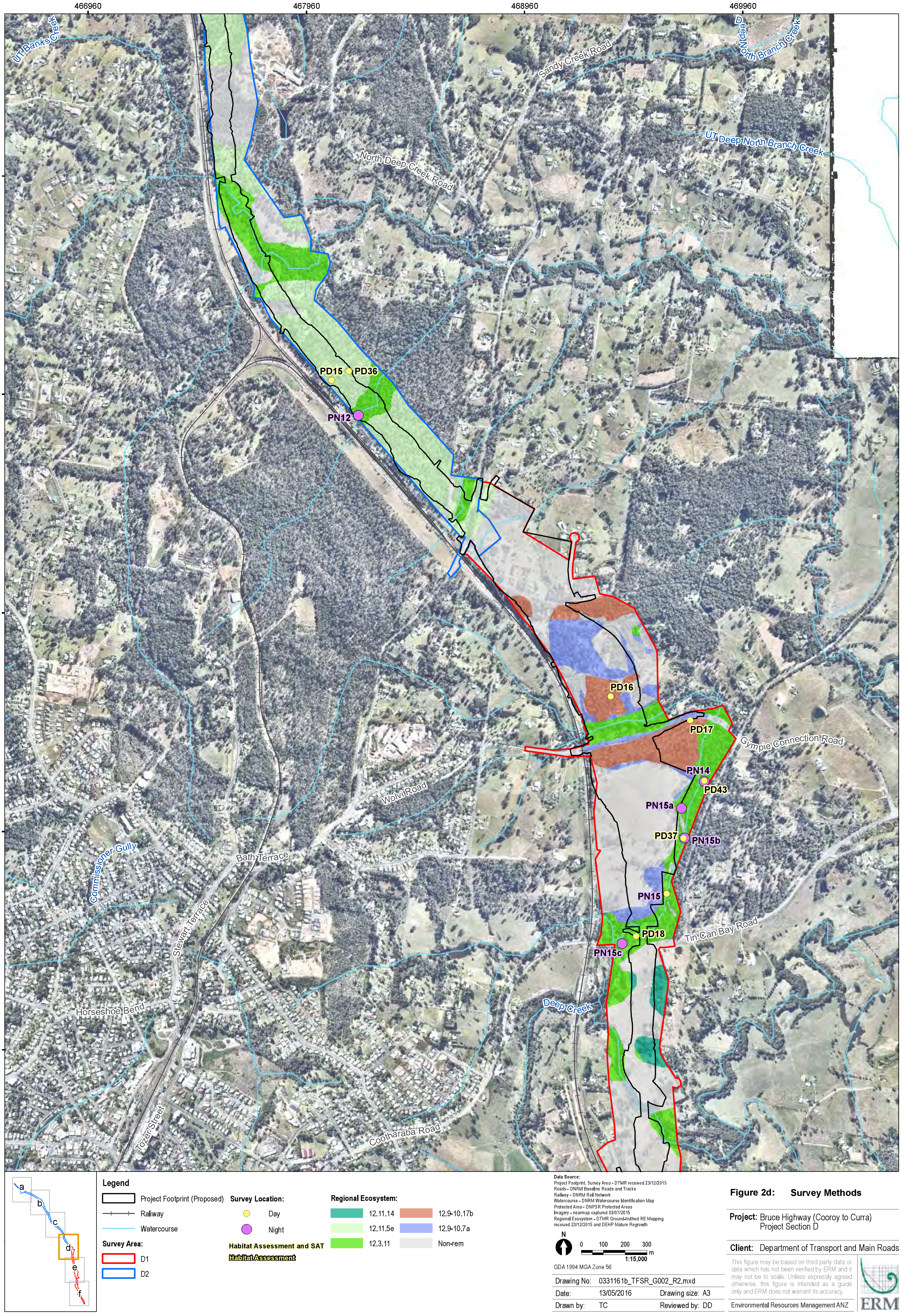
Drawing No:	0331161b_TFSR_G002_R2.mxd
Date: 13/05/2016	Drawing size: A3
Drawn by: TC	Reviewed by: DD

Figure 2c: Survey Methods

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ



Data Source:
Project Footprint, Survey Area – DTMR received 23/12/2015
Roads – DNRM Baseline Roads and Tracks
Railway – DNRM Rail Network
Watercourse – DNRM Watercourse Identification Map
Protected Area – DNPSR Protected Areas
Imagery – nearmap captured 03/07/2015
Regional Ecosystem – DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

Figure 2d: Survey Methods

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Drawing No:	0331161b_TFSR_G002_R2.mxd		
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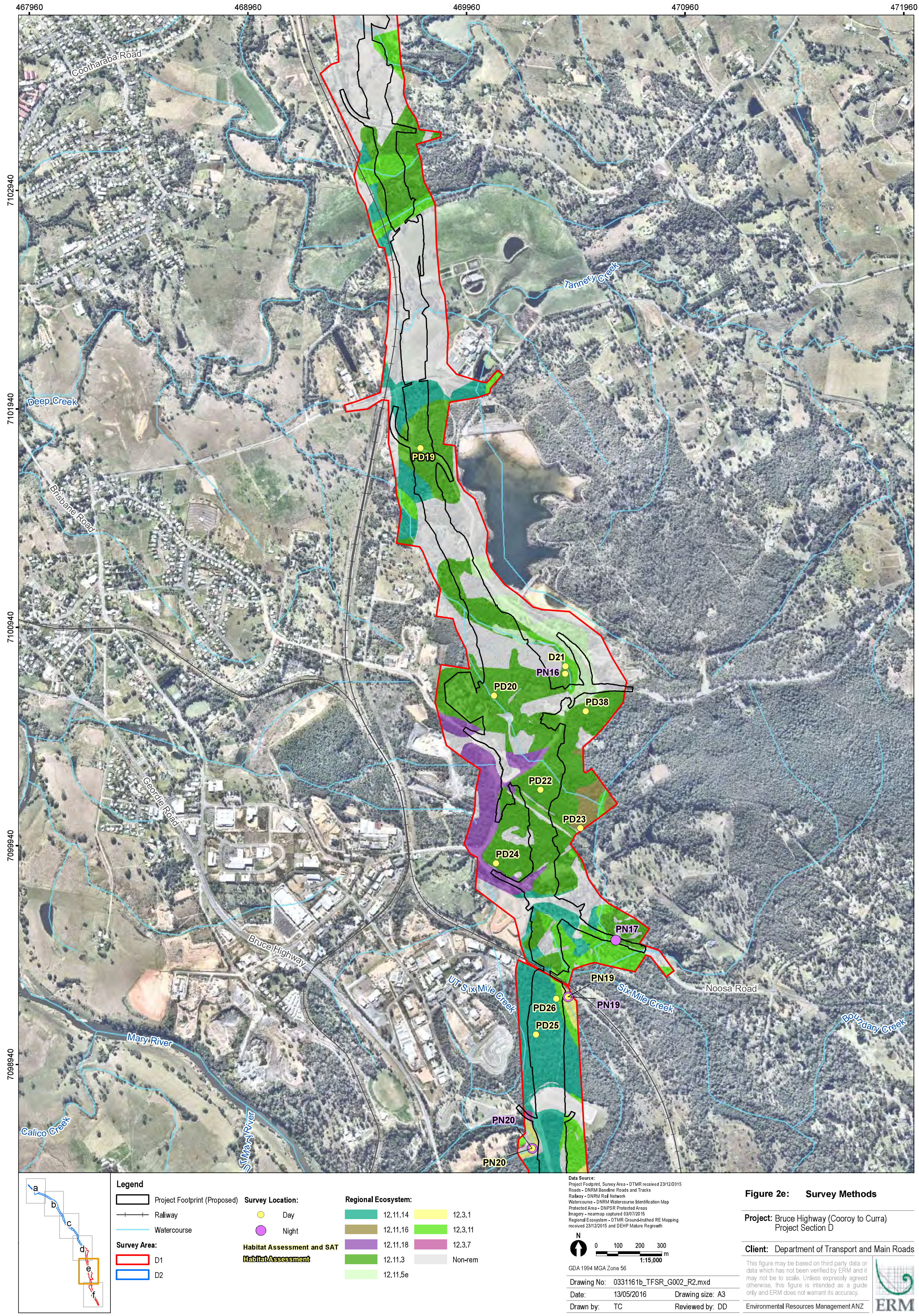
Environmental Resources Management ANZ



Data Source:
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Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Regional Ecosystem - DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

GDA 1994 MGA Zone 56

Figure 2e: Survey Methods

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Drawing No:	0331161b_TFSR_G002_R2.mxd		
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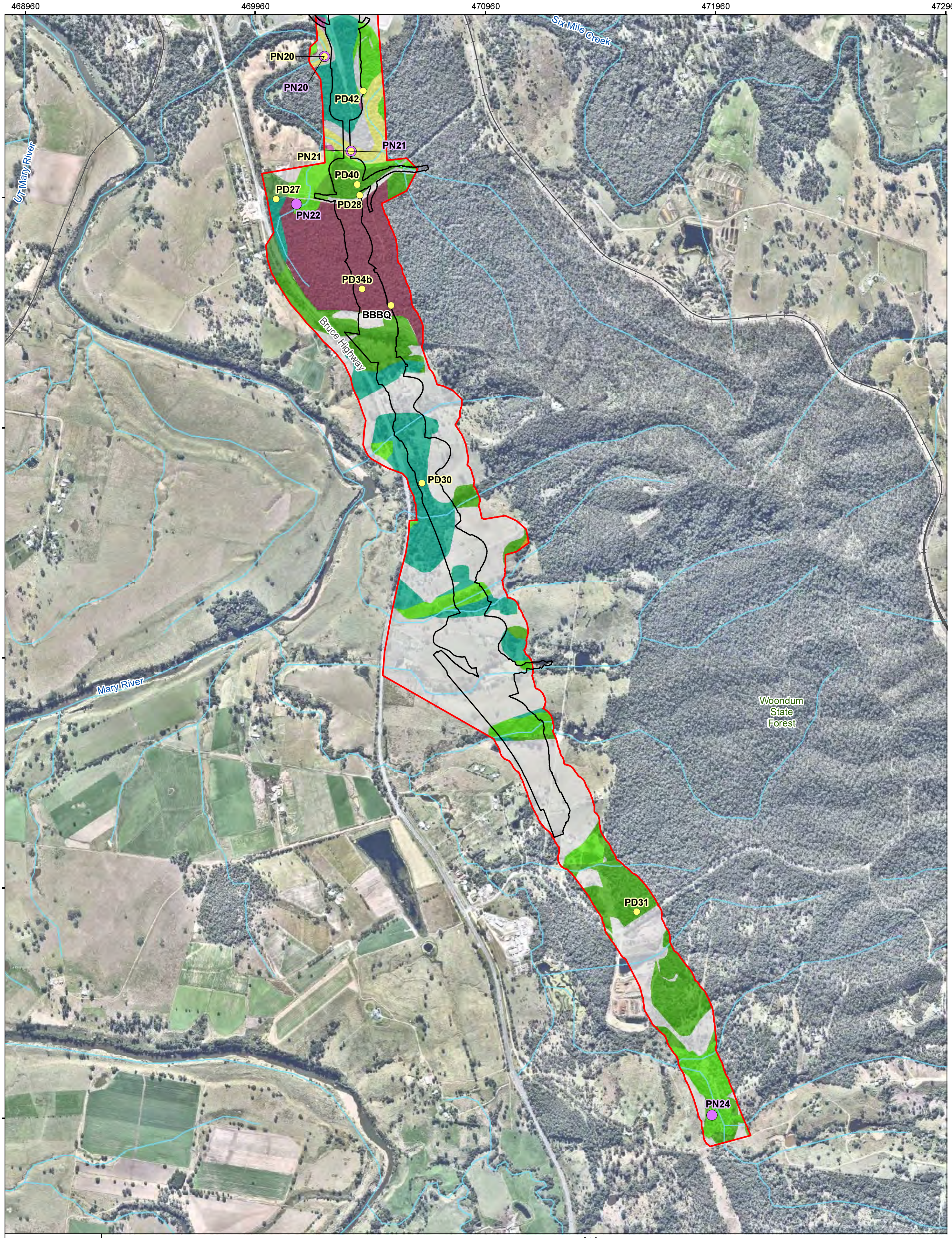
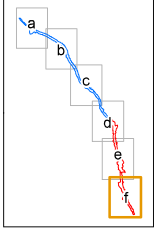
Drawn by:	TC	Reviewed by:	DD

Environmental Resources Management ANZ





Legend

- Project Footprint (Proposed)
- Railway
- Watercourse

Survey Area:

- D1
- D2

Survey Location:

- Day
- Night

Habitat Assessment and SAT

Habitat Assessment

Regional Ecosystem:

- 12.11.10
- 12.11.14
- 12.11.3
- 12.11.3/12.11.14
- 12.3.1
- 12.3.11
- 12.3.7
- 12.5.2
- Non-rem

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Regional Ecosystem - DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No: 0331161b_TFSR_G002_R2.mxd

Date: 13/05/2016 Drawing size: A3

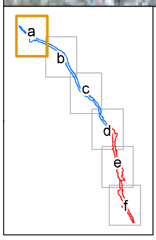
Drawn by: TC Reviewed by: DD

Figure 2f: Survey Methods

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ



Legend

Project Footprint (Proposed)

Railway

Watercourse

Hollow-bearing Trees Present

Survey Area:

D1

D2

Fauna Habitat Type:

Eucalypt Communities on Sedimentary and Metamorphic Rock

Eucalypt Communities On Alluvial Soils

Cleared Area

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Fauna Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No: 0331161b_TFSR_G003_R1.mxd

Date: 13/05/2016 Drawing size: A3

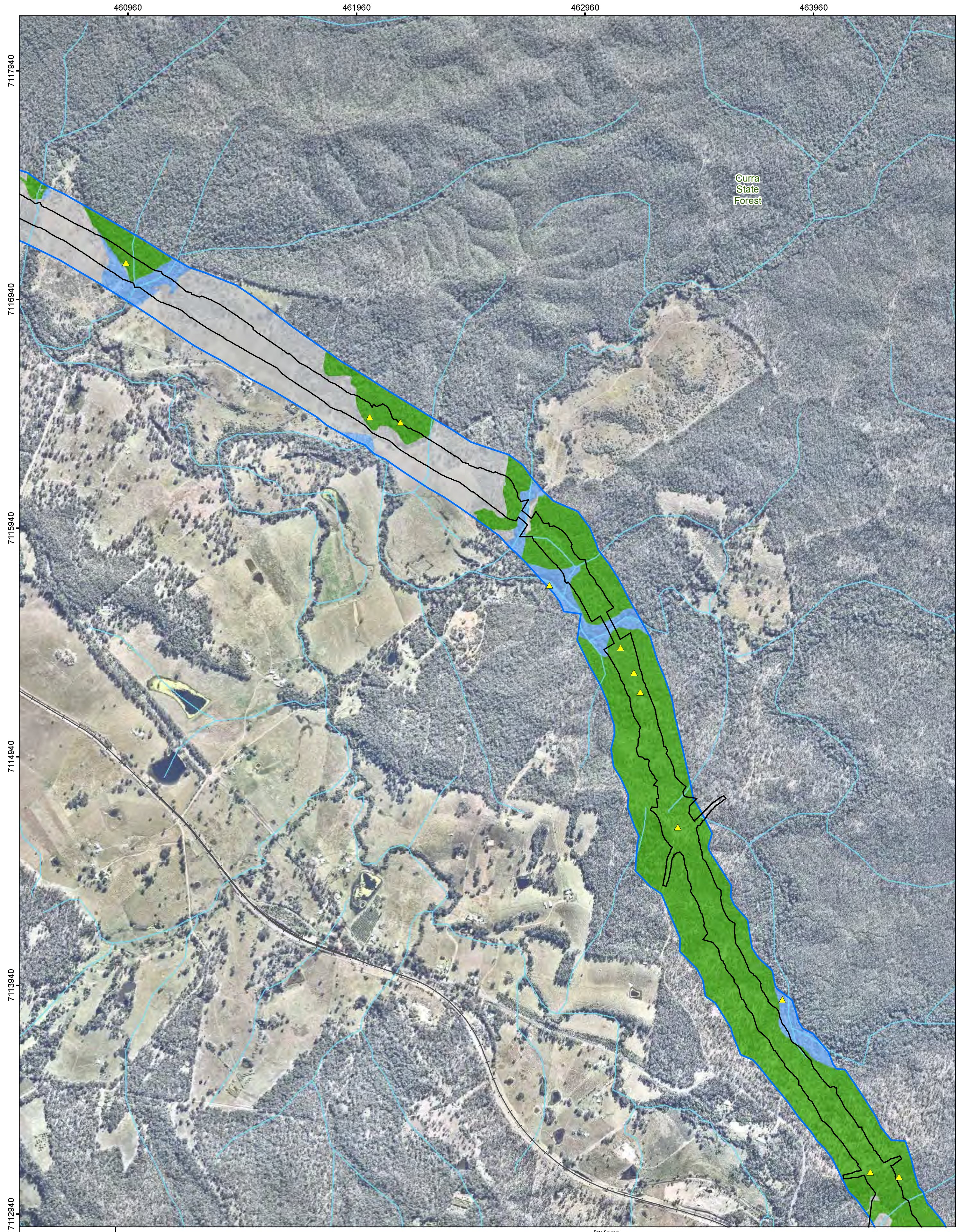
Drawn by: TC Reviewed by: DD

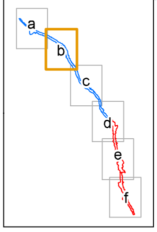
Figure 3a: Fauna Habitat Types

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ





Legend

Project Footprint (Proposed)

Railway

Watercourse

Hollow-bearing Trees Present

Survey Area:

D1

D2

Fauna Habitat Type:

Eucalypt Communities on Sedimentary and Metamorphic Rock

Eucalypt Communities On Alluvial Soils

Cleared Area

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Fauna Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

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GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G003_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

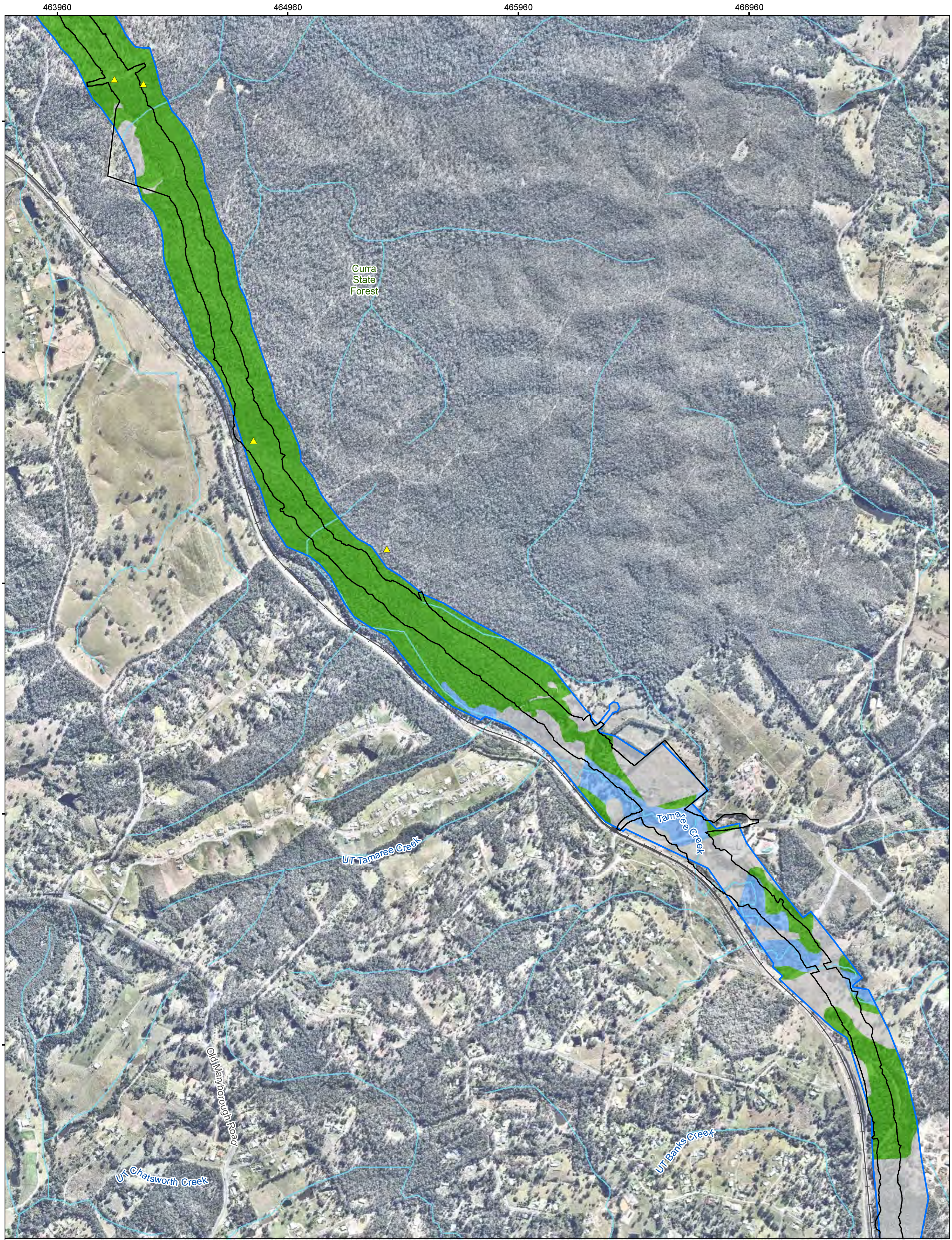
Figure 3b: Fauna Habitat Types

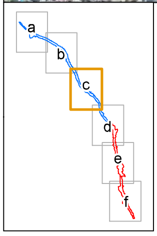
Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

ERM





Legend

Project Footprint (Proposed)

Railway

Watercourse

Hollow-bearing Trees Present

Survey Area:

D1

D2

Fauna Habitat Type:

Eucalypt Communities on Sedimentary and Metamorphic Rock

Eucalypt Communities On Alluvial Soils

Cleared Area

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Fauna Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G003_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

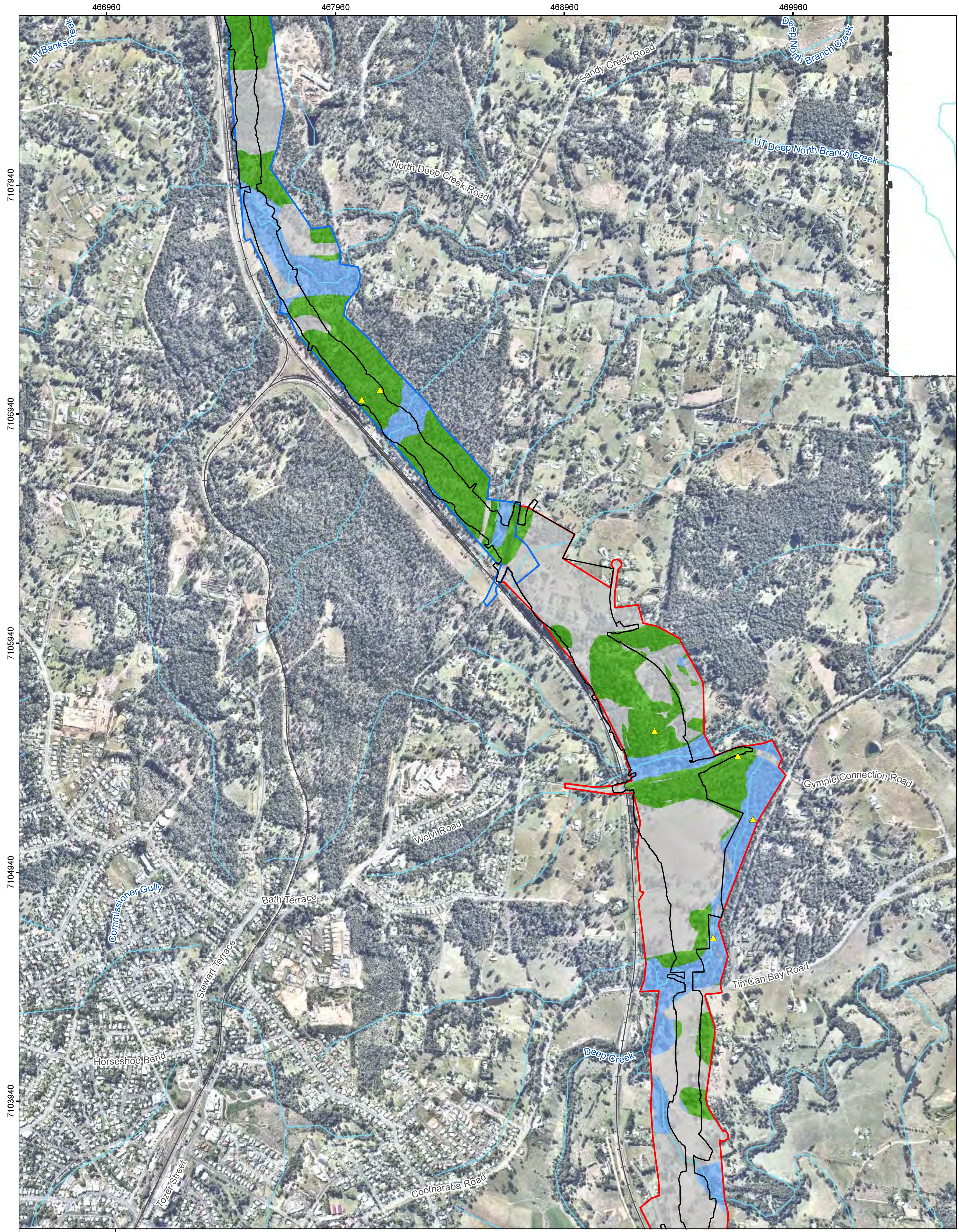
Figure 3c: Fauna Habitat Types

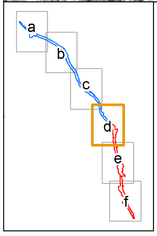
Project: Bruce Highway (Cooroy to Curra)
Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

ERM





Legend

- Project Footprint (Proposed)
- Railway
- Watercourse
- Hollow-bearing Trees Present

Survey Area:

- D1
- D2

Fauna Habitat Type:

- Eucalypt Communities on Sedimentary and Metamorphic Rock
- Eucalypt Communities On Alluvial Soils
- Cleared Area

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Fauna Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

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1:15,000
GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G003_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

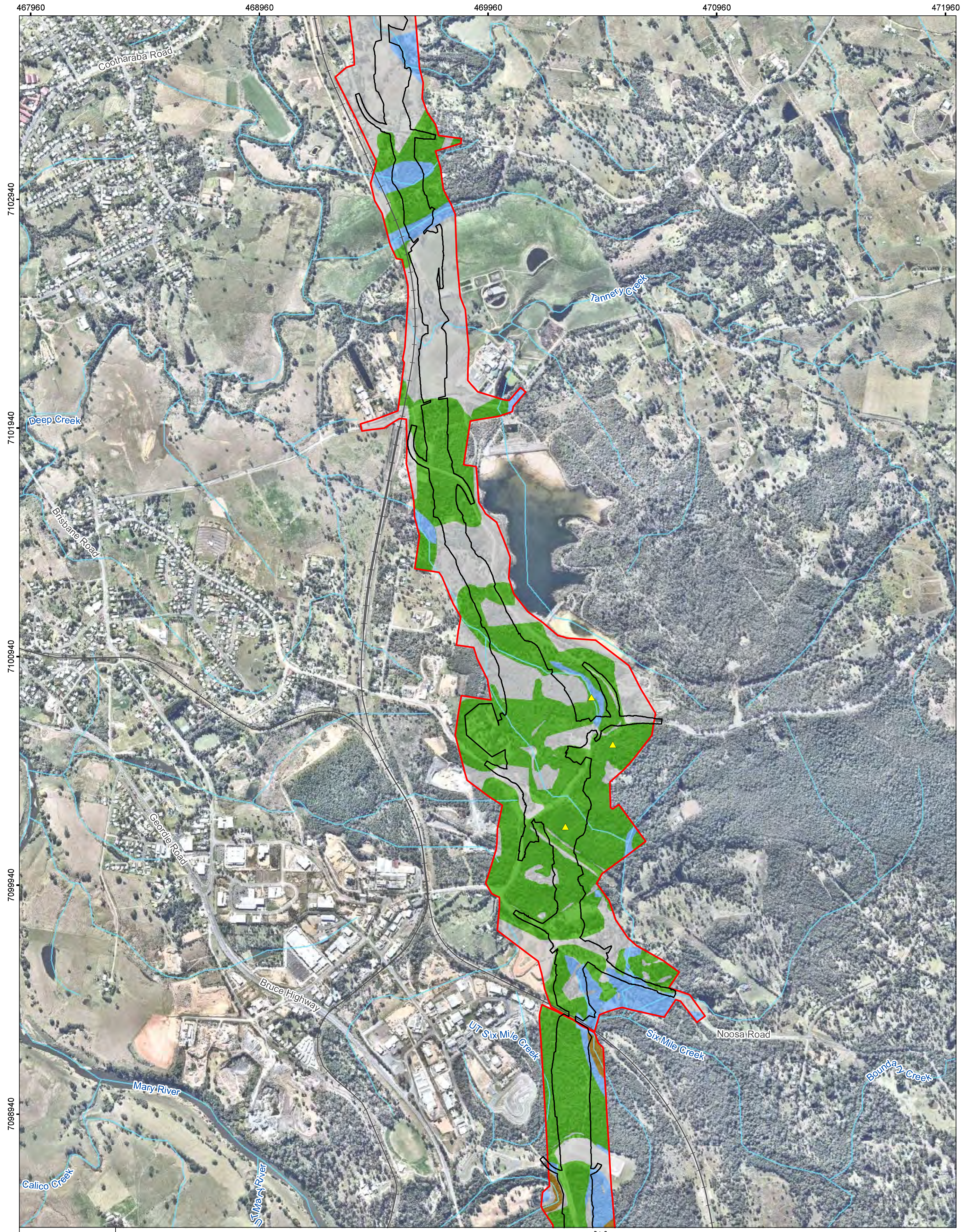
Figure 3d: Fauna Habitat Types

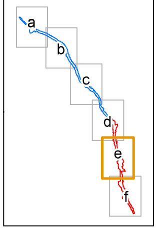
Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

ERM





Legend

Project Footprint (Proposed)

Railway

Watercourse

Hollow-bearing Trees Present

Survey Area:

D1

D2

Fauna Habitat Type:

Eucalypt Communities on Sedimentary and Metamorphic Rock

Eucalypt Communities On Alluvial Soils

Vine Forest

Cleared Area

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Fauna Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

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GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G003_R1.mxd
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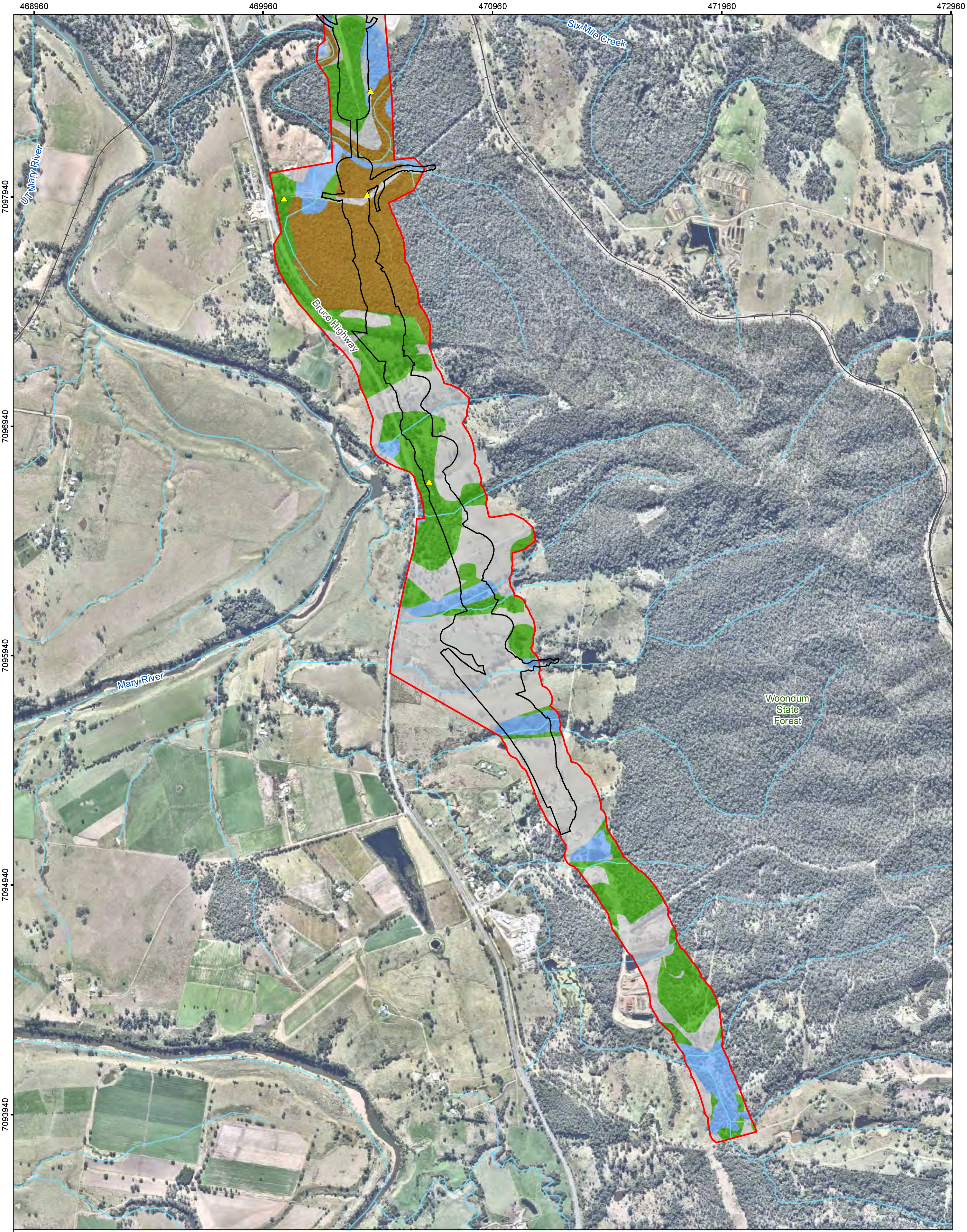
Drawn by: TC	Reviewed by: DD

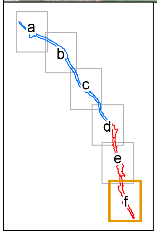
Figure 3e: Fauna Habitat Types

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ





Legend

- Project Footprint (Proposed)
- Railway
- Watercourse
- Hollow-bearing Trees Present

Survey Area:

- D1
- D2

Fauna Habitat Type:

- Eucalypt Communities on Sedimentary and Metamorphic Rock
- Eucalypt Communities On Alluvial Soils
- Vine Forest
- Cleared Area

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Fauna Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

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GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G003_R1.mxd
Date: 13/05/2016	Drawing size: A3
Drawn by: TC	Reviewed by: DD

Figure 3f: Fauna Habitat Types

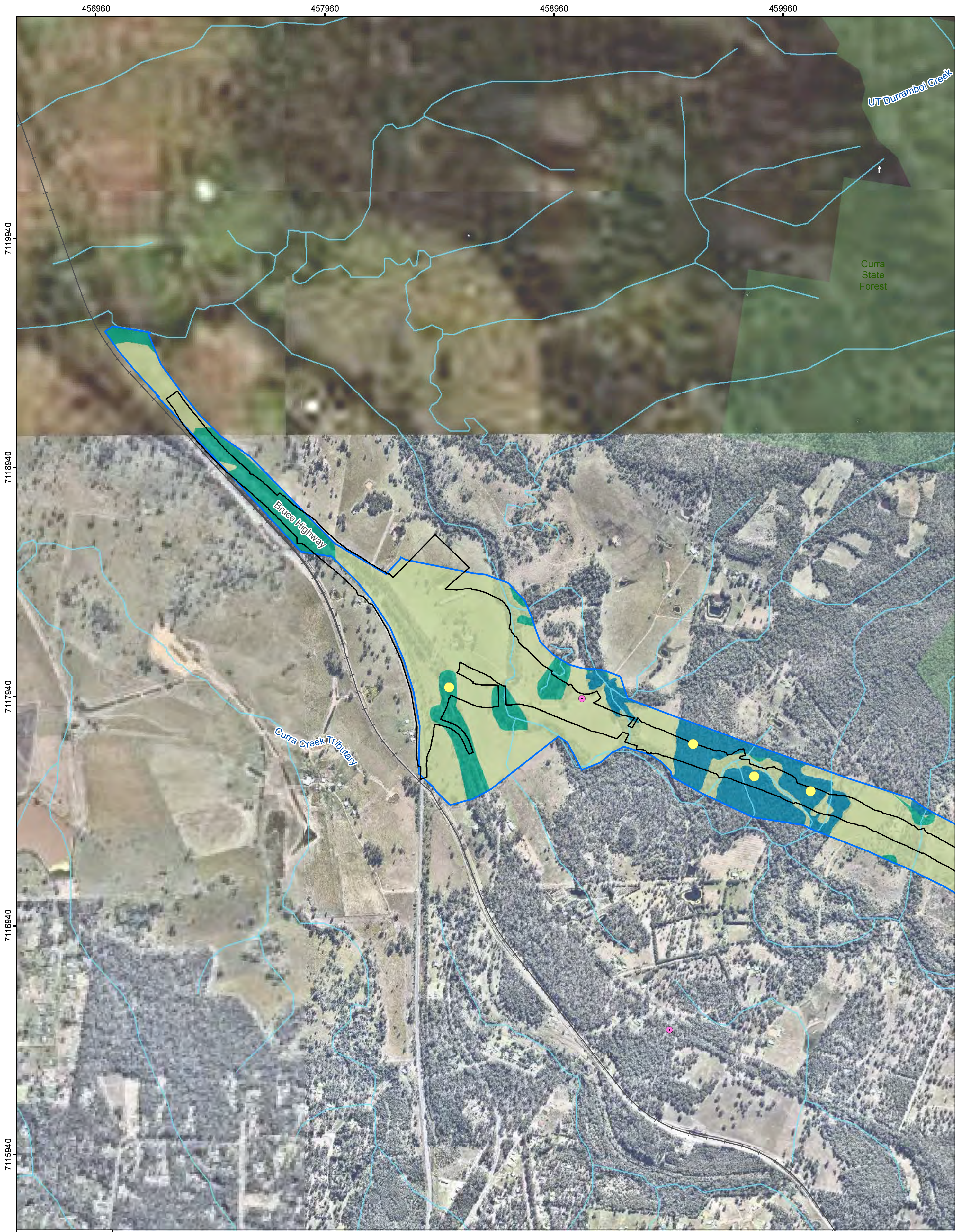
Project: Bruce Highway (Cooroy to Curra) Project Section D

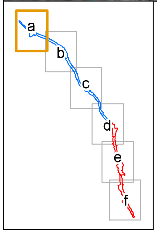
Client: Department of Transport and Main Roads

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Environmental Resources Management ANZ

ERM





Legend

Project Footprint (Proposed)

Survey Area:
- D1
- D2

Railway
Watercourse
Protected Area

Koala Habitat (Types 1 - 4):
- 4
- 3
- 2
- 1

SAT Survey:
- SAT Search Location

Other Koala Evidence:
- Record
- Scratches or Pellets

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Other Koala Evidence - Jacobs (2015) REF
Koala Habitat (Types 1 - 4) - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

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GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G004_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC / JL	Reviewed by:	DD

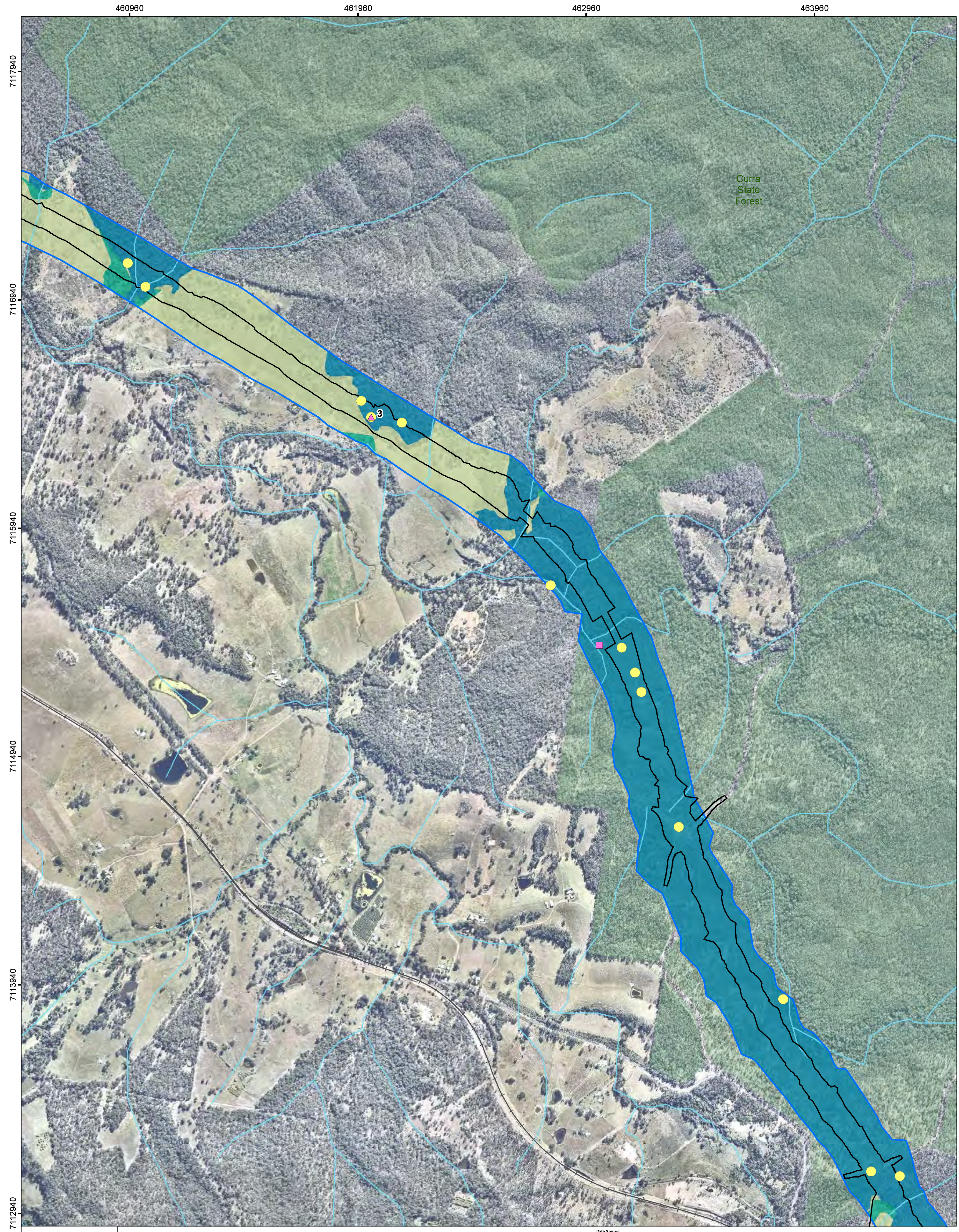
Figure 4a: Threatened Fauna Habitat (Koala)

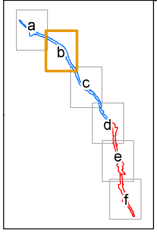
Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

ERM





Legend

Project Footprint (Proposed)

Survey Area:

D1

D2

Raliway

Watercourse

Protected Area

Koala Habitat (Types 1 - 4):

4

3

2

1

SAT Survey:

SAT Search Location

Pellet (Label indicates number observed)

Other Koala Evidence:

Record

Scratches or Pellets

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Other Koala Evidence - Jacobs (2015) REF
Koala Habitat (Types 1 - 4) - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G004_R1.mxd
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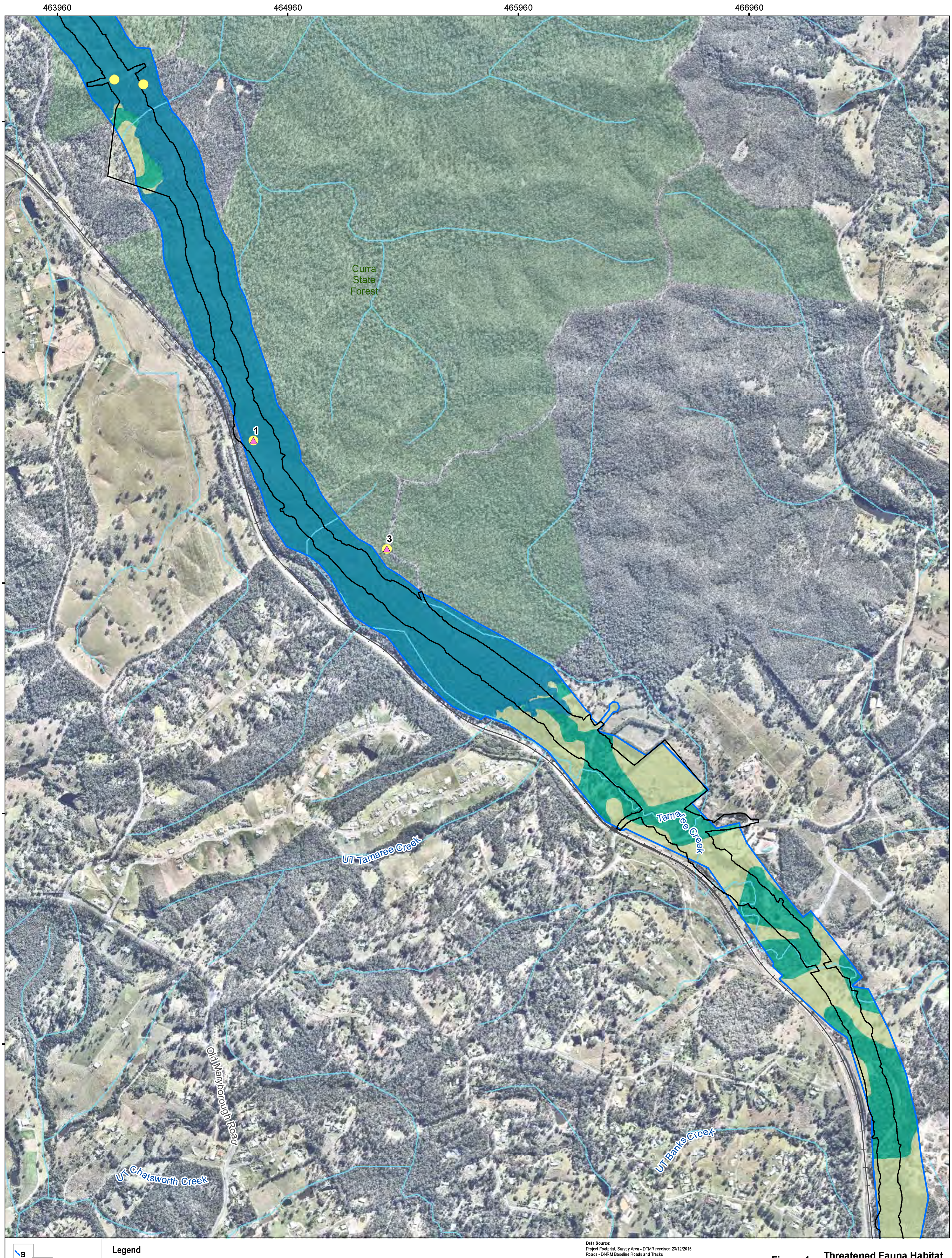
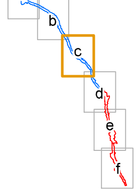
Figure 4b: Threatened Fauna Habitat (Koala)

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads





Legend

Project Footprint (Proposed)

Survey Area:
- D1
- D2

Railway

Watercourse

Protected Area

Koala Habitat (Types 1 - 4):
- 4
- 3
- 2
- 1

SAT Survey:
- SAT Search Location
- Pellet (Label indicates number observed)

Other Koala Evidence:
- Record
- Scratches or Pellets

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Other Koala Evidence - Jacobs (2015) REF
Koala Habitat (Types 1 - 4) - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G004_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC / JL	Reviewed by:	DD

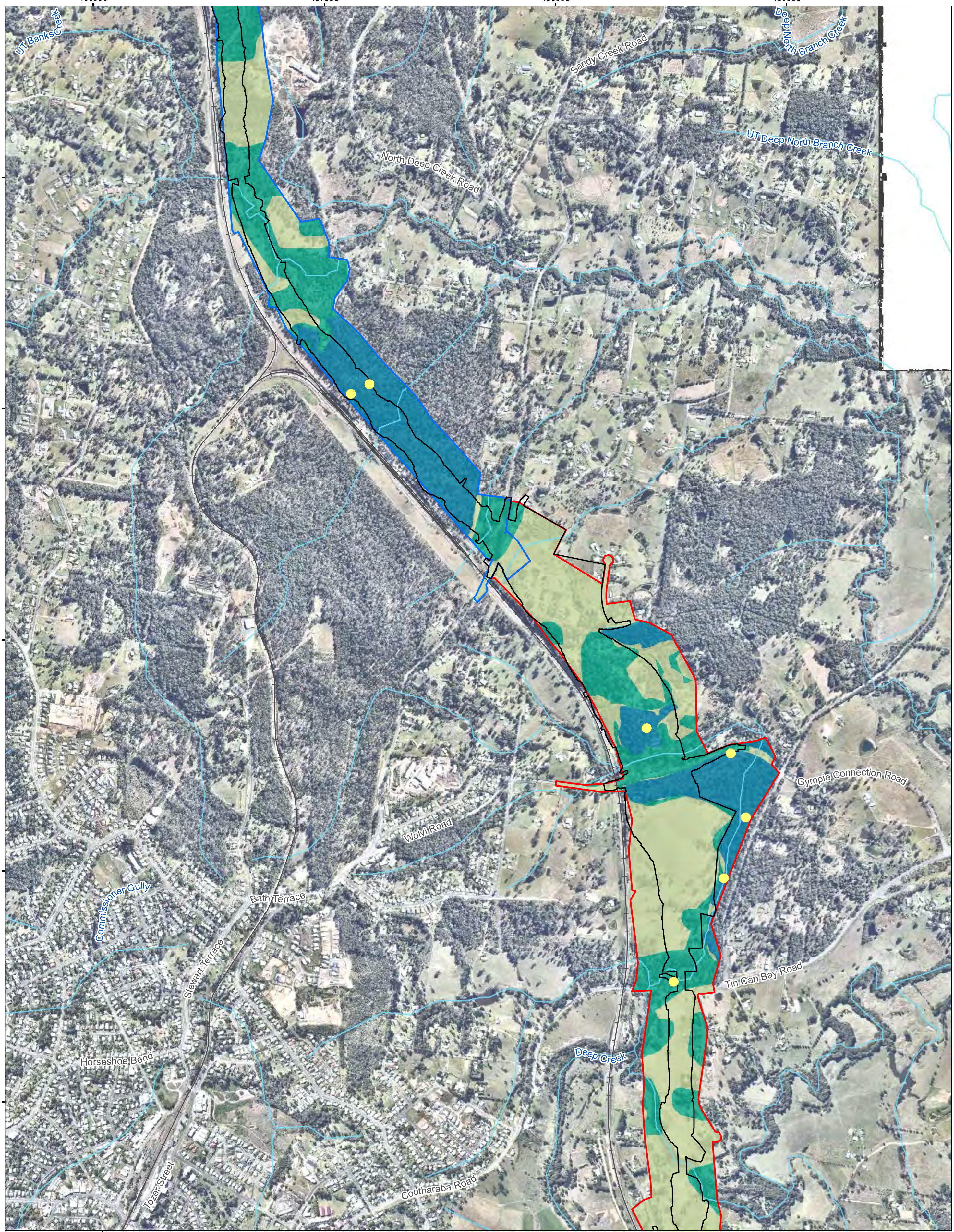
Figure 4c: Threatened Fauna Habitat (Koala)

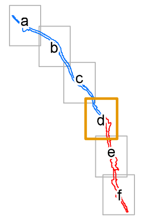
Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

ERM





Legend

Project Footprint (Proposed)

Survey Area:

D1

D2

Railway

Watercourse

Koala Habitat (Types 1 - 4):

4

3

2

1

SAT Survey:

SAT Search Location

Other Koala Evidence:

Record

Scratches or Pellets

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Other Koala Evidence - Jacobs (2015) REF
Koala Habitat (Types 1 - 4) - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G004_R1.mxd		
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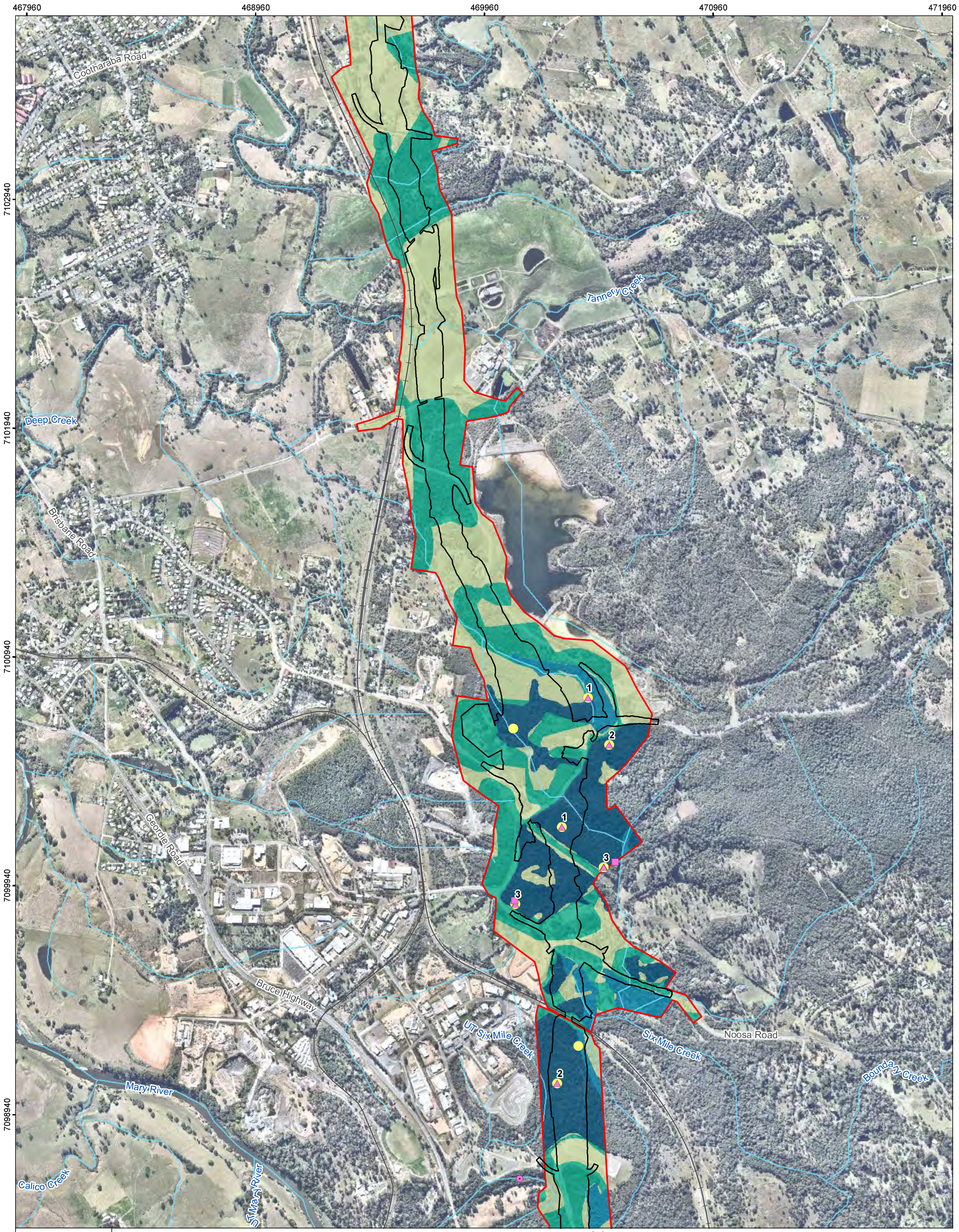
Drawn by:	TC / JL	Reviewed by:	DD

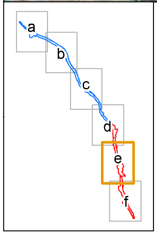
Figure 4d: Threatened Fauna Habitat (Koala)

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ





Legend

Project Footprint (Proposed)

Survey Area:

D1

D2

Railway

Watercourse

Koala Habitat (Types 1 - 4):

4

3

2

1

SAT Survey:

SAT Search Location

Pellet (Label indicates number observed)

Other Koala Evidence:

Record

Scratches or Pellets

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Other Koala Evidence - Jacobs (2015) REF
Koala Habitat (Types 1 - 4) - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

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1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G004_R1.mxd		
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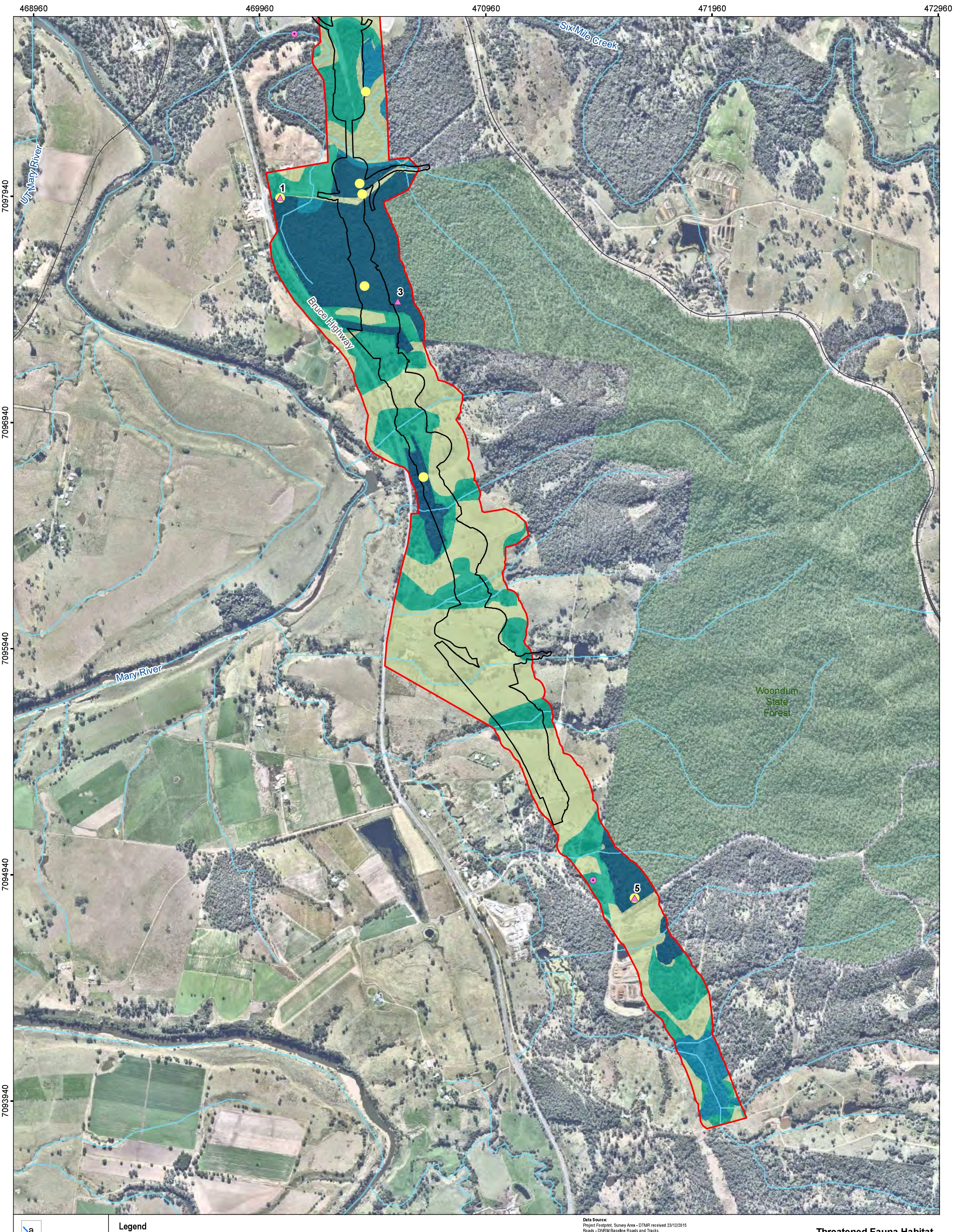
Drawn by:	TC / JL	Reviewed by:	DD

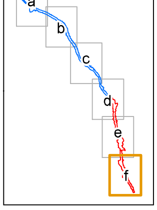
Figure 4e: **Threatened Fauna Habitat (Koala)**

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ





Legend

Project Footprint (Proposed)

Survey Area:

D1

D2

Railway

Watercourse

Protected Area

Koala Habitat (Types 1 - 4):

4

3

2

1

SAT Survey:

SAT Search Location

Pellet (Label indicates number observed)

Other Koala Evidence:

Record

Scratches or Pellets

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Other Koala Evidence - Jacobs (2015) REF
Koala Habitat (Types 1 - 4) - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G004_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC / JL	Reviewed by:	DD

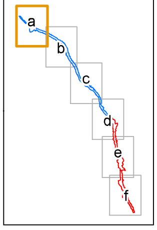
Figure 4f: Threatened Fauna Habitat (Koala)

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

ERM



Legend

Project Footprint (Proposed)
Railway
Watercourse
Protected Area

Survey Area:
D1
D2

Threatened Species Habitat:
Tusked Frog (Potential)
Powerful Owl (Potential Foraging)
Echidna (Potential)
Grey-Headed Flying Fox (Foraging)

Threatened Species Observations:
Tusked Frog Record
Grey-Headed Flying Fox (Fleshy Fruit Present)

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Threatened Species Records - Jacobs (2015) REF
Threatened Species Habitat - Derived from DTMR Ground-truthed
RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N
0 100 200 300 m
1:15,000

GDA 1994 MGA Zone 56

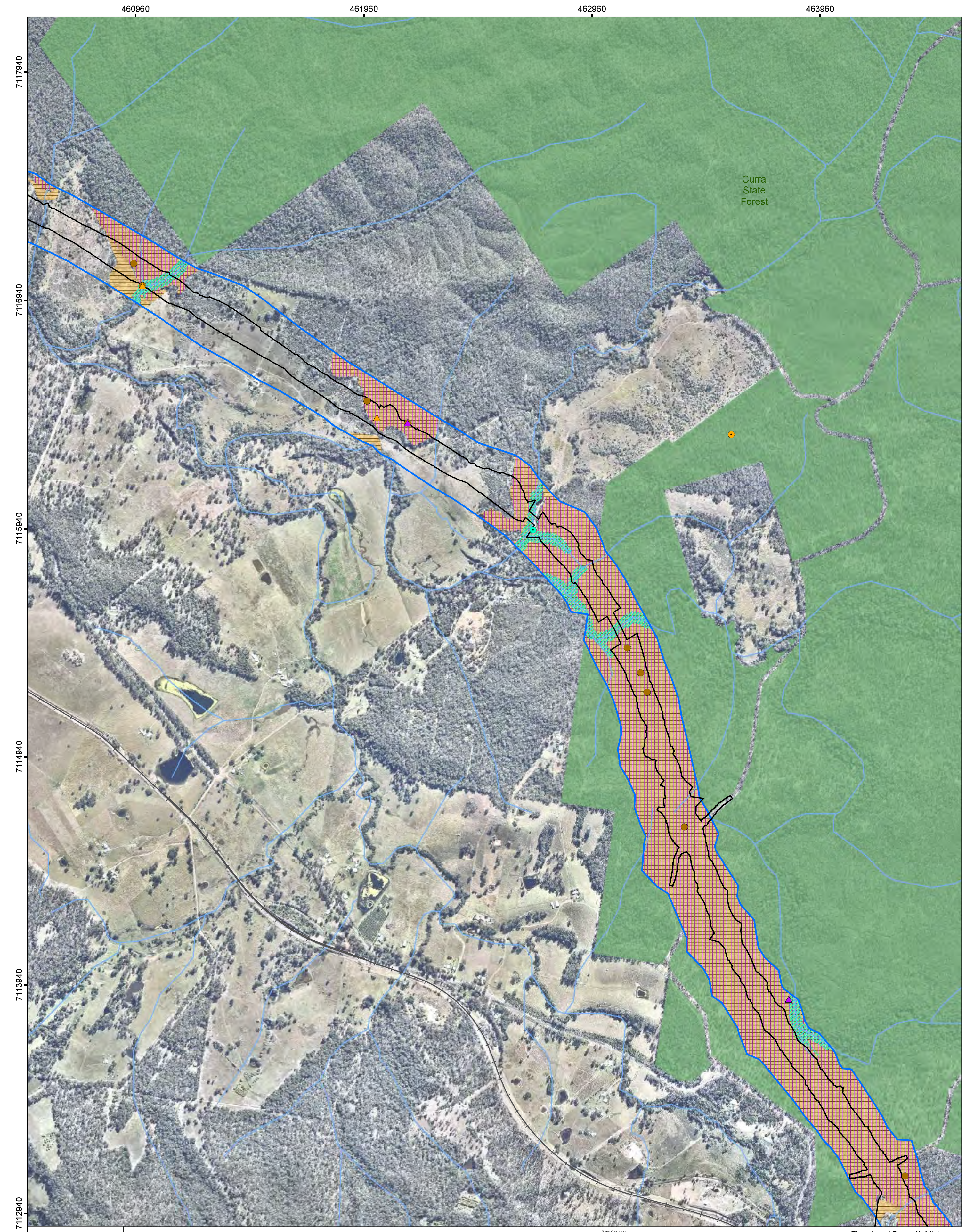
Drawing No:	0331161b_TFSR_G005_R1.mxd
Date:	13/05/2016 — Drawing size: A3
Drawn by:	TC — Reviewed by: DD

Figure 5a: Threatened Fauna Habitat (Black-breased Button Quail, Tusked Frog, Powerful Owl, Grey-Headed Flying Fox, Echidna)

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ



Legend

- Project Footprint (Proposed)
- Railway
- Watercourse
- Protected Area

Survey Area:

- D1
- D2

Threatened Species Habitat:

- Tusked Frog (Potential)
- Powerful Owl (Potential Foraging)
- Echidna (Potential)
- Grey-Headed Flying Fox (Foraging)

Threatened Species Observations:

- Grey-Headed Flying Fox Record
- Tusked Frog Record
- Powerful Owl Potential Nesting Hollow
- Echidna Feeding Sign
- Grey-Headed Flying Fox (Fleshy Fruit Present)

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Threatened Species Records - Jacobs (2015) REF
Threatened Species Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

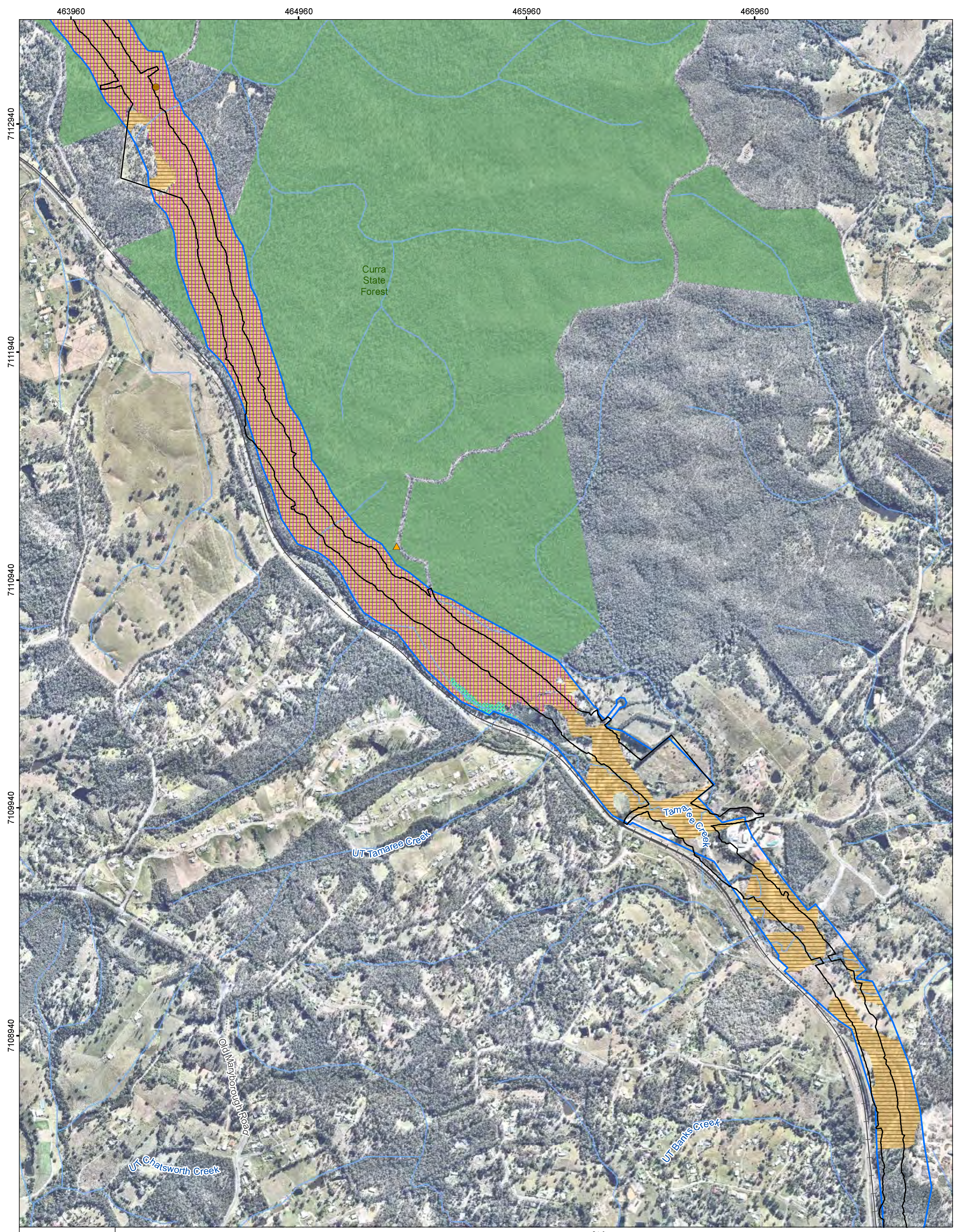
Drawing No:	0331161b_TFSR_G005_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

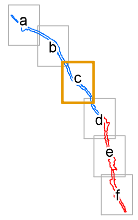
Figure 5b: **Threatened Fauna Habitat (Black-breased Button Quail, Tusked Frog, Powerful Owl, Grey-Headed Flying Fox, Echidna)**

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ





Legend

- Project Footprint (Proposed)
- Railway
- Watercourse
- Protected Area

Survey Area:

- D1
- D2

Threatened Species Habitat:

- Tusked Frog (Potential)
- Powerful Owl (Potential Foraging)
- Echidna (Potential)
- Grey-Headed Flying Fox (Foraging)

Threatened Species Observations:

- Echidna Feeding Sign
- Grey-Headed Flying Fox (Fleshy Fruit Present)

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Threatened Species Records - Jacobs (2015) REF
Threatened Species Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m
1:15,000

GDA 1994 MGA Zone 56

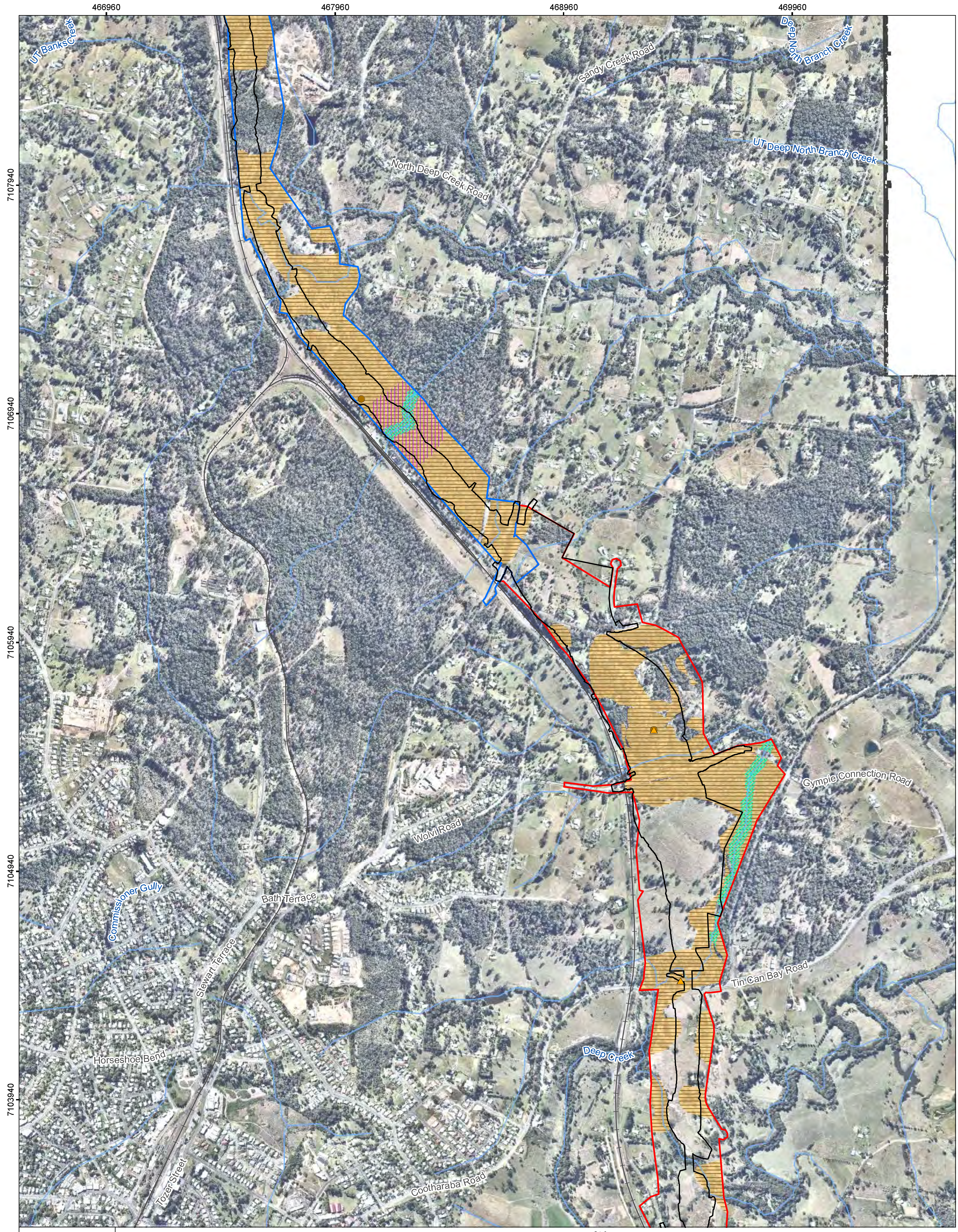
Drawing No:	0331161b_TFSR_G005_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

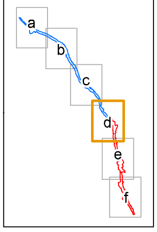
Figure 5c: **Threatened Fauna Habitat (Black-breased Button Quail, Tusked Frog, Powerful Owl, Grey-Headed Flying Fox, Echidna)**

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ





Legend

Project Footprint (Proposed)

Railway

Watercourse

Survey Area:

D1

D2

Threatened Species Habitat:

Tusked Frog (Potential)

Powerful Owl (Potential Foraging)

Echidna (Potential)

Grey-Headed Flying Fox (Foraging)

Threatened Species Observations:

Echidna Feeding Sign

Grey-Headed Flying Fox (Fleshy Fruit Present)

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Threatened Species Records - Jacobs (2015) REF
Threatened Species Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G005_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

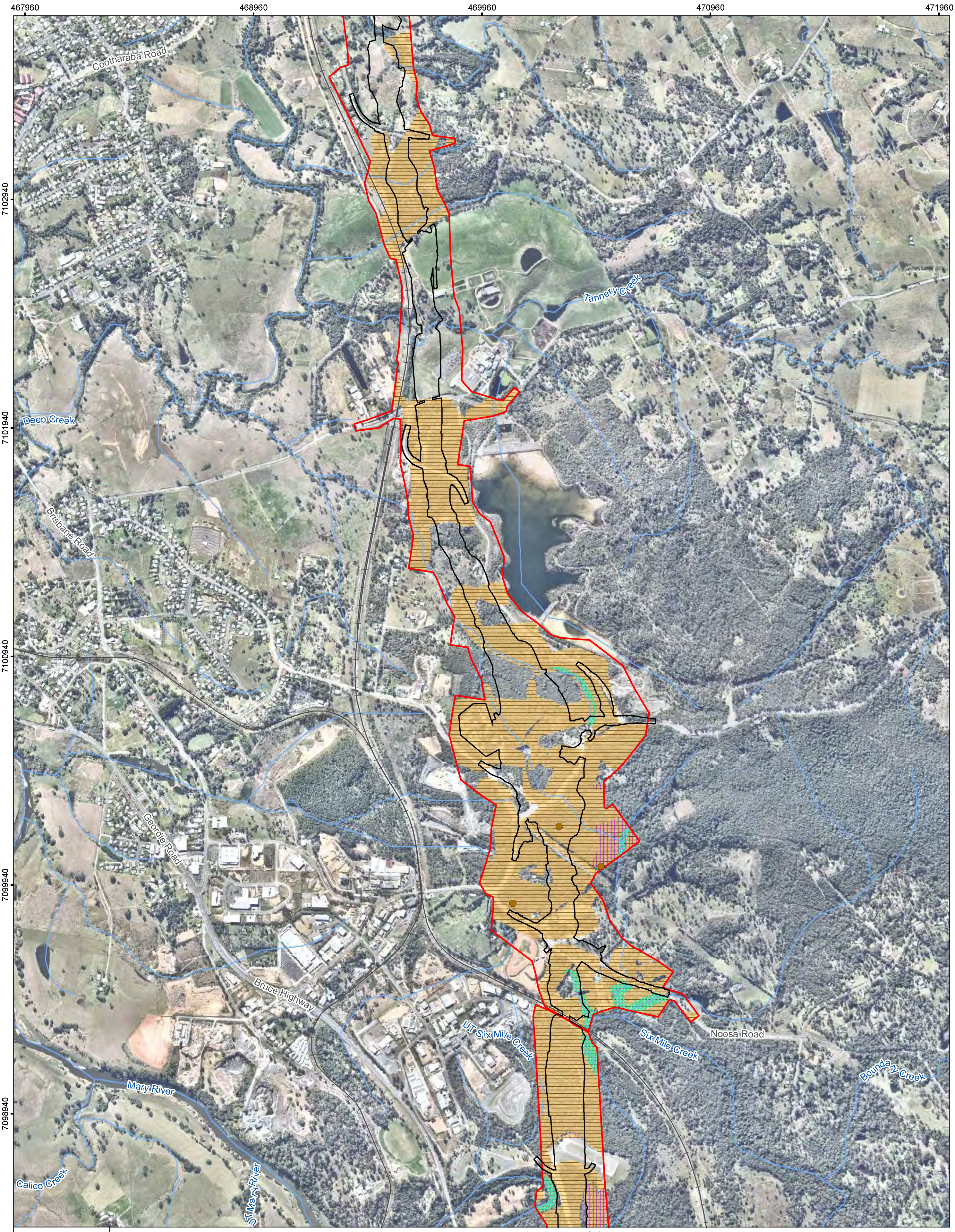
Figure 5d: **Threatened Fauna Habitat (Black-breased Button Quail, Tusked Frog, Powerful Owl, Grey-Headed Flying Fox, Echidna)**

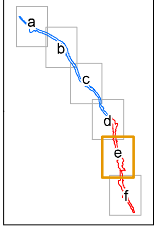
Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Environmental Resources Management ANZ





Legend

Project Footprint (Proposed)

Railway

Watercourse

Survey Area:

D1

D2

Threatened Species Habitat:

Tusked Frog (Potential)

Powerful Owl (Potential Foraging)

Echidna (Potential)

Grey-Headed Flying Fox (Foraging)

Threatened Species Observations:

Echidna Feeding Sign

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Threatened Species Records - Jacobs (2015) REF
Threatened Species Habitat - Derived from DTMR Ground-truthed RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Figure 5e: **Threatened Fauna Habitat (Black-breased Button Quail, Tusked Frog, Powerful Owl, Grey-Headed Flying Fox, Echidna)**

Project: Bruce Highway (Cooroy to Curra) Project Section D

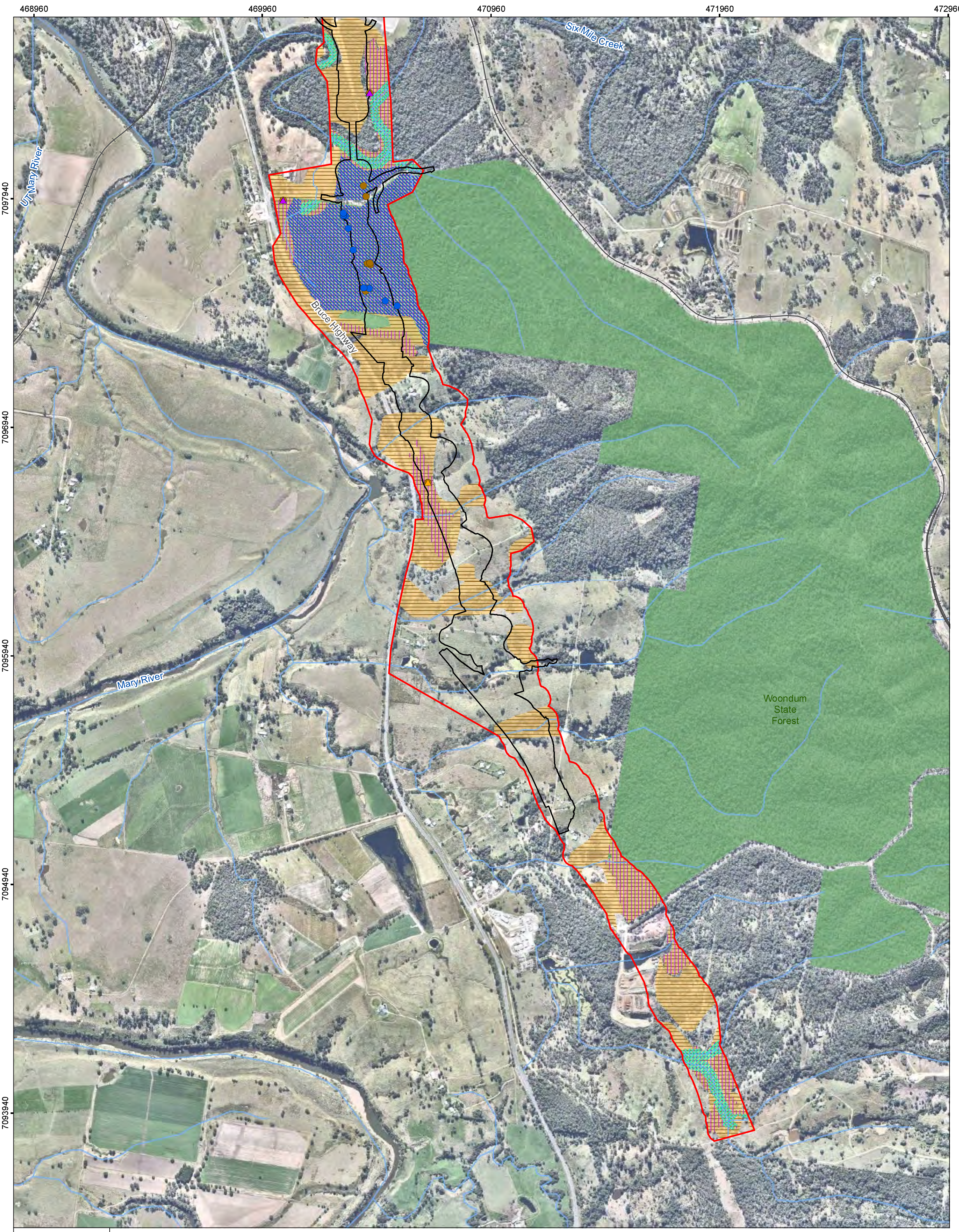
Client: Department of Transport and Main Roads

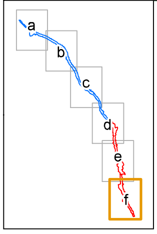
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Drawing No:	0331161b_TFSR_G005_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

Environmental Resources Management ANZ

ERM





Legend

- Project Footprint (Proposed)
- Railway
- Watercourse
- Protected Area

Survey Area:

- D1
- D2

Threatened Species Habitat:

- Black-breased Button Quail
- Tusked Frog (Potential)
- Powerful Owl (Potential Foraging)
- Echidna (Potential)
- Grey-Headed Flying Fox (Foraging)

Threatened Species Observations:

- Black-breased Button Quail Platelet
- Powerful Owl Potential Nesting Hollow
- Echidna Feeding Sign
- Grey-Headed Flying Fox (Fleshy Fruit Present)

Data Source:
Project Footprint, Survey Area - DTMR received 23/12/2015
Roads - DNRM Baseline Roads and Tracks
Railway - DNRM Rail Network
Watercourse - DNRM Watercourse Identification Map
Protected Area - DNPSR Protected Areas
Imagery - nearmap captured 03/07/2015
Threatened Species Records - Jacobs (2015) REF
Threatened Species Habitat - Derived from DTMR Ground-truthed
RE Mapping received 23/12/2015 and DEHP Mature Regrowth

N

0 100 200 300 m

1:15,000

GDA 1994 MGA Zone 56

Drawing No:	0331161b_TFSR_G005_R1.mxd		
Date:	13/05/2016	Drawing size:	A3
Drawn by:	TC	Reviewed by:	DD

Figure 5f: **Threatened Fauna Habitat (Black-breased Button Quail, Tusked Frog, Powerful Owl, Grey-Headed Flying Fox, Echidna)**

Project: Bruce Highway (Cooroy to Curra) Project Section D

Client: Department of Transport and Main Roads

Environmental Resources Management ANZ

ERM

Annex B

Bureau of Meteorology Weather Data

January and February 2016

Gympie, Queensland
January 2016 Daily Weather Observations

Australian Government
Bureau of Meteorology

Date	Day	Temps Min	Temps Max	Rain	Evap	Sun	Max wind gust Dirn	Max wind gust Spd	Max wind gust Time	9am Temp	9am RH	9am Cld	9am Dirn	9am Spd	9am MSLP	3pm Temp	3pm RH	3pm Cld	3pm Dirn	3pm Spd	3pm MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	eighths		km/h	hPa	°C	%	eighths		km/h	hPa
1	Fr	15.6	30.8	0			SE	33	13:07	25.3	51		SSE	11	1013.0	30.6	37		SSE	7	1009.1
2	Sa	14.4	33.0	0			ESE	30	15:38	25.9	50		ESE	6	1011.3	30.1	40		E	15	1006.6
3	Su	19.8	30.6	0			ENE	28	13:51	26.6	49		E	9	1010.7	27.7	43		E	11	1008.5
4	Mo	20.5	28.7	0.2			E	24	13:58	24.4	77		SSE	7	1011.7	22.9	73		SE	7	1009.8
5	Tu	19.3	27.4	25.0			ESE	28	12:56	20.9	98		SE	4	1009.4	25.3	76		ESE	15	1005.6
6	We	19.9	34.2	7.8			W	26	16:39	27.0	58		SW	4	1006.6	31.7	37		SW	13	1004.1
7	Th	17.3	34.2	0			SE	28	15:18	28.7	43		SE	4	1010.0	29.9	56		E	15	1008.7
8	Fr		30.6							25.7	58		SSE	11	1018.4	29.0	48		E	13	1015.7
9	Sa	17.9	31.4	0			ESE	28	17:02	26.3	56		SSE	7	1020.4	29.5	45		SE	7	1016.3
10	Su	17.7	32.6	0			E	33	14:33	26.1	60		WSW	4	1018.8	30.3	48		E	9	1014.8
11	Mo	17.4	33.0	0			E	24	17:06	26.4	56		E	6	1017.4	32.2	39		SE	6	1012.8
12	Tu	17.7	35.2	0			E	24	16:24	26.5	62		SW	7	1017.0	34.6	34		SSE	6	1012.5
13	We	17.1	34.9	0			E	28	15:35	26.6	59		SSW	4	1018.5	32.8	38		E	13	1015.6
14	Th	16.9	34.1	0			ENE	26	15:03	26.6	59		ENE	6	1018.4	33.0	38		E	9	1014.3
15	Fr	19.3	35.4	0			SSE	39	21:22	27.4	56		NNW	7	1016.0	33.8	39		ESE	17	1011.5
16	Sa	19.9	25.2	0			SSE	37	14:07	20.5	92		SSE	13	1019.6	22.1	76		SSE	13	1017.9
17	Su	18.6	29.3	0.4			ESE	41	14:50	25.1	55		SSE	15	1019.4	26.1	53		SE	20	1016.5
18	Mo	16.2	28.3	0			SE	28	11:16	24.3	57		SSE	9	1018.2	26.4	50		SE	9	1016.2
19	Tu	13.6	32.6	0			E	30	15:26	25.0	53		NNE	6	1019.0	31.4	33		SE	11	1014.3
20	We	16.9	34.8	0			E	33	15:01	26.5	50		WSW	2	1018.5	33.8	35		E	13	1013.2
21	Th	14.9	34.9	0			NNE	26	16:17	26.6	53		N	4	1017.2	34.1	32		ENE	11	1012.3
22	Fr	15.9	36.4	0			NE	31	17:21	26.4	59		NW	13	1015.1	35.1	28		NNE	6	1009.6
23	Sa	21.7	36.3	0			N	30	17:31	27.6	57		NNW	17	1010.1	35.6	32		NW	7	1005.2
24	Su	21.2	32.2	0			E	39	15:51	27.7	67		S	7	1010.4	31.5	55		SSE	17	1007.5
25	Mo	20.3	32.4	0			NNE	37	13:41	27.3	68		ESE	4	1012.7	25.1	73		ESE	7	1009.8
26	Tu	21.6	30.6	15.2			E	30	12:06	26.6	75		SE	6	1013.2	23.5	93		ESE	6	1012.7
27	We	20.7	29.9	27.2			E	24	15:35	25.1	72		SSE	6	1014.7	28.1	53		ESE	11	1011.2
28	Th	20.9	29.9	0			N	22	18:38	24.1	80		WSW	2	1010.9	28.0	71		N	11	1006.6
29	Fr	23.9	36.3	0			NNW	35	11:12	29.2	72		NNW	13	1005.6	34.2	49		NNW	11	1000.7
30	Sa	22.4	32.9	8.0			SW	41	14:42	25.5	89		NNW	6	1008.6	23.9	96		NNW	4	1006.0
31	Su	22.4	27.8	44.4			NE	24	13:38	24.1	94		NW	6	1011.6	26.0	84		NE	6	1008.5
Statistics for January 2016																					
	Mean	18.7	32.1							25.9	64			7	1014.3	29.6	51			10	1010.8
	Lowest	13.6	25.2							20.5	43		WSW	2	1005.6	22.1	28		NNW	4	1000.7
	Highest	23.9	36.4	44.4			#	41		29.2	98		NNW	17	1020.4	35.6	96		SE	20	1017.9
	Total			128.2																	

Observations were drawn from Gympie {station 040093}

IDCJDW4053.201601 Prepared at 16:05 GMT on 16 Mar 2016

Gympie, Queensland
February 2016 Daily Weather Observations

Australian Government
Bureau of Meteorology

Date	Day	Temps Min	Temps Max	Rain	Evap	Sun	Max wind gust Dirn	Max wind gust Spd	Max wind gust Time	9am Temp	9am RH	9am Cld	9am Dirn	9am Spd	9am MSLP	3pm Temp	3pm RH	3pm Cld	3pm Dirn	3pm Spd	3pm MSLP
		°C	°C	mm	mm	hours		km/h	local	°C	%	eighths		km/h	hPa	°C	%	eighths		km/h	hPa
1	Mo	22.9	34.7	7.0			NNE	41	16:32	27.6	85		NNW	11	1009.5	32.8	61		NNE	13	1004.1
2	Tu	24.1	34.5	11.2			NW	63	17:42	29.5	76		NNW	17	1006.5	33.8	56		WNW	7	1002.6
3	We	22.1	34.3	15.2			WNW	41	13:47	27.9	77		NW	11	1004.5	28.5	79		WNW	7	1001.4
4	Th	23.7	30.3	5.8			SE	35	14:23	28.6	76		SE	7	1003.8	24.3	92		SSE	15	1003.9
5	Fr	21.8	27.4	2.4			SE	44	20:45	25.1	76		SSE	13	1008.0	27.1	64		SSE	20	1006.6
6	Sa	21.7	27.1	1.4			SE	37	13:12	24.5	84		SE	9	1010.0	25.8	73		ESE	13	1008.3
7	Su	21.9	28.3	2.4			SE	37	14:28	24.5	79		SE	9	1012.3	25.3	76		SSE	13	1011.1
8	Mo	19.6	29.8	1.6			SE	33	13:25	24.6	65		SSE	7	1014.9	28.0	51		SE	11	1012.0
9	Tu	20.2	29.1	0			SE	39	13:29	25.1	66		SSE	15	1014.8	28.5	53		SE	17	1012.7
10	We	18.5	29.0	0			ESE	39	17:01	21.8	88		S	7	1013.3	27.7	63		SE	13	1010.1
11	Th	18.5	29.9	0.2			SE	43	14:38	25.8	70		SSE	9	1012.0	26.1	72		ESE	15	1010.2
12	Fr	18.7	29.5	0.2			SSE	44	13:09	25.5	69		SSE	13	1012.0	27.3	56		ESE	20	1010.4
13	Sa	20.8	28.3	2.2			SSE	46	13:15	24.7	69		S	19	1010.2	23.7	82		S	15	1008.6
14	Su	19.9	30.2	0			S	28	08:04	26.4	64		SSE	15	1008.1	29.4	58		SE	11	1006.3
15	Mo	17.2	32.4	0			SE	26	14:08	26.8	67		SSE	11	1009.4	31.6	50		SSE	11	1006.6
16	Tu	20.4	35.0	0			SSE	20	08:11	26.5	68		SSE	9	1009.2	34.2	42		SW	2	1004.8
17	We	22.8	33.8	0			NE	24	16:25	25.5	80		SE	2	1008.3	33.1	46		NE	6	1004.9
18	Th	23.8	33.4	1.2			N	39	19:01	28.3	67		N	4	1008.9	32.4	50		N	7	1005.2
19	Fr	20.0	32.2	10.6			SSW	28	23:54	25.9	79		S	2	1013.2	31.4	59		ENE	9	1010.0
20	Sa	21.1	30.7	38.8			WSW	43	00:09	25.8	80		SSE	6	1016.8	29.0	61		E	11	1014.2
21	Su	20.4	29.8	0			ESE	41	10:00	26.4	65		SSE	17	1019.3	28.0	60		SE	19	1017.3
22	Mo	22.1	29.0	0			SE	35	10:34	25.8	67		SSE	19	1021.1	28.4	60		SE	19	1018.0
23	Tu	19.2	29.5	0.2			SE	37	14:12	25.3	75		SSE	7	1018.5	28.6	51		SE	17	1015.6
24	We	18.1	30.0	1.2			SE	24	09:44	25.3	68		SSE	7	1016.9	29.0	55		E	9	1014.1
25	Th	17.0	30.8	0			E	24	16:11	25.8	64		SSE	6	1016.1	30.0	46		E	9	1012.4
26	Fr	16.9	33.9	0			E	22	16:28	25.3	70		NE	2	1012.8	33.0	49		ESE	2	1007.4
27	Sa	19.6	32.8	0			SE	33	08:55	26.9	60		SE	19	1012.7	32.6	46		SSE	9	1009.4
28	Su	22.8	31.8	0			SSE	37	08:41	26.8	70		SSE	17	1013.8	31.2	54		SE	13	1010.4
29	Mo	22.6	30.8	0			SE	44	15:28	26.3	69		SSE	15	1015.5	30.0	60		SE	17	1013.1
Statistics for February 2016																					
	Mean	20.6	31.0							26.0	72			10	1012.2	29.3	59			12	1009.4
	Lowest	16.9	27.1							21.8	60		#	2	1003.8	23.7	42		#	2	1001.4
	Highest	24.1	35.0	38.8			NW	63		29.5	88		#	19	1021.1	34.2	92		#	20	1018.0
	Total			101.6																	

Observations were drawn from Gympie {station 040093}

IDCJDW4053.201602 Prepared at 13:05 GMT on 21 Mar 2016

Annex C

Survey Site Summary

C.1 SURVEY SITE SUMMARY

Survey Period	Site ID	Date	Terr. Habitat Assessment	Aquatic Habitat Assessment	SAT	Tusked Frog	Powerful Owl	Giant barred frog	Other	Regional Ecosystem
SP2	BBBQ	4/02/2016	X						X	12.11.3/12.11.14
SP1	PD1	27/01/2016	X		X					Regrowth
SP1	PD10	28/01/2016	X		X					12.11.5e
SP1	PD11	28/01/2016	X		X					12.11.5e
SP1	PD12	28/01/2016	X		X					12.11.5e
SP1	PD13	28/01/2016	X	X						Regrowth
SP1	PD15	28/01/2016	X	X	X					12.11.5e
SP1	PD16	29/01/2016	X		X					12.9-10.17b
SP1	PD17	28/01/2016	X		X					12.9-10.17b
SP1	PD18	29/01/2016	X	X	X					Regrowth
SP1	PD19	29/01/2016	X							Regrowth
SP1	PD2	27/01/2016	X	X	X					12.3.3d
SP2	PD20	24/02/2016	X	X	X					12.11.3
SP2	PD21	23/02/2016	X		X					12.11.3
SP2	PD22	24/02/2016	X		X					12.11.3
SP2	PD23	23/02/2016	X		X					12.11.16
SP1	PD24	29/01/2016	X		X					12.11.3
SP1	PD25	29/01/2016	X	X	X					12.11.14
SP1	PD26	29/01/2016	X		X					12.11.14
SP1	PD27	29/01/2016	X		X					12.11.14
SP1	PD28	29/01/2016	X		X					12.11.3
SP2	PD29	22/02/2016	X		X					12.9-10.4
SP1	PD3	27/01/2016	X	X	X					12.3.3d
SP2	PD30	24/02/2016	X		X					12.11.14
SP1b	PD31	4/02/2016	X		X					12.11.3
SP2	PD32	22/02/2016	X		X					12.9-10.4
SP2	PD33	23/02/2016	X		X					12.11.5e
SP2	PD34b	25/02/2016							X	12.11.3/12.11.14
SP2	PD34	26/02/2016							X	12.11.3/12.11.

Survey Period	Site ID	Date	Terr. Habitat Assessment	Aquatic Habitat Assessment	SAT	Tusked Frog	Powerful Owl	Giant barred frog	Other	Regional Ecosystem
	b									14
SP2	PD34 b	25/02/2016	X		X					12.11.3/12.11. 14
SP2	PD35	24/02/2016	X		X					12.11.5e
SP2	PD36	22/02/2016	X		X					12.11.5e
SP2	PD37	23/02/2016	X		X					12.9-10.4
SP2	PD38	23/02/2016	X		X					12.11.3
SP2	PD39	23/02/2016	X	X	X					12.3.11
SP1	PD4	27/01/2016	X	X	X					12.3.3d
SP2	PD40	24/02/2016	X		X					12.11.3
SP2	PD42	24/02/2016	X	X	X					12.3.11
SP2	PD43	23/02/2016	X	X	X					12.3.11
SP2	PD44	23/02/2016	X		X					12.9-10.4
SP2	PD45	23/02/2016	X		X					12.9-10.4
SP1	PD5	27/01/2016	X		X					12.9-10.17b
SP1	PD6	27/01/2016	X		X					12.3.11
SP1	PD7	28/01/2016	X	X	X					12.9-10.4
SP1	PD8	27/01/2016	X	X	X					12.3.11
SP1	PD9	28/01/2016	X		X					12.9-10.4
SP1	PN(New)	28/01/2016				X	X			Non-remnant
SP2	PN(New)	25/02/2016				X				Non-remnant
SP1	PN1	27/01/2016		X		X				12.3.11
SP2	PN1	22/02/2016		X		X	X	X		12.3.11
SP2	PN10	25/02/2016		X		X	X	X		12.3.11 and 12.11.5e
SP1	PN10 b	28/01/2016							X	12.11.5e
SP1	PN12	28/01/2016				X	X			12.3.11
SP2	PN12	23/02/2016				X	X	X		12.3.11
SP2	PN14	23/02/2016				X	X	X		12.3.11
SP2	PN14	24/02/2016				X	X	X		12.3.11
SP1	PN15	28/01/2016		X						12.3.11
SP2	PN15	24/02/2016				X	X			12.3.11

Survey Period	Site ID	Date	Terr. Habitat Assessment	Aquatic Habitat Assessment	SAT	Tusked Frog	Powerful Owl	Giant barred frog	Other	Regional Ecosystem
	a									
SP2	PN15 a	23/02/2016				X	X			12.3.11
SP2	PN15 b	24/02/2016				X	X			12.3.11
SP2	PN15 b	23/02/2016				X	X			12.3.11
SP2	PN15 c	24/02/2016				X				Non-remnant
SP2	PN15 c	23/02/2016				X	X			Non-remnant
SP1	PN16	28/01/2016		X						12.3.11
SP2	PN17	23/02/2016				X				Non-remnant
SP1	PN17	28/01/2016		X		X				Non-remnant
SP1	PN19	29/01/2016		X						12.3.11 and 12.3.1 and 12.11.14
SP2	PN19	24/02/2016				X	X	X		12.3.11 and 12.3.1 and 12.11.14
SP1b	PN19	4/02/2016				X				12.3.11 and 12.3.1 and 12.11.14
SP2	PN2	22/02/2016		X		X	X	X		12.3.3d and non-remnant
SP1	PN20	29/01/2016		X						12.3.1 and non-remnant
SP2	PN20	24/02/2016				X	X	X		12.3.1 and non-remnant
SP1b	PN20	4/02/2016				X				12.3.1 and non-remnant
SP1	PN21	29/01/2016		X						12.3.1 and non-remnant
SP2	PN21	24/02/2016				X	X	X		12.3.1 and non-remnant
SP1b	PN21	4/02/2016				X				12.3.1 and non-remnant
SP2	PN22	23/02/2016				X	X	X		12.11.3/12.11.14 and 12.3.11

Survey Period	Site ID	Date	*Terr. Habitat Assessment*	*Aquatic Habitat Assessment*	*SAT*	*Tusked Frog*	*Powerful Owl*	*Giant barred frog*	*Other*	Regional Ecosystem
SP1b	PN22	4/02/2016		X		X		X		12.11.3/12.11.14 and 12.3.11
SP2	PN24	23/02/2016				X	X	X		12.3.11
SP1b	PN24	4/02/2016		X		X		X		12.3.11
SP1	PN2A	27/01/2016				X	X			12.3.3d/non-remnant
SP1	PN2B	27/01/2016				X				12.3.3d and non-remnant
SP1	PN4A	27/01/2016		X		X	X			12.3.3d and non-remnant
SP1	PN4B									
SP1	PN6	27/01/2016		X		X	X			12.3.3d and non-remnant
SP2	PN6	22/02/2016				X	X	X		12.3.3d and non-remnant
SP1	PN7	27/01/2016		X						12.9-10.17b and 12.3.11
SP2	PN7	25/02/2016				X	X	X		12.3.11
SP1	PN9	27/01/2016				X	X			12.3.11
SP2	PN9	22/02/2016				X	X	X		12.3.11

Annex D

Fauna Species Recorded During Summer 2016 Field Surveys

D.1 *FAUNA SPECIES RECORDED DURING FIELD SURVEYS*

Scientific Name	Common Name	Comment
BIRDS		
Acanthiza pusilla	Brown thornbill	
Accipiter novaehollandiae	Grey goshawk	
Aegotheles cristatus	Australian owlet-nightjar	
Alectura lathami	Australian brush-turkey	
Apus pacificus	Fork-tailed swift	Subject species
Cacomantis variolosus	Brush cuckoo	
Calyptorhynchus funereus	Yellow-tailed black-cockatoo	
Chalcites basalis	Horsfield's bronze-cuckoo	
Chalcites lucidus	Shining bronze-cuckoo	
Chenonetta jubata	Australian wood duck	
Colluricincla harmonica	Grey shrike-thrush	
Coracina novaehollandiae	Black-faced cuckoo-shrike	
Coracina tenuirostris	Cicadabird	
Cormobates leucophaea	White-throated treecreeper	
Corvus orru	Torresian crow	
Cracticus nigrogularis	Pied butcherbird	
Cracticus tibicen	Australian magpie	
Cracticus torquatus	Grey butcherbird	
Dacelo novaeguineae	Laughing kookaburra	
Dicaeum hirundinaceum	Mistletoe bird	
Dicrurus bracteatus	Spangled drongo	
Eopsaltria australis	Eastern yellow robin	
Eurostopodus mystacalis	White-throated nightjar	
Geopelia humeralis	Bar-shouldered dove	
Geopelia striata	Peaceful dove	
Gerygone mouki	Brown gerygone	
Gerygone olivacea	White-throated gerygone	
Lalage leucomela	Varied triller	
Leucosarcia melanoleuca	Wonga pigeon	
Lichenostomus chrysops	Yellow-faced honeyeater	
Lichmera indistincta	Brown honeyeater	
Lonchura castaneothorax	Chestnut-breasted mannikin	
Macropygia amboinensis	Brown cuckoo-dove	
Malurus melanocephalus	Red-backed fairy-wren	
Manorina melanocephala	Noisy miner	
Megalurus timoriensis	Tawny grassbird	
Meliphaga lewinii	Lewin's Honeyeater	
Melithreptus albogularis	White-throated honeyeater	
Merops ornatus	Rainbow bee-eater	Subject species
Myiagra inquieta	Restless flycatcher	
Myiagra rubecula	Leaden flycatcher	
Myzomela obscura	Dusky honeyeater	
Myzomela sanguinolenta	Scarlet honeyeater	
Neochmia temporalis	Red-browed finch	
Ninox boobook	Southern boobook	
Pachycephala pectoralis	Golden whistler	
Pachycephala rufiventris	Rufous whistler	
Pardalotus striatus	Striated pardalote	
Philemon corniculatus	Noisy friarbird	
Platycercus adscitus	Pale-headed rosella	
Podargus strigoides	Tawny frogmouth	
Psophodes olivaceus	Eastern whipbird	
Rhipidura fuliginosa	Grey fantail	
Rhipidura leucophrys	Willie wagtail	
Rhipidura rufifrons	Rufous fantail	Subject species
Sericornis frontalis	White-browed scrubwren	

Scientific Name	Common Name	Comment
Sericornis magnirostris	Large-billed scrubwren	
Sphecotheres vieilloti	Australasian figbird	
Strepera graculina	Pied currawong	
Symposiarchus trivirgatus	Spectacled monarch	Subject species
Todiramphus sanctus	Sacred kingfisher	
Trichoglossus chlorolepidotus	Scaly-breasted lorikeet	
Trichoglossus haematodus	Rainbow lorikeet	
Trichosurus vulpecula	Brushtail possum	
Turnix melanogaster (sign)	Black-breasted button quail (sign)	Subject species
Tyto novaehollandiae	Masked owl	
Zosterops lateralis	Silvereye	
MAMMALS		
Aepyprymnus rufescens (anecdote)	Rufous bettong (anecdote)	
Macropus rufogriseus	Red-necked wallaby	
Perameles nasuta	Long-nosed bandicoot	
Petaurus breviceps	Sugar glider	
Phascolarctos cinereus (sign)	Koala (sign)	Subject species
Pseudocheirus peregrinus	Common ringtail possum	
Pteropus sp.	Fruit bats	
Tachyglossus aculeatus (sign)	Short-beaked echidna (sign)	Subject species
INVERTEBRATES		
Danaus plexippus	Monarch butterfly	
Tirumala hamata	Blue tiger butterfly	
REPTILES		
Dendrelaphis punctulata	Green tree snake	
Intellagama lesueurii	Eastern water dragon	
Oedura tryoni	Southern spotted velvet gecko	
Pogona barbata	Bearded dragon	
Tropidonophis mairii	Keelback snake	
Varanus varius	Lace monitor	
AMPHIBIANS		
Crinia parinsignifera	Eastern sign-bearing froglet	
Limnodynastes peronii	Striped marsh frog	
Litoria caerulea	Green tree frog	
Litoria dentata	Bleating tree frog	
Litoria fallax	Eastern dwarf tree frog	
Litoria gracilenta	Dainty green tree frog	
Litoria latopalmata	Broad-palmed frog	
Litoria peronii	Peron's tree frog	
Litoria wilcoxii	Wilcox's frog	
Mixophyes fasciolatus	Great barred frog	
Pseudophryne raveni	Copper-backed broodfrog	
Rhinella marina	Cane toad	Non-native species
Uperoleia fusca	Dusky toadlet	

Annex E

Subject Species Profiles and Updated Likelihood of Occurrence

E.1 *SUBJECT SPECIES PROFILES*

The following profiles detail the information collected on each subject species that was assessed. The information is presented in a series of species profiles which outline:

- general information on the species conservation status, distribution, habitat preferences and, where relevant, population estimates;
- records of the species from field surveys (including Summer 2016 field surveys, and field surveys undertaken for the REF), and database records for the species from the surrounding area;
- suitability of habitat within the Survey Area, including description of breeding, foraging and dispersal habitats, where relevant;
- the revised likelihood of occurrence assessment, based on summer 2016 field surveys and current database searches;
- evaluation of the likelihood of breeding places being present within the Survey Area, based on species' known breeding habitat requirements and habitat features identified through field surveys; and
- a conclusion of the key findings of the species, separated for Section D1 and D2, to assist in understanding the ecological value of each section of the alignment for species of conservation significance.

For species listed under the EPBC Act, the following items were also evaluated, in light of field survey findings and available information on species ecology and biology, as required by the SIG 1.1 (DoE 2013):

- whether habitat present at the Survey Area is habitat critical to the survival of species; and
- whether the Survey Area contains important populations of a species.

The profiles are ordered with reference to an updated likelihood of occurrence based on desktop and recently collected field data, for those species known, likely, or with potential to occur in the Study Area.

E.2 *KNOWN WITHIN THE SURVEY AREA*

Black-Breasted Button-Quail (Turnix Melanogaster)

Species	Black-Breasted Button-Quail (*Turnix Melanogaster*)
Conservation Status	*EPBC Act:* Vulnerable *NC Act:* Vulnerable *Back on Track:* Critical priority (Regional)
Background	Ground dwelling and ground nesting bird. Preferred habitats typically have thick leaf litter 3-10 cm deep (Mathieson and Smith 2009). Makes platelets/soup-plate depressions when feeding (as does Painted Button-quail) 15-25 cm in diameter (Curtis and Dennis 2012). Diet consists mainly of small, ground-dwelling invertebrates and seeds (Curtis and Dennis 2012). In Queensland, they are distributed from the Byfield region in the north to at least the Border Ranges rainforests in the south, generally east of the Great Dividing Range (Mathieson and Smith 2009). Habitat includes: • Leaf litter in drier rainforests, vine thickets • Scrubby woodlands of eucalypts, she-oaks, bottle-trees, brush box, Brigalow and other *Acacia* sp • Thickets of lantana on rainforest fringes, hoop pine plantations • Grain stubbles (Curtis and Dennis 2012; Pizzey and Knight 2012; Department of the Environment 2014c) Patch size may be critical to persistence. Habitat considered critical to the survival of the black-breasted button-quail includes: • Vine thickets and rainforests that are periodically water-stressed; • Low thickets or woodlands typically dominated by Acacia sp. with a dense understorey and little ground cover; and • In littoral situations, dry vine scrubs, acacia thickets and areas of dense shrub cover, particularly *Austromyrtus dulcis* (Mathieson and Smith 2009) Black-breasted button-quail inhabit fragments of microphyll and notophyll vine forest, thickets and coastal scrubs. For example, semi-evergreen vine thicket, some rainforest communities and some littoral vegetation types such as Regional Ecosystems 12.2.2, 12.2.3, 12.8.13, 12.8.21, 12.8.22, 12.8.23, 12.9-10.6, 12.9-10.15, 12.11.13, 12.12.18, 12.12.26 (Mathieson and Smith 2009). In 1997, the key subpopulations included the Yarraman-Nanango, Jimna-Conondale Range and Great Sandy regions subpopulations due to their size and the land being of State-owned tenure. Other important subpopulations were those at the Palm Grove National Park and the Barakula State Forest area because they appeared to be the last remnant populations within an area where the species was formerly widespread. (Mathieson and Smith 2009) In 2005, there were 14 known subpopulations in Queensland (Department of the Environment 2014c).
Records	*Field* No individuals were directly observed during 2016 summer field surveys, however, fresh feeding platelets were observed in SEVT and surrounding eucalypt woodland with lantana in the understorey in Woondum State Forest (refer *Figure 5* in Annex A). Vegetation in this area within the footprint includes *E. propinqua* dominated woodland with areas of vine forest on gentle slopes. Platelets were also observed at this location during field surveys for the *Databases:* Wildnet: two records within 10 km of the alignment: Six Mile Creek Reserve (2006) < 1 km west of the alignment, Mothar Mountain State Forest 393 (1997) 7.5 km south east of the alignment. ALA: 3 records within 10 km of the alignment: 2 records as above and one Queensland Museum specimen collected from <3 km west of the alignment.

Species	Black-Breasted Button-Quail (*Turnix Melanogaster*)	
	REF (Jacobs 2015). A high density of platelets were observed in Woondum State Forest, and a lesser density of platelets in rainforest further east on private property.	
Habitat Suitability	Known habitat in the southern portion of D1 in Woondum State Forest with fresh feeding platelets observed. SEVT and surrounding eucalypt woodland with lantana in the understorey, including *E. propinqua* dominated woodland with areas of vine forest on gentle slopes (refer *Figure 5* in Annex A). No suitable habitat (vine thicket, vine forest, elements of these in understorey or acacia thickets) was observed within D2.	
Likelihood of occurrence	*Likelihood from REF* Expected to occur	*Revised Likelihood* Known to occur
Likelihood of Breeding Places	The species is considered sedentary and a high density of fresh feeding platelets was observed during the summer 2016 field surveys and the REF surveys. It is therefore likely that breeding occurs within the observed habitat, and potentially in suitable habitat outside the Survey Area.	
Evaluation of Habitat Critical to the Survival of the Species	Fresh feeding platelets were observed in SEVT and surrounding eucalypt woodland with lantana in the understorey in Woondum SF within the proposed footprint (D1). The SEVT habitat type and surrounding eucalypt woodland with lantana in the understorey in the Survey Area is regarded as habitat critical to the survival of the species. It is recognised foraging habitat (based on field observations) and due to the sedentary nature of the species, it is also likely to be breeding habitat.	
Importance of Population	In 1997, the national recovery plan for Black-breasted Button-Quail described key subpopulations included the Yarraman-Nanango, Jimna-Conondale Range and Great Sandy regions subpopulations due to their size and habitat protected within State-owned tenure. Other important subpopulations were those at the Palm Grove National Park and the Barakula State Forest area because they appeared to be the last remnant populations within an area where the species was formerly widespread. The key sub-populations listed in the recovery plan do not include the population detected within the Survey Area. This population is not located near the limit of the species range. No information regarding the genetics of this population was collected during this study and there is no published data about this population. Field surveys were confined to within the Survey Area. The full extent of the patch, connectivity and existence of the species in adjacent vegetation outside the alignment is not known. Further information may be needed to assess the importance of the population at a later stage in the project.	
Conclusion	*Section D1* Species known to occur (previous records in area and fresh feeding platelets observed during field surveys) within suitable SEVT and adjacent eucalypt woodland habitat in the Survey Area (refer *Figure 5* in Annex A).	*Section D2* Unlikely to occur as suitable habitat is not present within this portion of the footprint and REF and summer 2016 field surveys failed to identify signs or individuals.
References	Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. Department of Environment and Heritage Protection (2015) *WetlandInfo*. Accessed 1 April 2015 from http://wetlandinfo.ehp.qld.gov.au/wetlands/. Department of Environment and Resource Management (2010) *Burnett Mary Natural Resource Management Region Back on Track Actions for Biodiversity*,	

Species	Black-Breasted Button-Quail (*Turnix Melanogaster*)
	Brisbane. Jacobs (2015) *Flora and Fauna*. In *Review of Environmental Factors (Business Case).* Report prepared for Department of Transport and Main Roads. pp. 7–2 to 7–87. Mathieson, M. and Smith, G.C. (2009) *National recovery plan for the black-breasted button-quail Turnix melanogaster*, Brisbane: The State of Queensland, Department of Environment and Resource Management. Pizzey, G. and Knight, F. (2012) *The Field Guide to the Birds of Australia* ninth. S. Pizzey, ed., Sydney, NSW: HarperCollinsPublishers.

Koala (Phascolarctos Cinereus)

Species	Koala (*Phascolarctos cinereus*)	
Conservation Status	*EPBC Act:* Vulnerable *NC Act:* Vulnerable *Back on Track:* -	
Background	A large arboreal marsupial that is found in a range of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species (Department of the Environment 2015c; Curtis and Dennis 2012; Van Dyck et al. 2013). The two most important factors for habitat suitability are (1) the presence of tree species preferred by koalas (usually eucalypts, but also some non-eucalypts) growing in particular associations on suitable soils with adequate rainfall and (2) the presence of other koalas. Habitat of higher suitability in the Gympie region are those habitats that contain the presence of a combination of the following tree species: • *Corymbia citriodora* ssp *variegata* • *Corymbia intermedia* • *Eucalyptus carnea* • *Eucalyptus crebra* • *Eucalyptus exserta* • *Eucalyptus fibrosa* • *Eucalyptus grandis* • *Eucalyptus major* • *Eucalyptus microcorys* • *Eucalyptus moluccana* • *Eucalyptus propinqua* • *Eucalyptus racemosa* • *Eucalyptus resinifera* • *Eucalyptus robusta* • *Eucalyptus siderophloia* • *Eucalyptus tereticornis* • *Eucalyptus tindaliae* • *Lophostemon confertus* • *Lophostemon suaveolens* • *Melaleuca quinquenervia* The highest density of the koala population in Queensland occurs in South-east Queensland, with lower densities occur through central and eastern areas (Department of the Environment 2015c).	
Records	*Field:* Koala scats were found at 12 of 41 sites searched using the modified SAT, as described in *Section 2.3*. Site locations are shown in *Figure 4* in Annex A. The scats were found within large patches of remnant vegetation in association with State Forest areas (Curra SF in the north and Woondum SF in the south) and the East Deep Creek and Mothar Mountain area just north of Woondum SF. During the surveys, koala scats were found beneath 2%	*Databases* ALA: One record within 10 km of the alignment: Gympie National Park (2013) included in Wildnet above. In addition, based on experience undertaking field surveys in the region, it is understood there are numerous additional records of the species within 5 km of the Survey Area which are not available through database searches.

Species	Koala (*Phascolarctos cinereus*)
	of searched trees (28 of 1230 trees), indicating that koalas use the area but are likely to occur in low densities (about 0.02 koalas/ha). Several known koala food tree species were identified throughout remnant and regrowth vegetation and associated habitats throughout the Survey Area. Signs of koala were also detected during field surveys for the REF. This included detection of scats at two locations in Section D1 and detection of a characteristic scratch mark on a tall *Eucalyptus grandis* tree within Curra State Forest (Section D2).
Habitat Suitability	While most eucalypt forests and woodland in the Survey Area contained tree species used by koalas, findings from summer 2016 field surveys indicated that koalas are present in low densities (estimated at about 0.02 koalas/ha). Koala scats were found within three general regions during the summer 2016 field surveys - Curra State Forest, East Deep Creek and Mothar Mountain area, and Woondum State Forest. Scats were found using the adapted SAT method (refer *Section 2.3*) associated with the tree species listed in brackets at the following sites: • PD7 (1x *C. intermedia*, 1x *E. acmenoides*, 1x *E. propinqua* in mapped 12.9-10.4) – Woodland dominated by *E. racemosa*, *E. propinqua*, *A. leiocarpa*, *C. intermedia*, *E. acmenoides*, *L. confertus* over *Acacia disparrima*. Understorey dominated by *Pteridium esculentum* and *Imperata*. • PD11 (*E. propinqua* in mapped 12.11.5e) – open forest dominated by *E. propinqua* with *C. intermedia*, *C. citriodora* (on ridges). Mid storey dominated by *L. suaveolens*. Shrub layer *A. disparrima*. Lantana present. • PD12 (2x *E. acmenoides*, 1x *E. siderophloia* in mapped 12.11.5e) – open forest with *C. citriodora*, *E. siderophloia* and *E. acmenoides*. Low shrub layer of *Carissa ovata* and *Petalostigma triloculare*. • PD21 (*E. melanophloia* in mapped 12.11.3) – steep slope with mixed *Eucalyptus* canopy, with *Acacia* and *Eucalyptus* regrowth in sub-canopy. Native grass understorey (kangaroo grass, *Panicum* sp). Patches of dense lantana. Dry drainage line at base of slope with denser regrowth, *Alphitonia excelsa*, *Melaleuca* sp., *Lophostemon confertus* • PD22 (*E. propinqua* in mapped 12.11.3) – mixed Eucalyptus woodland. Lantana dominated undergrowth. In gully with lower lantana density. • PD23 (1x *Eucalyptus acmenoides*, 1x *Eucalyptus moluccana*, 1x *Lophostemon confertus* in mapped 12.11.16) – mixed *Eucalyptus* woodland with *Eucalyptus* regrowth in sub-canopy and dense lantana below. • PD24 (1x *Eucalyptus acmenoides*, 2x *E. propinqua* in mapped 12.11.3) – mixed eucalypt woodland with *E. propinqua*, *E. acmenoides*, *C. intermedia* over *L. confertus* and *A. disparrima* with native grassy understorey (*Themeda triandra*). Lantana present • PD25 (1x *E. tereticornis*, 1x *L. suaveolens* in mapped 12.11.14) – *E. tereticornis* woodland with *L. suaveolens* and *A. disparrima* over native grassy understorey. • PD27 (*E. tereticornis* in mapped 12.11.14) – *E. siderophloia*, *E. tereticornis*, *L. suaveolens*, *C. intermedia* over lantana and grass • PD31 (1x *C. intermedia*, 4x *E. acmenoides* in mapped 12.11.3) – *C. intermedia*, *E. acmenoides* and *E. siderophloia*

Species	Koala (*Phascolarctos cinereus*)	
	• PD34b (2x *E. propinqua*, *1xL. suaveolens*) – *E. propinqua* dominated woodland with areas of vine forest on gentle slope • PD38 (1x *E. propinqua*, 1x *L. confertus* in mapped 12.11.3) – *E. acmenoides*, *L. confertus*, *L. suaveolens*, *E. propinqua*. Lantana throughout Based on the results of the SAT, habitat within the Survey Area has been divided into four habitat groups: • Generally unsuitable habitat • Regrowth habitat • Remnant habitat with less frequent detection of koalas or signs • Remnant habitats with more frequent detection of koalas or signs. These habitat types and the locations of koala faecal pellets detected are shown in *Figure 4* Annex A.	
Likelihood of occurrence	*Likelihood from REF* Known to occur	*Revised Likelihood* Known to occur
Likelihood of Breeding Places	Established adults are fairly sedentary and there have been records of koalas within the Survey Area and surrounds. It is therefore likely that breeding occurs within habitat within the Survey Area.	
Evaluation of Habitat Critical to the Survival of the Species	The koala habitat assessment tool provided in the EPBC Act referral guidelines for the vulnerable koala (Department of the Environment 2014a) was used and is shown in the table below. The assessment yielded a score of eight. The referral guidelines state that habitat which receives a score of five or more is considered habitat critical to the survival of the koala. Therefore, the Survey Area is considered to contain habitat critical to the survival of the koala.	

Attribute	*Description*	*Score*
Koala Occurrence	Signs of the koala have been recorded within the Survey Area.	+2
Vegetation Composition	The alignment contains a range of forest and woodland communities dominated by eucalypt species. 14 koala food tree species were present within the Survey Area, with at least two present at each survey site.	+2
Habitat Connectivity	The alignment contains native vegetation that is suitable habitat for koalas and is contiguous with Curra State Forest (4,845 ha) in D2. The alignment contains native vegetation that is suitable habitat for koalas and is contiguous with Woondum State Forest in D1. The State Forest area is 452.4 ha but the contiguous patch is larger.	+2
Key Existing Threats	Anecdotal evidence and the existence of built up areas or road networks through fragmented habitats suggests infrequent and irregular instances of koala mortality from vehicle strike could be expected within the area. Most properties visited either had dogs or were neighboured by properties with dogs either adjacent to or with access to forested areas. One resident was encountered searching for their loose dog. Mortality due to dog attach could reasonably be expected to occur on an infrequent and irregular basis.	+1

Species	Koala (*Phascolarctos cinereus*)		
	Recovery Value	The interim recovery objectives for the koala are: • Protect and conserve large, connected areas of koala habitat, particularly large, connected areas that support koalas that are: – Of sufficient size to be genetically robust / operate as a viable sub-population OR – free of disease or have a very low incidence of disease OR – breeding. • Maintain corridors and connective habitat that allow movement of koalas between large areas of habitat. During the summer 2016 surveys, koala scats were found beneath 2% of searched trees (28 of 1230 trees), indicating that koalas use the area but are likely to occur in low densities (estimated at about 0.02 koalas/ha). The genetic and disease status of the koalas present in the Survey Area is not known and no evidence of breeding was gathered during the summer 2016 surveys. It is uncertain whether the habitat is important for achieving the interim recovery objectives above.	+1
	Total		*+8*
Importance of Population	During the summer 2016 surveys, koala scats were found beneath 2% of searched trees (28 of 1230 trees), indicating that koalas use the area but are likely to occur in low densities (estimated at about 0.02 koalas/ha). The genetic and disease status of the koalas present in the Survey Area is not known and no evidence of breeding was gathered during the summer 2016 surveys. It is uncertain whether the habitat is important for achieving the interim recovery objectives above.		
Conclusion	*Section D1* Species known to occur (previous records in area and suitable habitat and scats observed during summer 2016 field surveys) within eucalypt dominated forest and woodland communities in the Survey Area. Of particular note are the areas associated with Woondum State Forest (including residential land adjoining the southern extent of Woondum State Forest) and the area surrounding Penny Road.	*Section D2* Species known to occur (previous records in area and suitable habitat and scats observed during summer 2016 field surveys) within eucalypt dominated forest and woodland communities in the Survey Area. Faecal pellets were found in the south of Curra State Forest, and on freehold land in vegetation contiguous with Curra State Forest.	
References	Cristescu, R.H. et al. (2015) *Accuracy and efficiency of detection dogs: a powerful new tool for koala conservation and management*. Scientific Reports, vol. 5, p.8349. Accessed 23 March 2016 from: http://www.nature.com/doifinder/10.1038/srep08349. Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Phillips, S. and Callaghan, J. (2011) *The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas Phascolarctos cinereus.*		

Species	Koala (*Phascolarctos cinereus*)
	Australian Zoologist, vol. 35, no. 3, pp.774–780. Van Dyck, S., Gynther, I. and Baker, A. eds. (2013). *Field Companion to Mammals of Australia*, Sydney: New Holland Publishers.

Tusked Frog (Adelotus Brevis)

<table>
<tr><th>Species</th><th colspan="2">Tusked frog (Adelotus brevis)</th></tr>
<tr><td>Conservation Status</td><td colspan="2">EPBC Act: -
NC Act: Vulnerable
Back on Track: Critical Priority (Regional), Medium Priority (State)</td></tr>
<tr><td>Background</td><td colspan="2">This species is found in wet and dry forest environments, usually along streams but also around dams (Curtis and Dennis 2012). It inhabits areas of rainforest, wet sclerophyll and open grazing country along the Great Dividing Range and coast from central-eastern Queensland to southern New South Wales. Usually found under logs or stones, or in cavities and crevices, beside puddles and streams (Curtis and Dennis 2012).
Breeding takes place in ponds and slow moving streams (Curtis and Dennis 2012). Unpigmented eggs are laid in a foam nest hidden from the light, often concealed under a log or rock (Curtis and Dennis 2012).
The species is now absent from some areas of apparently suitable habitat (Curtis and Dennis 2012). In Queensland, it has disappeared from the New England Tableland and Bunya Mountains and is very scarce or patchy in upland areas of the Scenic Rim. Upland populations in northern New South Wales have also declined (Curtis and Dennis 2012).
There is no published information on its overall population size, structure, genetics or dynamics.</td></tr>
<tr><td>Records</td><td>Field:
The species was recorded at two locations in the north of Section D2 during field surveys for the REF (refer Figure 5 in Annex A).
The species was not observed directly or indirectly during Summer 2016 surveys, despite significant duplicate survey effort. Conditions were considered conducive to amphibian activity with numerous other least concern amphibian species observed during the same survey period. Despite no direct or indirect observations, most night survey sites were considered likely habitat, including pools and slow moving waterways with overhanging ledges, rocks or logs.</td><td>Databases
ALA: 1 record since 2010 (inclusive) in Bollier (approximately 17 km south of the alignment).
Wildlife Online: One record within 10 km of the alignment.</td></tr>
<tr><td>Habitat Suitability</td><td colspan="2">This species was recorded at two locations during the 2015 surveys for the REF and are expected to occur in wetlands and slow moving waterways within the footprint. These two locations were again re-surveyed in January 2016 and February 2016 and no direct or indirect observations were reported although other least concern amphibian species were observed.
Despite no records during recent intensive survey effort these areas are considered suitable habitat given the presence of slow moving sections and pooled areas along these creeks and the wide range of habitats that Adelotis</td></tr>
</table>

Species	Tusked frog (*Adelotus brevis*)	
	brevis is known to occur in. *Figure 5* in Annex A shows suitable breeding habitat for *Adelotis brevis*, based on a 25 m buffer to the stream centreline, within habitat mapped within the REF. The 25 m buffer was applied as the species is recognised as occur within or beside streams, and only occasionally more distant from streams (Curtis and Dennis 2012). Waterways within mature regrowth were not added to the mapped habitat, as it was considered unlikely these would provide the level of habitat complexity found in the remnant vegetation.	
Likelihood of occurrence	*Likelihood from REF* Known to Occur	*Revised Likelihood* Known to Occur
Likelihood of Breeding Places	There are wetlands and slow moving waterways with overhanging ledges, rocks or logs present within the footprint. Breeding places are likely to occur given records of the species within the vicinity and the presence suitable breeding habitat.	
Conclusion	*Section D1* Species likely to occur within the Survey Area, as there are previous records of the species approximately 3 km to the west of Section D1 and suitable habitat observed during field surveys, within and adjacent to waterways in regional ecosystems associated with moist forest and dense undergrowth habitats.	*Section D2* The species has been recorded at two locations in Section D2 (refer *Figure 5* in Annex A) and additional suitable habitat is present in Section D2 within and adjacent to waterways in regional ecosystems associated with moist forest and dense undergrowth habitats.
References	Cogger, H.G. (2014) *Reptiles and Amphibians of Australia* 7th ed., CSIRO Publishing. Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. IUCN (2014) *The IUCN Red List of Threatened Species. Version 2014.3.* Accessed 23 March 2016 from http://www.iucnredlist.org.	

E.3 *LIKELY TO OCCUR WITHIN THE SURVEY AREA*

Powerful Owl (Ninox Strenua)

Species	Powerful Owl (*Ninox strenua*)	
Conservation Status	*EPBC Act:* - *NC Act:* Vulnerable *Back on Track:* Critical Priority (Regional), Medium Priority (State)	
Background	Suitable habitat for this very large owl occurs mostly within around 200 km of the coast, from Queensland's central coast to south-eastern South Australia (Pizzey and Knight 2012). In south-east Queensland, it is found in extensive native forest in coastal and upland areas from north of Eungella to the New South Wales border, inland to Carnarvon Gorge, Blackdown Tableland and Durikai State Forest west of Warwick (Curtis and Dennis 2012). Pairs occupy a large, probably permanent, home range in mountain forests, gullies and forest margins; sparser hilly woodlands; coastal forests, woodlands, scrubs; exotic pine plantations; large trees in private/public gardens, sometimes in cities. Wet sclerophyll forest, dry sclerophyll forest and woodland (Pizzey and Knight 2012). Roost sites are sheltered groves of midstorey trees, or sometimes pine plantations, and paperbark thickets on inland rivers. Uses secluded roosting sites on bare branches 2-20 m above the ground under a dense leafy canopy. Roost and nest sites are usually in gullies (Curtis and Dennis 2012). Require large hollow 45-100 cm wide and 45-200 cm deep in a big old tree, usually live but sometimes dead, 8-45 m above the ground for nesting (Curtis and Dennis 2012). Powerful owls have large permanent home ranges of approximately 600 ha (in moist, highly productive coastal forests) and up to 3,000 ha in dry inland forests (Curtis and Dennis 2012).	
Records	*Field*: The species was not recorded during summer 2016 and REF field surveys. Large trees with potential nesting hollows at PD32 and PD39 in Curra State Forest, and PD27 and PD42 in Woondum State Forest. Signs and direct observations of prey species such as possums, gliders and flying foxes were observed within Curra State Forest and Woondum State Forest, as well as on freehold land within the Survey Area.	*Databases:* ALA: Three records since 2010 (inclusive) in Gympie National Park and Bella Creek areas. The two records in Gympie National Park are less than 10 km from the nearest point on the alignment (approximately 7 km and 8.5 km), while Bella Creek is approximately 28 km from the nearest point on the alignment (D1 southern end). Wildlife Online: 12 records within 10 km of alignment. The two closest wildlife online records are the same records reported in Gympie National Park on ALA (ie. 7 km and 8.5 km from alignment).
Habitat Suitability	This species is known to persist in native commercial timber estates where it forages in logged or regenerating areas and roosts in unlogged areas such as gullies where large trees with hollows still remain (Curtis and Dennis 2012). Some areas within the Survey Area remain connected to extensive areas of native forest which has been and is currently selectively harvested for commercial timber. These areas include Curra State Forest and Woondum State Forest. There are few large, well-positioned hollows in both living and dead trees within the Survey Area (*Figure 5* in Annex A). The large, well-positioned hollows are restricted to gullies where previous and current native timber harvesting is impeded due to access into these areas. The large trees which	

Species	Powerful Owl (*Ninox strenua*)	
	would have previously contained suitable hollows outside of these gully areas have been selectively logged in the remaining large tracts of bushland. Indirect and direct observations of prey species such as possums, gliders and flying foxes were observed within Curra State Forest and Woondum State Forest within the Survey Area.	
Likelihood of occurrence	*Likelihood from REF* Likely to occur	*Revised Likelihood* Likely to occur
Likelihood of Breeding Places	Powerful owls have large home ranges and have previously been recorded within 10 km of the alignment. The large, well-positioned hollows observed in the Survey Area are restricted to gullies within the large patches of woodland (Curra and Woondum State Forests). Adjacent selectively logged areas and rural bushland areas are considered suitable foraging habitat given the direct and indirect observations of prey species such as possums, gliders and flying foxes. The gully areas within Curra and Woondum State Forest with large hollows are considered likely breeding areas within the Survey Area, given the previous records within 10 km of the alignment, large home range, connectivity to extensive native forest, appropriate size and position of hollows and surrounding suitable foraging habitat.	
Conclusion	*Section D1* Species likely to occur (previous records within 10 km and suitable habitat observed during field surveys) within Survey Area.	*Section D2* Species likely to occur (previous records within 10 km and suitable habitat observed during field surveys) within Survey Area.
References	Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. Pizzey, G. and Knight, F. (2012) *The Field Guide to the Birds of Australia* ninth. S. Pizzey, ed., Sydney, NSW: HarperCollinsPublishers.	

Grey-Headed Flying-Fox (Pteropus Poliocephalus)

Species	Grey-headed flying-fox (*Pteropus poliocephalus*)
Conservation Status	*EPBC Act:* Vulnerable *NC Act:* - *Back on Track:* Critical priority (Regional)
Background	Australia's only endemic flying-fox occurs in the coastal belt from Rockhampton in central Queensland to Melbourne(Curtis and Dennis 2012; Churchill 2008). It is a large nomadic bat that generally moves camp in response to changing food availability, thus only a small proportion of this range is used at any one time (Department of the Environment 2014b). The national population is spatially structured into colonies of one single interbreeding population (Department of the Environment 2014b). The grey-headed flying-fox forages and roosts in mangroves, rainforests, open forests, closed and open woodlands, paperbark swamps, *Banksia* woodlands and urban and commercial landscapes (Van Dyck et al. 2013). Roosts are often located near water (Churchill 2008). Camps may be shared with *P. alecto* and *P. scapulatus* (Van Dyck et al. 2013). The species forages at night up to 50 km from camp (Churchill 2008; Australian Museum 2009) in a variety of forest and woodland communities and urban and production landscapes on fruit, flowers, pollen, nectar and, rarely, leaves (Eby and Law 2008). *Eucalyptus* blossoms are their major food source and a diverse range of vegetation communities is required to access year round food supplies (Curtis and Dennis 2012). In order to survive, grey-headed flying-foxes require a continuous sequence of productive foraging habitats, migration corridors or stopover habitats that link them, and suitable roosting habitat within nightly commuting distance of foraging areas (NSW Department of Environment Climate Change and Water 2009). The Draft National Recovery Plan for Grey-headed Flying-fox (NSW Department of Environment Climate Change and Water 2009) lists natural foraging habitat includes that which is: • productive during winter and spring, when food bottlenecks have been identified; • known to support populations of > 30,000 individuals within an area of 50 km radius (the maximum foraging distance of an adult); • productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (September to May); • productive during the final stages of fruit development and ripening in commercial crops affected by grey-headed Flying-foxes (months vary between regions); and • known to support a continuously occupied camp. Roosting habitat listed in the Draft National Recovery Plan for Grey-headed Flying-fox (NSW Department of Environment Climate Change and Water 2009) includes that which: • is used as a camp either continuously or seasonally in > 50% of years; • has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained >10,000 individuals, unless such habitat has been used only as a temporary refuge, and the use has been of limited duration (i.e. in the order of days rather than weeks or months); and • has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained >2,500 individuals, including reproductive females during the final stages of pregnancy, during lactation, or during the period of conception (i.e. September to May).

Species	Grey-headed flying-fox (*Pteropus poliocephalus*)	
Records	*Field:* No roost sites were detected during the survey. Flying fox species were observed during summer 2016 field surveys but species identity is unconfirmed. Fruit bat species (species identity unconfirmed) observed at PN1, PN10, PN12 and PN9. The REF reported a record of grey-headed flying-fox in Curra State Forest, approximately 500 m north east of the Survey Area.	*Databases:* Wildnet: 39 records within 10 km of the alignment: 38 records at Gympie township, Widgee Crossing (2004-2011) 5 km west of the alignment, 1 record at Hill Street Camp (2004) 1.7 km west of the alignment ALA: as above 2012-2015 monitoring program: Known camps for this species within the region are in the Goomboorian, Gympie township, Kandanga and Cooran areas (DoE 2015) (refer *Figure 1* in Annex A).
Habitat Suitability	Suitable foraging habitat occurs throughout the footprint – eucalypts will flower within the footprint at different times throughout the year. Fleshy fruiting trees also recorded at D3, D4, D7, D12, PD30, PD39, PD16, PD18 and PN7. There are no historical (2012-2015) camp sites within the Survey Area (DoE 2015).	
Likelihood of occurrence	*Likelihood from REF* Expected to occur	*Revised Likelihood* Likely to occur
Likelihood of Breeding Places	There are no historical (2012-2015) roost sites within the Survey Area (DoE 2016), where breeding occurs, but likely to breed at the roosts identified in *Figure 1* Annex A and use the Survey Area for foraging.	
Evaluation of Habitat Critical to the Survival of the Species	While habitat used for foraging is located within the Survey Area, this species is highly mobile and the foraging habitat within the Survey Area is small in comparison to the patches of continuous habitat adjacent and in the wider landscape. As there are alternate foraging habitats across the region, the foraging habitat within the Survey Area is not likely to be regarded as habitat critical to the survival of the species.	
Importance of Population	The national population is spatially structured into colonies of one single interbreeding population (DoE 2016). The individuals that camp within the region and use the foraging habitat within alignment are therefore a part of a larger population and are not a separate sub-population that are a key source of genetics for breeding or dispersal. The alignment is not near the limit of the species range.	
Conclusion	*Section D1* Species likely to occur within remnant vegetation throughout Survey Area. There are previous records of the species within 10 km of the Survey Area, and there are roosting colonies at Goomboorian, Gympie township, Kandanga and Cooran areas.	*Section D2* Species likely to occur within remnant vegetation throughout Survey Area. There are previous records of the species within 10 km of the Survey Area, and there are roosting colonies at Goomboorian, Gympie township, Kandanga and Cooran areas.
References	Churchill, S. (2008) *Australian Bats* 2nd ed., Crows Nest, NSW: Allen and Unwin. Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. Department of the Environment (2015) *National Flying-Fox Monitoring Programme.* Accessed 3 March 2016 from http://www.environment.gov.au/biodiversity/threatened/species/flying-fox-monitoring. DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.	

Species	Grey-headed flying-fox (*Pteropus poliocephalus*)
	Jacobs (2015) *Flora and Fauna*. In *Review of Environmental Factors (Business Case). Report prepared for Department of Transport and Main Roads.* pp. 7–2 to 7–87. Van Dyck, S., Gynther, I. and Baker, A. eds. (2013) *Field Companion to Mammals of Australia*, Sydney: New Holland Publishers.

E.4 *POTENTIAL TO OCCUR WITHIN THE SURVEY AREA*

Australian Painted Snipe (Rostratula Australis)

Species	Australian Painted Snipe (*Rostratula australis*)	
Conservation Status	*EPBC Act:* Endangered *NC Act:* Vulnerable *Back on Track:* High Priority (Regional), Medium Priority (State)	
Background	The Australian Painted Snipe generally inhabits shallow terrestrial wetlands, including temporary and permanent lakes, swamps and claypans (DoE 2016). Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*) (DoE 2016). Australian Painted Snipe breeding habitat requires shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby (DoE 2016). Nest records are nearly all from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (DoE 2016). The Australian Painted Snipe can use modified habitats, such as low-lying woodlands converted to grazing pasture, sewage farms, dams, bores and irrigation schemes, however they do not necessarily breed in such habitats (DoE 2016). This species is generally seen singly or in pairs, or less often in small flocks (DoE 2016). Flocking occurs during or after the breeding season (DoE 2016). The Australian Painted Snipe is considered to occur in a single, contiguous breeding population (DoE 2016).	
Records	*Field:* This species was not recorded during field surveys.	*Databases:* There are no database records (Birdata or Wildlife Online) of the species within 10 km of the Survey Area. The nearest recent (post 2000) records are from Cove Road (Birdata), 30 km north east of the Survey Area (2007) and from Bli Bli, 45 km south east (2014) (WO).
Habitat Suitability	Dams with dense fringing vegetation, and waterlogged pasture may provide suitable foraging habitat for the species. No remnant or naturally occurring wetlands were found to provide suitable habitat for the species. No suitable nesting habitat (i.e. small islands in freshwater wetlands) was observed within the Survey Area. Refer to Waterways, Dams and Cleared Areas on *Figure 3* in Annex A for the locations of potential suitable habitat for this species.	
Likelihood of occurrence	*Likelihood from REF:* Low potential to occur around artificial wetlands within the Survey Area. No potential breeding habitat was detected during the surveys.	*Revised Likelihood:* **Potential** – there is potential for the species to occur as an occasional visitor to dams and waterlogged pasture in the Survey Area. The Survey Area does not provide suitable breeding habitat for the species.
Likelihood of Breeding Places	No suitable nesting habitat (i.e. small islands in freshwater wetlands) was observed within the Survey Area. The Survey Area is unlikely to contain breeding places for the species.	

Species	Australian Painted Snipe (*Rostratula australis*)	
Evaluation of Habitat Critical to the Survival of the Species	As the Survey Area provides only suitable foraging habitat and the species has not been recorded within 10 km of the Survey Area, the Survey Area is unlikely to contain areas necessary for the long-term maintenance of the species or to maintain genetic diversity of the species. While dams and waterlogged pastures in the Survey Area may provide foraging or dispersal habitat for the species, these habitat features are common throughout the surrounding agricultural landscape. Therefore the habitat features within the Survey Area are not considered 'necessary' for foraging or dispersal.	
Importance of Population	The Survey Area is considered to provide suitable foraging and dispersal habitat for occasional visiting individuals, and is not considered to support a population of the species.	
Conclusion	*Section D1* Section D1 provides potential foraging habitat and the species may be a temporary visitor to the Survey Area. Section D1 is unlikely to contain breeding places, or habitat critical to the survival of the species.	*Section D2* Section D2 provides potential foraging habitat and the species may be a temporary visitor to the Survey Area. Section D2 is unlikely to contain breeding places, or habitat critical to the survival of the species.
References	DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.	

Coxen's Fig-Parrot (Cyclopsitta Diophthalma Coxeni)

Species	Coxen's Fig-Parrot (*Cyclopsitta diophthalma coxeni*)	
Conservation Status	*EPBC Act:* Endangered *NC Act:* Endangered *Back on Track:* Critical Priority (Regional), Critical Priority (State)	
Background	The distribution of Coxen's Fig-Parrot is poorly known. Coxen's Fig-Parrot is estimated to occur in four subpopulations: greater Bundaberg region, Maleny/Imbil/Kin Kin Creek area, the Qld/NSW border area, and the upper Hastings River catchment (DoE 2016). The total population of Coxen's Fig-Parrot is estimated, with low reliability, at 100 breeding birds (DoE 2016). Coxen's Fig-Parrot occurs in rainforest habitats including subtropical rainforest, dry rainforest, littoral and developing littoral rainforest, and vine forest (DoE 2016). Most recent records of the fig-parrot have been from small stands of remnant native vegetation, at forest edges, and in thin tracts of gallery forest (at edges of rivers or streams) (DoE 2016). Coxen's Fig-Parrot has also been recorded in other habitat types including sub-littoral mixed scrub; corridors of riparian vegetation in woodland, open woodland or other types of cleared or partially-cleared habitat; and isolated stands of fig or other trees on urban, agricultural or cleared land. The species nests in a chamber that is excavated in the rotting wood of a decaying limb or trunk of a living or dead tree (DoE 2016).	
Records	*Field:* This species was not recorded during field surveys.	*Databases:* There is one record of the species within 10 km of the Survey Area from 1880. There are additional records approximately 40 km south of the Survey Area from the 1960s to 1990s. The Wildlife Online database does not contain any recent (post 2000) records of the species.

<table>
<tr><th>Species</th><th colspan="2">Coxen's Fig-Parrot (Cyclopsitta diophthalma coxeni)</th></tr>
<tr><td>Habitat Suitability</td><td colspan="2">Riparian vegetation at Six Mile Creek and vine forest within Woondum State Forest provide suitable habitat for the species. The riparian forest at Six Mile Creek may be favoured by the species, as is it contains the fig species Ficus coronata, and the species is said to favour alluvial areas that support fig species (DoE 2016). However, the area of suitable riparian habitat at Six Mile Creek is reduced due to the presence of dense infestations of cat's claw creeper. Cat's claw creeper invasion is a recognised threat to this species (DoE 2016).
The broad location of habitat for this species is mapped as 'Vine Forest' on Figure 3 in Annex A. The mapping does not exclude areas of weed infestation.</td></tr>
<tr><td>Likelihood of occurrence</td><td>Likelihood from REF:
Low potential to occur particularly in habitat along Six Mile Creek.</td><td>Revised Likelihood:
Potential - riparian habitat along Six Mile Creek and vine thicket at Woondum State Forest may provide suitable habitat for the species.</td></tr>
<tr><td>Likelihood of Breeding Places</td><td colspan="2">The species nests in chambers excavated in decaying limbs or trunks of living or dead trees (DoE 2016). There is potential for suitable nesting habitat to be present within riparian areas of Six Mile Creek, however the value of this habitat is considered low due to the cat's claw creeper infestation.</td></tr>
<tr><td>Evaluation of Habitat Critical to the Survival of the Species</td><td colspan="2">The Recovery Plan for the Coxen's fig parrot states that, due to a lack of knowledge of the distribution, patterns of movements and ecology of the species, it is not yet possible to define what constitutes habitat critical to the survival of the taxon (Coxen's Fig-Parrot Recovery Team 2001). Given the lack of records of the species in the Survey Area or surrounding area, and the disturbed condition of suitable riparian habitat, it is considered unlikely that the Survey Area would contain areas necessary for: foraging, breeding roosting or dispersal; the long-term maintenance of the species; or the maintenance of genetic diversity of the species. It is therefore considered unlikely that the Survey Area would contain habitat critical to the survival of Coxen's fig-parrot.</td></tr>
<tr><td>Importance of Population</td><td colspan="2">The DoE note that the lack of knowledge about the subspecies makes it impossible to assess the importance of individual populations and indicates that all remaining populations are important for the long-term survival of the subspecies (DoE 2016). Further, as the Survey Area is at the northern limit of the species range, a population present here may be considered an important population. However, the likelihood of a population occurring is considered low.</td></tr>
<tr><td>Conclusion</td><td>Section D1
Riparian vegetation at Six Mile Creek and vine forest within Woondum State Forest provide suitable habitat for the species, however it is considered unlikely that the Survey Area would contain habitat critical to the survival of the species.</td><td>Section D2
No suitable habitat for the species was recorded in Section D2. The species is unlikely to occur in Section D2.</td></tr>
<tr><td>References</td><td colspan="2">DoE (2016) Species Profile and Threats Database. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.
Coxen's Fig-Parrot Recovery Team (2001) Coxen's fig-parrot Cyclopsitta diophthalma coxeni recovery plan 2001-2005. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane.</td></tr>
</table>

Red Goshawk (Erythrotriorchis Radiatus)

Species	Red Goshawk (*Erythrotriorchis radiatus*)	
Conservation Status	*EPBC Act:*	Vulnerable
	NC Act:	Endangered
	Back on Track:	High Priority (Regional), High Priority (State)
Background	The Red Goshawk occurs in coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia (DoE 2016). Riverine forests are also used frequently (DoE 2016). Such habitats typically support high bird numbers and biodiversity, especially medium to large species which the goshawk requires for prey (DoE 2016). This species prefers forest and woodland with a mosaic of vegetation types, large prey populations (birds), and permanent water (DoE 2016). The vegetation types include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins (DoE 2016). The Red Goshawk nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within 1 km of and often beside, permanent water (river, swamp, pool), usually in fairly open, biologically rich forest or woodland (DoE 2016). Breeding pairs use the same nesting territories year after year, renovating the nest used in the previous year or nesting nearby (DoE 2016). It has been estimated that there are 10 to 30 pairs of red goshawks in southern Queensland (DoE 2016).	
Records	*Field:* This species was not recorded during field surveys.	*Databases:* There are two records of the species within 10 km of the Survey Area. The records are from December 1993 (Birdata) and January 1994 (WO), located approximately 500 m from the Survey Area, near Curra train station. The nearest recent (post 2000) record is from Conondale National Park (2007), approximately 50 km south of the Survey Area.
Habitat Suitability	Woodland and forest communities within the Survey Area may provide suitable foraging habitat for the species. In particular, habitat at Moody Creek and within Woondum State Forest contained high numbers of birds, which present suitable prey for the species. No suitable nesting trees (emergent trees within a tall stand of trees) were identified during Summer 2016 surveys, however there is potential for suitable trees to be present surrounding Curra Creek. The broad area of potential foraging and dispersal habitat for this species is mapped as Eucalypt Communities on Sedimentary and Metamorphic Rock, Eucalypt Communities On Alluvial Soils and Vine Forest on *Figure 3* in Annex A.	
Likelihood of occurrence	*Likelihood from REF:* Historical records from the Survey Area. The species has declined over much of its range. Low potential to occur.	*Revised Likelihood:* **Potential** – there is potential for this species to use forest and woodland communities within the Survey Area for foraging and dispersal. Potential nesting habitat may be available at Curra Creek.
Likelihood of Breeding Places	No suitable nesting trees (emergent trees within a tall stand of trees) were identified during Summer 2016 surveys, however there is potential for suitable trees to be present surrounding Curra Creek.	

Species	Red Goshawk (*Erythrotriorchis radiatus*)	
Evaluation of Habitat Critical to the Survival of the Species	As the species has not been recorded within 10 km of the Survey Area for over 20 years, it is considered unlikely that the Survey Area would be necessary for activities such as foraging, breeding, roosting or dispersal; for long-term maintenance of the species; or for maintenance of genetic diversity of the species. Therefore, the Survey Area is not considered to provide habitat critical to the survival of the species.	
Importance of Population	The National Recovery Plan for the Red Goshawk states that there is currently little information available to identify important populations of the species (DERM 2012). However it is noted that there appears to be limited genetic interchange between red goshawks from the Top End, Tiwi Islands, Cape York, central coastal Queensland and southern Queensland/NSW, or that fragmentation of the red goshawk population is only a recent phenomenon (DERM 2012). On the basis of the lack of recent records of the species surrounding the Survey Area, the apparent lack of genetic variation of the species across its range, and that the Survey Area is not near the limit of the species' range, individuals that may occur within the Survey Area are unlikely to form part of an important population.	
Conclusion	*Section D1* Woodland and forest throughout Section D1 provide potential foraging and dispersal habitat for the species. The Survey Area is not considered to provide habitat critical to the survival of the species, and it is considered unlikely that individuals within the Survey Area, if present, would form part of an important population of the species.	*Section D2* Woodland and forest throughout Section D2 provide potential foraging and dispersal habitat for the species. The Survey Area is not considered to provide habitat critical to the survival of the species, and it is considered unlikely that individuals within the Survey Area, if present, would form part of an important population of the species.
References	DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. Department of Environment and Resource Management (DERM) (2012) *National recovery plan for the red goshawk Erythrotriorchis radiatus.* Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Queensland Department of Environment and Resource Management, Brisbane.	

Spotted-Tailed Quoll (Southern Subspecies) (Dasyurus Maculatus Maculatus)

Species	Spotted-Tailed Quoll (Southern Subspecies) (*Dasyurus maculatus maculatus*)	
Conservation Status	*EPBC Act:*	Endangered
	NC Act:	Vulnerable
	Back on Track:	High Priority (Regional) High Priority (State)
Background	The spotted-tailed quoll occurs in the ACT, NSW, Queensland and South Australia (DoE 2016). Within Queensland the species occurs coastally from Bundaberg south to NSW, and west to Monto and Stanthorpe (DoE 2016). The species has been recorded from a range of habitat types, including: rainforest in mountain areas; wet schlerophyll forest; lowland forests; open and closed eucalypt woodlands; inland riparian and River Red Gum (*Eucalyptus camaldulensis*) forests; dry 'rainshadow' woodland; sub-alpine woodlands; coastal heathlands and occasional sightings from open country, grazing lands, rocky outcrops and other treeless areas(DoE 2016). The species is reported to prefer mature wet forest habitat and unlogged forest	

Species	Spotted-Tailed Quoll (Southern Subspecies) (*Dasyurus maculatus maculatus*)	
	or forest that has been less disturbed by timber harvesting (DoE 2016). Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves; an abundance of food such as birds and small mammals; and large areas of relatively intact vegetation to forage within (DoE 2016). Home ranges are estimated at 620–2560 ha for males, and 90–650 ha for females (DoE 2016).	
Records	*Field:* This species was not recorded during field surveys.	*Databases:* There are four records of the species within the 10 km of the Survey Area. The most recent record is from Deep Creek (Cedar Pocket), approximately 5 km east of the Survey Area from 2004. Aerial imagery indicates this record is from a vegetated riparian corridor (width of 50 m to 100 m) within an agricultural landscape.
Habitat Suitability	Broadly, eucalypt woodland within the Survey Area is considered to provide suitable habitat for the species. Hollow logs were present at numerous locations throughout and may provide suitable den sites for the species. Some tree hollows are present, however are not abundant within the Survey Area. Rocky areas to the north of Curra State Forest may also provide suitable denning habitat. The majority of the Survey Area is unlikely to provide preferred habitat, as woodland within the state forests has been selectively logged, and the Survey Area does not contain wet forest habitat. The broad area of potential habitat for this species is mapped as Eucalypt Communities on Sedimentary and Metamorphic Rock, Eucalypt Communities On Alluvial Soils and Vine Forest on *Figure 3* in Annex A.	
Likelihood of occurrence	*Likelihood from REF:* Low potential to occur in the Survey Area in the vicinity of Curra State Forest and adjacent habitats.	*Revised Likelihood:* **Potential** - As the Survey Area is within the species' distribution, and provides suitable habitat for the species, the species in State Forests is considered to have potential to occur.
Likelihood of Breeding Places	As the species has potential to occur in the Survey Area, there is considered to be potential for breeding places to be present within the Survey Area. Potential breeding places include potential den sites (hollow logs, tree hollows and rocky areas) located within woodland and forest.	
Evaluation of Habitat Critical to the Survival of the Species	As the species has not been recorded within the Survey Area, it is unknown if the Survey Area is necessary for foraging, breeding or dispersal of the species. However, as the Survey Area does not contain 'preferred' habitat, as described by DoE (2016) (due to selective logging with state forests, and absence of wet forest habitats) the Survey Area is unlikely to contain habitat critical to the survival of the species.	
Importance of Population	Insufficient information is available regarding current populations of the spotted-tailed quoll to determine if individuals present at the Survey Area would form part of an important population. The Survey Area is not near the limit of the species' range.	
Conclusion	*Section D1* The species is considered to have potential to occur in the Survey Area. Eucalypt woodland within the Survey Area provides suitable habitat for the species, however the habitat is unlikely to be considered habitat critical to the survival of the species.	*Section D2* The species is considered to have potential to occur in the Survey Area. Eucalypt woodland within the Survey Area provides suitable habitat for the species, however the habitat is unlikely to be considered habitat critical to the survival of the species.

Species	Spotted-Tailed Quoll (Southern Subspecies) (*Dasyurus maculatus maculatus*)
References	DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

Common Death Adder (Acanthophis Antarcticus)

Species	**Common Death Adder (*Acanthophis antarcticus*)**	
Conservation Status	*EPBC Act:* - *NC Act:* Vulnerable *Back on Track:* High (Regional), Medium (State)	
Background	This secretive snake is usually found half buried in sand, soil or litter, often at the base of trees or shrubs. This species occurs in southern continental Australia, from south-western Australia to eastern and central Queensland. It is found in a wide variety of habitats in association with deep leaf litter, including rainforests, wet sclerophyll forests, woodland, grasslands, chenopod dominated shrublands, and coastal heathlands.	
Records	*Field:* This species was not recorded during field surveys.	*Databases:* ALA: last record in 1997 in Kandanga State Forest which is approximately 20 km to the south west of the southern portion of the D1 alignment.
Habitat Suitability	This species is found in a wide variety of habitats in association with deep leaf litter. Suitable habitat of deep leaf litter and/or loose soil was observed within most wooded or forested areas. Of note, however, is the high abundance of cane toads throughout the footprint. Predators rarely discriminate between native frogs and toads and as toads are highly toxic, death adder mortality is often the result of catching a toad (Phillips *et al.* 2010). Cane toads are therefore considered a major threat to this species The observed high abundance of cane toads throughout the Survey Area is considered to reduce the habitat value and likelihood of occurrence.	
Likelihood of occurrence	*Likelihood from REF* Low potential to occur	*Revised Likelihood* Potential to occur
Likelihood of Breeding Places	Suitable habitat is available throughout the footprint for breeding. It is likely that if the species is present, it also breeds in the area. Detectability of the species is difficult due to its cryptic nature.	
Conclusion	*Section D1* Based on the likelihood of occurrence criteria, this species has the potential to occur within Section D1. Encounters likely to be infrequent.	*Section D2* Based on the likelihood of occurrence criteria, this species has the potential to occur within the Section D2. Encounters likely to be in frequent.
References	Cogger, H.G. (2014) *Reptiles and Amphibians of Australia* 7th ed., CSIRO Publishing. Department of Environment and Heritage Protection (2015) *Common death adder*. Accessed 4 March 2016 from: https://www.ehp.qld.gov.au/wildlife/animalsa-z/common_death_adder.html.	

Giant Barred Frog (Mixophyes Iteratus)

Species	Giant Barred Frog (*Mixophyes iteratus*)
Conservation Status	*EPBC Act:* Endangered *NC Act:* Endangered *Back on Track:* High Priority (Regional), Medium Priority (State)
Background	In south-eastern Queensland, the Giant Barred Frog is known from Doongul Creek in the Burrum River catchment, at scattered locations in the Mary River catchment downstream to Kenilworth, the Upper Stanley River, Caboolture River and Coomera River. A survey in 2011-2012 between Cooroy and Curra detected the species at 11 of 19 surveyed sites at Cooroy Creek, Six Mile Creek and Skyring Creek. Occurs along permanent shallow rocky streams in rainforest, wet sclerophyll forest and farmland between 100 and 1000m or deep, slow moving streams with steep banks in lowland areas. Rainforests, Antarctic beech or wet sclerophyll forests with rainforest understorey. Giant Barred Frogs in the Cooroy to Curra (between Cooroy and Pomona) area have been observed to prefer a closed forest canopy with a relatively light cover of vegetation at ground level (Aland and Wood 2013). It is a stream-breeding species. Eggs are deposited out of water, under overhanging banks or on steep banks of large pools. The stream microhabitats used by the species for oviposition are limited.
Records	*Field:* Despite intensive duplicate surveys in January and February 2016, no *Mixophyes iteratus* were directly or indirectly observed within the Survey Area. Conditions during the surveys were conducive to amphibian activity. *Mixophyes fasciolatus*, a least concern related species, was directly and indirectly observed near waterways throughout the Survey Area. *Databases:* ALA: last records in 2006 along Skyring Creek and Mary River approximately 20 km south of the D1 alignment. A survey between Cooroy and Curra (Cooroy Creek, Six Mile Creek and Skyring Creek between Cooroy and Pomona south of the current Survey Area) detected the species at 11 of 19 surveyed sites targeted multiple times in 2011-12 (Aland and Wood 2013). Monitoring has continued and the most recent monitoring survey conducted in late 2015 reported continued presence of the species at the upstream and downstream monitoring transects of Six Mile Creek and Cooroy Creek (near Cooroy) with evidence of recent recruitment (tadpole and juvenile frog stages) within these populations (Aland and Wood 2016). A small population that was detected on Skyring Creek (near Pomona) during the early 2014 surveys have not been detected since (Aland and Wood 2016).
Habitat Suitability	Some low value suitable habitat occurs along Six Mile Creek within the Survey Area. Although Six Mile Creek is a wide slow moving (fast and subject to flooding during peak rainfall events), steep banked creek with wet sclerophyll riparian habitat, the habitat is considered low value as it is severely degraded due to a heavy infestation of cat's claw creeper. The cat's claw creeper appears to be shading out and killing the riparian canopy vegetation resulting in an open canopy rather than closed canopy. The infestation has also created a

Species	Giant Barred Frog (*Mixophyes iteratus*)	
	thick cover of vine vegetation at ground level. Habitat in this area may once have been considered higher in value however due to the current level of degradation, the habitat is considered low value for this species.	
Likelihood of occurrence	*Likelihood from REF* Low potential to occur	*Revised Likelihood* Potential to occur
Likelihood of Breeding Places	One small area of low value suitable habitat occurs along Six Mile Creek within the alignment (refer *Figure 3* in Annex A). Six Mile Creek in this area has overhanging banks, steep banks, large pools on slow moving stream sections and shallow rocky riffle areas, which typically would be considered suitable habitat for this species. However, the riparian areas along Six Mile Creek in the Survey Area are severely degraded as a result of a heavy infestation of cats claw creeper. The cats claw has opened up the canopy (through completion) and created a thick blanket of creeper ground cover along the riparian area. *Mixophyes iteratus* in the local area have been observed to prefer a closed forest canopy with a relatively light cover of vegetation at ground level. As such, the likelihood of suitable breeding places within the Survey Area is considered low.	
Evaluation of Habitat Critical to the Survival of the Species	As the species has not been recorded in the Survey Area, and the Survey Area contains only degraded habitat, the Survey Area is not considered to provide habitat critical to the survival of the species.	
Importance of Population	As the species has not been recorded in the Survey Area, and the Survey Area contains only degraded habitat, the Survey Area is unlikely to contain an important population of the species.	
Conclusion	*Section D1* There is potential for the species to occur, however, limited suitable habitat was observed during field surveys within Survey Area.	*Section D2* Suitable habitat for the species was not observed in Section D2. The species is considered unlikely to occur in Section D2.
References	Aland, K. and P. Wood (2013) *Giant Barred Frog (Mixophyes iteratus) Baseline Survey. Bruce Highway (Cooroy to Curra) Upgrade Section A - (Cooroy southern interchange to Sankeys Road).* EPBC Referral 2011/6024. Report Prepared for Department of Transport and Main Roads. Future-Plus Environmental. Cogger, H.G. (2014) *Reptiles and Amphibians of Australia* 7th ed., CSIRO Publishing. Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. IUCN (2014) *The IUCN Red List of Threatened Species. Version 2014.3.* Accessed 23 March 2016 http://www.iucnredlist.org.	

E.5 *SPECIES UNLIKELY TO OCCUR WITHIN THE SURVEY AREA*

Glossy Black-Cockatoo (Calyptorhynchus Lathami)

Species	Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	
Conservation Status	*EPBC Act:* - *NC Act:* Vulnerable *Back on Track:* High Priority (Regional), High Priority (State)	
Background	Glossy black-cockatoos feed almost exclusively on the seeds of nine species of Allocasuarina and Casuarina species throughout their range (Hourigan 2012). The glossy black cockatoo occurs as two subspecies in Queensland: *Calyptorhynchus lathami lathami* in the south and *Calyptorhynchus lathami erebus* in the north. Gympie is at the boundary of the distribution of the two subspecies (Hourigan 2012). The species occurs in woodland areas dominated by she-oak Allocasuarina, or open sclerophyll forests and woodlands with a stratum of Allocasuarina beneath Eucalyptus, Corymbia or Angophora (Hourigan 2012). An obligate hollow nester, glossy black-cockatoos require large old trees (living or dead), usually eucalypts, for breeding (Hourigan 2012). Hollows used for nests are usually between 10-20 m above ground, in vertical or near vertical branches, stems, and spouts, or in trunk cavities (Hourigan 2012).	
Records	*Field:* This species was not recorded during field surveys.	*Databases:* There is one record of the species within 10 km of the Survey Area, from 2000 in Birdata, and three records of the species from 1988 to 2010 on ALA.
Habitat Suitability	Allocasuarina species were recorded at 22% of the sites surveyed, however, at these sites Allocasuarina species were not common, and typically were small, young trees, sparsely scattered through Eucalypt communities. Due to a large area of woodland habitat being subject to selective logging, the Survey Area contains few large old trees that would provide suitable nesting habitat for the species.	
Likelihood of occurrence	*Likelihood from REF* Limited feeding resources were found within the Survey Area, with very patchy occurrences of *Allocasuarina torulosa* and *A. littoralis*. Low potential to occur.	*Revised Likelihood* **Unlikely** – due to the lack of habitat dominated by Allocasuarina species and the limited presence of large old trees, the Survey Area is not considered to provide suitable habitat for the species.
Likelihood of Breeding Places	NA – the species is considered unlikely to occur within the Survey Area.	
Conclusion	*Section D1* Glossy black-cockatoo is considered unlikely to occur within the Survey Area, due to a lack of suitable habitat.	*Section D2* Glossy black-cockatoo is considered unlikely to occur within the Survey Area, due to a lack of suitable habitat.
References	Hourigan, C (2012) *Glossy black-cockatoo, Calyptorhynchus lathami. Targeted species survey guidelines*. Queensland Herbarium, Department of Science, Information Technology and Innovation, Brisbane.	

Northern Quoll (Dasyurus Hallucatus)

Species	Northern Quoll (*Dasyurus hallucatus*)	
Conservation Status	*EPBC Act:* Endangered *NC Act:* Least Concern *Back on Track:* High Priority (Regional), Medium Priority (State)	
Background	The Northern Quoll was historically common across northern Australia, however is now primarily restricted to five regions. Within Queensland, the species occurs from south of Rockhampton, north to Weipa and west to Carnarvon Range National Park (DoE 2016). The QLD Department of Environment and Heritage Protection notes that the species is occasionally recorded as far south as Maleny in the Sunshine Coast Hinterland (DEHP 2013). The species occurs in a range of habitats, including rocky areas eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert (DoE 2016). Recent surveys throughout Queensland have suggested Northern Quolls are more likely to be present in high relief areas that have shallower soils, greater cover of boulders, less fire impact and were closer to permanent water (DoE 2016). Northern Quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal (DoE 2016).	
Records	*Field:* This species was not recorded during field surveys.	*Databases:* A search of the Wildlife Online database indicated there are no recent records of the species within the Mary River Catchment Area. The most recent records within the catchment area are two records from the Sunshine Coast Hinterland from 1989 and 1991, and two records within 10 km of the Survey Area from 1945 and 1955.
Habitat Suitability	The Survey Area contains habitats consistent with the habitat types known to support the northern quoll. In particular, areas containing boulders on creeklines and gullies are present north of Curra State Forest. These habitat features are consistent with the rocky areas known to provide denning habitat for the species.	
Likelihood of occurrence	*Likelihood from REF:* Low potential to occur in the Survey Area, in the vicinity of Curra State Forest and adjacent habitats.	*Revised Likelihood:* Due to the paucity of recent records of the species in south east Queensland, the Survey Area is considered to be outside the species known distribution, and the species is therefore considered **unlikely** to occur.
Likelihood of Breeding Places	NA – the species is considered unlikely to occur within the Survey Area.	
Evaluation of Habitat Critical to the Survival of the Species	NA – the species is considered unlikely to occur within the Survey Area.	
Importance of Population	NA – the species is considered unlikely to occur within the Survey Area.	

Species	Northern Quoll (*Dasyurus hallucatus*)	
Conclusion	*Section D1* Due to the paucity of records of the species in south east Queensland, the Survey Area is considered to be outside the species known distribution, and the species is therefore considered unlikely to occur.	*Section D2* **Unlikely -** Due to the paucity of records of the species in south east Queensland, the Survey Area is considered to be outside the species known distribution, and the species is therefore considered unlikely to occur.
References	DEHP (2013) *Queensland's Quolls*. Accessed 7 March 2016 from https://www.ehp.qld.gov.au/wildlife/threatened-species/endangered/endangered-animals/queenslands_quolls.html. DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.	

Richmond Birdwing Butterfly (Ornithoptera Richmondia)

Species	Richmond Birdwing Butterfly (*Ornithoptera richmondia*)	
Conservation Status	*EPBC Act:* - *NC Act:* Vulnerable *Back on Track:* High Priority (Regional), Medium Priority (State)	
Background	This large butterfly species is restricted to subtropical rainforest areas containing the larval food plants *Pararistolochia praevenosa* and *P. laheyana*, inhabiting lowland coastal rainforests and montane rainforests along the Queensland-New South Wales border respectively. This species originally occurred from Maryborough into northern New South Wales but has since lost about 60 per cent of its previous range and contracted to south of Kin Kin. Today its distribution is fragmented, with the species occurring in two main areas: in the north from Cootharaba on the Sunshine Coast to near Caboolture and in the south, from Ormeau and Mount Tamborine on the Gold Coast to Wardell in north-east New South Wales. The Richmond birdwing occasionally occurs and breeds in the Brisbane area.	
Records	*Field:* This species and its larval food plant were not recorded during field surveys.	*Databases*: ALA: no records within 10 km of the Survey Area, or the broader Gympie Regional Council area. There is one record of *Pararistolochia praevenosa* (2004) within the Gympie Regional Council Area, more than 10 km from the Survey Area. Wildlife Online: There are no records of the species within 10 km of the Survey Area since 1980. Wildlife Online spatial data shows the northern most record near Eumundi, approximately 30 km south of the Survey Area.
Habitat Suitability	No suitable habitat containing the larval food plant was recorded during Summer 2016 field surveys.	
Likelihood of occurrence	*Likelihood from REF* Low potential to occur	*Revised Likelihood* Unlikely to occur - As the species' current range is believed to occur from Cootharaba south, and no

Species	Richmond Birdwing Butterfly (*Ornithoptera richmondia*)	
		larval food plants have been recorded within the Survey Area, the species is considered unlikely to occur within the Survey Area.
Likelihood of Breeding Places	NA – the species is considered unlikely to occur within the Survey Area.	
Conclusion	*Section D1* As the species' current range is believed to occur from Cootharaba south, and no larval food plants have been recorded within the Survey Area, the species is considered unlikely to occur within the Survey Area.	*Section D2* As the species' current range is believed to occur from Cootharaba south, and no larval food plants have been recorded within the Survey Area, the species is considered unlikely to occur within the Survey Area.
References	Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. Department of Environment and Heritage Protection (2012) *Richmond birdwing butterfly*. Accessed 20 January 2015 from: http://www.ehp.qld.gov.au/wildlife/threatened-species/vulnerable/richmond_birdwing_butterfly.html.	

Australian Fritillary Butterfly (Argyreus Hyperbius Inconstans)

Species	Australian Fritillary Butterfly (*Argyreus hyperbius inconstans*)	
Conservation Status	*EPBC Act:* - *NC Act:* Endangered *Back on Track:* -	
Background	This medium-sized butterfly is restricted to open, coastal, grassy sedgelands and wetlands where its larval food plant, *Viola betonicifolia*, is distributed. It is also sometimes found in disturbed areas (e.g. the drainage ditches of sugarcane farms) or in association with watercourse plant communities when its food plant *Viola betonicifolia* is present. Most specimens have been collected from river estuaries or swampy coastal areas at or near sea level. It is not known why the larval food plant is much more widespread than the butterfly. The larval food plant, *Viola betonicifolia,* grows as a small, insignificant ground herb in association with *Lomandra longifolia* (long leaved matrush) and grasses, especially the grass *Imperata cylindrica* (bladey grass), in the Melaleuca wetland plant community. The larval food plant does not occur in all sub-types of this plant community. The Australian fritillary butterfly has been recorded in south-eastern Queensland and north-eastern New South Wales between Gympie and Port Macquarie. Of the 23 recorded localities only four have extant populations. The range contraction for this species is greater than 80 percent.	
Records	*Field:* This species has not been recorded within the Survey Area during Summer 2016 surveys or surveys for the REF. *Viola betonicifolia*, the larval host species has not been recorded during summer 2016 surveys.	*Databases:* ALA: There are historic records (late 1800s to late 1970s) of the species within 10 km of the Survey Area, however there are not recent records of the species or its larval host plant. Wildlife Online: Specific location details of the Australian fritillary butterfly are not available from

Species	Australian Fritillary Butterfly (*Argyreus hyperbius inconstans*)	
		Wildlife Online, however there are historic records of the species from the Wildlife Online search area (a search area of >10 km from the Survey Area). There have been no records of the species since 1980. The nearest record of the larval food plant is approximately 30 km from the Survey Area.
Habitat Suitability	No suitable habitat containing the larval food plant, *Viola betonicifolia*, was recorded during Summer 2016 field surveys.	
Likelihood of occurrence	*Likelihood from REF* Potential to occur	*Revised Likelihood* Unlikely to occur
Likelihood of Breeding Places	No suitable breeding habitat (i.e. *Viola betonicifolia*) has been recorded within the Survey Area.	
Conclusion	*Section D1* As there have been no confirmed records of *Viola betonicifolia,* it is unlikely the species occurs in Section D1	*Section D2* As there have been no confirmed records of *Viola betonicifolia,* it is unlikely the species occurs in Section D2
References	Curtis, L.K. and Dennis, A.J. eds. (2012) *Queensland's Threatened Animals*, Collingwood, VIC, Australia: CSIRO Publishing. Department of Environment and Heritage Protection (2011) Australian fritillary butterfly. Accessed 4 March 2016 from https://www.ehp.qld.gov.au/wildlife/animals-az/australian_fritillary_butterfly.html.	

E.6 *MIGRATORY AND SPECIAL LEAST CONCERN SPECIES*

The series of species profiles below for migratory and special least concern species contain:

- general information on the species conservation status, distribution, habitat preferences and, where relevant, population estimates;
- records of the species from field surveys (including Summer 2016 field surveys, and field surveys undertaken for the REF), and database records of the species from the surrounding area;
- suitability of habitat within the Survey Area, including description of breeding, foraging and dispersal habitats, where relevant;
- the revised likelihood of occurrence assessment, based on summer 2016 field surveys and current database searches;
- evaluation of the likelihood of breeding places being present within the Survey Area, based on species' known breeding habitat requirements and habitat features identified through field surveys;
- for migratory species, an evaluation of the likelihood of the Survey Area supporting an ecologically significant proportion of a population, or important habitat for these species; and
- a conclusion of the key findings of the species, separated for Section D1 and D2, to assist in understanding the ecological value of each section of the alignment for migratory and special least concern species.

Migratory Rainforest and Wet Eucalypt Forest Species

Species	**Rainforest and Wet Forest Migratory Species** Black-faced monarch *Monarcha melanopsis* | Rufous fantail *Rhipidura ruficauda* |Spectacled monarch *Symposiarchus trivirgatus* | Satin Flycatcher *Myiagra cyanoleuca*		
Conservation Status	*EPBC Act:*	Migratory	
	NC Act:	Special Least Concern	
	Back on Track:	-	
Background	These species are distributed throughout eastern Australia, and occur within rainforest or wet forest habitats (DoE 2015, DoE 2016). These species are sometimes recorded in drier eucalypt forest while on passage (DoE 2015, DoE 2016). These species nest in trees, and the rufous fantail and spectacled monarch also nest in shrubs or vines lower to the ground (less than 6 m) (DoE 2016, BirdLife Australia 2016).		
Records	*Species*	*Field Records*	*Database Records*
	Satin Flycatcher	Not recorded.	No records (ALA, Birdata)
	Spectacled monarch (southern population)	One individual recorded in Vine Forest	8 records from 1993 to 2015 (ALA); 21

Species	Rainforest and Wet Forest Migratory Species Black-faced monarch *Monarcha melanopsis* | Rufous fantail *Rhipidura ruficauda* |Spectacled monarch *Symposiarchus trivirgatus* | Satin Flycatcher *Myiagra cyanoleuca*

	within Woondum State Forest.	records from 1999 to 2007
Rufous fantail	One individual recorded in Vine Forest within Woondum State Forest.	22 records from 1993 to 2015 (ALA); 21 records from 1999 to 2000 (Birdata)
Black-faced monarch	Not recorded.	12 records from 1977 to 2015 (ALA); 6 records from 1999 to 2007 (Birdata)

Habitat Suitability

Suitable habitat for these species is present at Woondum State Forest and riparian areas of Six Mile Creek, as well as well as wetter eucalypt forest on Land Zone 3 (refer to area mapped as Vine Forest and Eucalypt Communities On Alluvial Soils on *Figure 3*, Annex A). Other areas of forest and woodland habitat may provide suitable dispersal habitat for these species while on passage (refer to Area mapped as Eucalypt Communities on Sedimentary and Metamorphic Rock on *Figure 3*, Annex A).

Likelihood of occurrence

Species	*Likelihood from REF*	*Revised Likelihood*
Satin Flycatcher	Potential	Potential
Spectacled monarch (southern population)	Expected*	Known
Rufous fantail	Known	Known
Black-faced monarch	Expected*	Likely

*Also reported as recorded in the REF

Likelihood of Breeding Places

No nest sites were identified during field surveys, however these species do not have highly specific breeding habitat requirements, and therefore trees, shrubs and vines in Vine Forest habitat may provide suitable breeding places.

Ecologically significant proportion of a population

The Referral Guidelines for 14 Migratory species defines ecologically significant proportions of populations for these species. The guidelines state that 1% of the population is internationally important and 0.1% of a population is considered nationally important.

Species	*Internationally Important*	*Nationally Important*
Satin Flycatcher	17,000	1,700
Spectacled monarch (southern population)	4,100	410
Rufous fantail	48,000	4,800
Black-faced monarch	4,600	460

Bird densities are reported for the black-faced monarch as 0.01 to 0.5 birds per hectare, and for the satin flycatcher as 0.2 to 1.25 birds per hectare (DoE 2016). Densities are not reported for the spectacled monarch or rufous fantail, however are likely to be in the same order as the satin flycatcher and black-faced monarch. As the Survey Area contains only 32 ha of Vine Forest habitat and 124 ha of wetter eucalypt communities, the Survey Area is considered

Species	Rainforest and Wet Forest Migratory Species	
	Black-faced monarch *Monarcha melanopsis* | Rufous fantail *Rhipidura ruficauda* |Spectacled monarch *Symposiarchus trivirgatus* | Satin Flycatcher *Myiagra cyanoleuca*	
	unlikely to support a nationally or internationally ecological significant proportion of these populations.	
Important Habitat Evaluation	The Draft Referral Guidelines describe the types of habitats that may be considered important habitats by these species. These include: • dense vegetation in rainforest, moist forest or wet sclerophyll forest • tall wet sclerophyll forest, often in gullies or along water courses • occasionally, such as when on migration, these species are recorded in other more open or drier wooded habitats Based on the criteria presented in the SIG 1.1, the Survey Area is unlikely to provide important habitat for these species, as: • it is unlikely to support an ecologically significant proportion of the population (refer above); • is unlikely to be of critical important to the species at particular life-cycle stages, as no nest sites were recorded and these species do not have highly specific breeding habitat requirements; • is not at the limit of these species' ranges; and • the Survey Area is not within an area where these species are declining.	
Conclusion	*Section D1* Rufous fantail and spectacled monarch have been recorded in Woondum State Forest, within Section D1. Vine forest habitat in Section D1 is also likely to provide suitable habitat for the satin flycatcher and black-faced monarch. Other eucalypt forest and woodland habitats in Section D1 may provide suitable dispersal habitat for these species. Section D1 is unlikely to support a significant proportion of a population of these species.	*Section D2* Section D2 may provide suitable dispersal habitat for these species, however does not contain rainforest or wet eucalypt forest habitats in which these species typically occur. Section D2 is unlikely to support a significant proportion of a population of these species.
References	DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. DoE (2015) *Referral guideline for 14 birds listed as migratory species under the EPBC Act.* Accessed 18 March 2016 from: http://www.environment.gov.au/system/files/resources/c05f5b87-0a99-4998-897e-7072c236cf83/files/migratory-birds-draft-referral-guideline.pdf. BirdLife Australia (2016) *Spectacled Monarch Symposiarchus trivirgatus*. Accessed 18 March 2016 from: http://www.birdlife.org.au/bird-profile/spectacled-monarch.	

Oriental Cuckoo (Cuculus optatus)

Species	**Oriental Cuckoo *Cuculus optatus***	
Conservation Status	*EPBC Act:*	Migratory
	NC Act:	Special Least Concern
	Back on Track:	-
Background	This species is distributed throughout eastern and northern Australia, and occurs in monsoonal rainforest, vine thickets, wet sclerophyll forest or open Casuarina, Acacia or Eucalyptus woodlands (DoE 2015). Frequently at edges or ecotones between habitat types. Riparian forest is favoured habitat in the Kimberley region (DoE 2015).	
Records	*Field:* This species has not been recorded during field surveys.	*Databases:* Two undated records (ALA).
Habitat Suitability	Vine Forest habitat at Woondum State Forest and riparian areas of Six Mile Creek, and eucalypt forest and woodland elsewhere in the Survey Area may provide suitable habitat for the species. Refer to areas mapped as Eucalypt Communities on Sedimentary and Metamorphic Rock, Eucalypt Communities On Alluvial Soils and Vine Forest on *Figure* 3, Annex A.	
Likelihood of occurrence	*Likelihood from REF:* Potential	*Revised Likelihood:* Potential
Likelihood of Breeding Places	This species does not breed in Australia.	
Ecologically significant proportion of a population	The Referral Guidelines for 14 Migratory species defines ecologically significant proportions of populations for these species. For the oriental cuckoo, 10,000 individuals is considered an internationally important population, and 1,000 individuals is considered a nationally important population. As the species distributes widely across northern and eastern Australia during the non-breeding season, and has not previously been recorded in the Survey Area, it is considered very unlikely that an ecologically significant proportion of the population would occur within the Survey Area.	
Important Habitat Evaluation	The Draft Referral Guidelines notes that habitat in Australia is non-breeding habitat only. Based on the criteria presented in the SIG 1.1, the Survey Area is unlikely to provide important habitat for these species, as: • it is unlikely to support an ecologically significant proportion of the population - refer above; • is unlikely to be of critical important to the species at particular life-cycle stages – the species does not breed in Australia, and has not been recorded using habitat within the Survey Area; • is not at the limit of these species' ranges; and • the Survey Area is not within an area where these species are declining.	
Conclusion	*Section D1* Suitable habitat is present within Section D1, and the species is considered to have potential to occur. However, the Survey Area is unlikely to support an ecologically significant proportion of the population.	*Section D2* Suitable habitat is present within Section D2, and the species is considered to have potential to occur. However, the Survey Area is unlikely to support an ecologically significant proportion of the population.

Species	Oriental Cuckoo *Cuculus optatus*
References	DoE (2015) *Referral guideline for 14 birds listed as migratory species under the EPBC Act.* Accessed 18 March 2016 from: http://www.environment.gov.au/system/files/resources/c05f5b87-0a99-4998-897e-7072c236cf83/files/migratory-birds-draft-referral-guideline.pdf.

Migratory Species with Generalist Habitat Requirements

<table>
<tr><th>Species</th><th colspan="3">Species with Generalist Habitat Requirements
Rainbow bee-eater Merops ornatus | White-throated needletail Hirundapus caudacutus | Fork-tailed swift Apus pacificus</th></tr>
<tr><td>Conservation Status</td><td colspan="3">EPBC Act: Migratory
NC Act: Species Least Concern
Back on Track: -</td></tr>
<tr><td>Background</td><td colspan="3">The rainbow bee-eater, white-throated needletail and fork-tailed swift have generalist habitat requirements, occurring in a range of landscapes including cleared farmland (DoE 2016). The fork-tailed swift and white-throated needletail are aerial species which rarely alight while in Australia (DoE 2016).</td></tr>
<tr><td rowspan="4">Records</td><td>Species</td><td>Field Records</td><td>Database Records</td></tr>
<tr><td>Fork-tailed swift</td><td>Less than 10 individuals were observed flying overhead on one occasion during Summer 2016, at the north of Curra State Forest.</td><td>One undated record (ALA).</td></tr>
<tr><td>Rainbow bee-eater</td><td>Recorded on three occasions during Summer 2016, at Curra State Forest, Woondum State Forest and in Victory Heights near Gympie Connection Road. The species was also observed on a fourth occasion within Curra State Forest, approximately 3 km east of Survey Area. The species was also recorded during REF surveys.</td><td>110 records from 1976 to 2014 (ALA).
91 records from 1998 to 2014 (Birdata).</td></tr>
<tr><td>White-throated needletail</td><td>Not recorded during field surveys.</td><td>24 records from 1906 to 2015 (ALA)</td></tr>
<tr><td>Habitat Suitability</td><td colspan="3">These species occur in a broad range of habitats, and woodland and eucalypt forest, cleared areas and suburban areas may provide suitable habitat for the species.</td></tr>
<tr><td rowspan="4">Likelihood of occurrence</td><td>Species</td><td>Likelihood from REF</td><td>Revised Likelihood</td></tr>
<tr><td>Fork-tailed swift</td><td>Likely</td><td>Known</td></tr>
<tr><td>Rainbow bee-eater</td><td>Known</td><td>Known</td></tr>
<tr><td>White-throated needletail</td><td>Likely</td><td>Likely</td></tr>
<tr><td>Likelihood of Breeding Places</td><td colspan="3">Sandy banks within the Survey Area may provide breeding habitat for the rainbow bee-eater. The fork-tailed swift and white-throated needletail do not breed in Australia.</td></tr>
</table>

<table>
<tr><th>Species</th><th>Species with Generalist Habitat Requirements
Rainbow bee-eater Merops ornatus | White-throated needletail Hirundapus caudacutus | Fork-tailed swift Apus pacificus</th></tr>
<tr><td>Ecologically significant proportion of a population</td><td>The Referral Guidelines for 14 Migratory species defines ecologically significant proportions of populations for these species. The guidelines state that 1% of the population is internationally important and 0.1% of a population is considered nationally important. The estimates of ecologically significant population size is provided in the table below.
<table>
<tr><th>Species</th><th>Internationally Important</th><th>Nationally Important</th></tr>
<tr><td>Fork-tailed swift</td><td>1,000</td><td>100</td></tr>
<tr><td>White-throated needletail</td><td>100</td><td>10</td></tr>
</table>
The rainbow bee-eater is not included in the referral guidelines, however globally the population is estimated at over one million (IUCN 2016), and the population size in Australia is assumed to be reasonably large based on reporting rates for the species (DoE 2016).

As these species are wide ranging across Australia, have generalist habitat requirements, and less than 10 individuals of each were recorded during field surveys, it is considered unlikely that the Survey Area would contain an ecologically significant proportion of any of these species.</td></tr>
<tr><td>Important Habitat Evaluation</td><td>Due to these generalist habitat requirements, habitat within the Survey Area is unlikely to be of critical importance to the species at a particular life-cycle stage. The Survey Area is not at the edge of the range of these species, and there is no evidence to suggest these species are declining in this region. Therefore, the Survey Area is not considered to provide important habitat for these species.</td></tr>
<tr><td>Conclusion</td><td>Section D1
The rainbow bee-eater has been recorded in the Section D1 Survey Area, and Section D1 provides suitable foraging and dispersal habitat for the white-throated needle-tail and fork-tailed swift. Section D1 is unlikely to support an ecologically significant proportion of the populations or important habitat for these species.

Section D2
The fork-tailed swift and rainbow bee-eater have been recorded in the Section D2 Survey Area, and Section D2 provides suitable habitat for the white-throated needle-tail. Section D2 is unlikely to support an ecologically significant proportion of the populations or important habitat for these species.</td></tr>
<tr><td>References</td><td>BirdLife International (2012) Merops ornatus. The IUCN Red List of Threatened Species 2012. Accessed 21 March 2016 from: http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T22683753A40588668.en.

DoE (2015) Referral guideline for 14 birds listed as migratory species under the EPBC Act. Accessed 18 March 2016 from: http://www.environment.gov.au/system/files/resources/c05f5b87-0a99-4998-897e-7072c236cf83/files/migratory-birds-draft-referral-guideline.pdf.

DoE (2016) Species Profile and Threats Database. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.</td></tr>
</table>

Migratory Wetland Species

Species	Migratory Wetland Species		
	Australian Reed-Warbler *Acrocephalus australis* | Common Sandpiper *Actitis hypoleucos* | Latham's Snipe *Gallinago hardwickii* | Eastern Great Egret *Ardea modesta* | Cattle Egret *Ardea ibis*		
Conservation Status	*EPBC Act:*	Migratory	
	NC Act:	Special Least Concern	
	Back on Track:	-	
Background	These species are widespread across eastern Australia. The species occur within an around wetland habitats, and the cattle egret, eastern great egret and Latham's snipe are also known to use damp or flooded pasture. • The Australian Reed-Warbler prefers dense vegetation alongside water, especially thick reed beds, as well as tall crops, bamboo thickets and lantana. The species nests among reeds. • Latham's snipe inhabits open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). • Common sandpiper is a coastal species which uses some inland wetlands, including dams. • The eastern great egret and cattle egret occur at the margins of rivers, lakes and dams, and damp or flooded grasslands		
Records	*Species*	*Field Records*	*Database Records*
	Common Sandpiper	Not recorded.	ALA: one record from 2007
	Latham's Snipe	Not recorded.	ALA: four records between 1905 and 2003 Birdata: One record from 2008
	Cattle Egret	Not recorded within Survey Area during Summer 2016 surveys, but common in surrounding farmland. Recorded during the REF field surveys.	ALA: 156 records between 1986 and 2015 Birdata: 158 records between 1998 and 2014
	Australian Reed-Warbler	Not recorded.	ALA: 18 records between 1977 and 2000
	Eastern Great Egret	Not recorded within Survey Area, but recorded in surrounding farmland.	ALA: 42 records between 1977 and 2010 Birdata: 40 records between 1999 and 2014
Habitat Suitability	Areas containing dams or watercourses, as well as areas of low-lying pasture with long grass may provide suitable habitat for these species. A drainage line located between Keefton Road and Six Mile Creek contained tall reeds within low lying pasture, which may provide suitable breeding habitat for the Australian reed warbler. Refer to Waterways, Dams and Cleared Areas on *Figure 3*, Annex A for the locations of potential suitable habitat for this species.		

<table>
<tr><th>Species</th><th>Migratory Wetland Species
Australian Reed-Warbler Acrocephalus australis | Common Sandpiper Actitis hypoleucos | Latham's Snipe Gallinago hardwickii | Eastern Great Egret Ardea modesta | Cattle Egret Ardea ibis</th></tr>
<tr><td>Likelihood of occurrence</td><td><table>
<tr><th>Species</th><th>Likelihood from REF:</th><th>Revised Likelihood:</th></tr>
<tr><td>Common Sandpiper</td><td>Potential</td><td>Likely</td></tr>
<tr><td>Latham's Snipe</td><td>Likely</td><td>Likely</td></tr>
<tr><td>Cattle Egret</td><td>Known</td><td>Known</td></tr>
<tr><td>Australian Reed-Warbler</td><td>Potential</td><td>Potential</td></tr>
<tr><td>Eastern Great Egret</td><td>Likely</td><td>Likely</td></tr>
</table></td></tr>
<tr><td>Likelihood of Breeding Places</td><td>The Survey Area is considered unlikely to contain breeding places of these species, as:
The cattle egret and eastern great egret breed in wooded and shrubby swamps, which are not present in the Survey Area; and
The common sandpiper and Latham’s snipe do not breed in Australia.
One area of suitable potential breeding habitat for the Australian reed warbler was observed, however due to the lack of recent records of the Australian reed warbler in the surrounding area, it is considered unlikely that the species would be breeding at this location.</td></tr>
<tr><td>Ecologically significant proportion of a population</td><td>The population sizes of these species are estimated at:
Common Sandpiper East Asian-Australasian Flyway population is estimated to be between 25 000–100 000;
25,000 to 100,000 eastern great egret individuals within Australia;
100,000 cattle egret individuals within Australia, New Guinea and New Zealand; and
25,000 to 100,000 Latham’s snipe individuals within Australia (DoE 2016).
There is no available population estimate for the Australian reed warbler. These species are widespread throughout eastern Australia and habitats for these species within the Survey Area are limited to habitat type typical of agricultural landscapes in eastern Australia (e.g. low lying pasture and farm dams). It is therefore considered unlikely that the Survey Area would contain habitat features that would attract an ecologically significant proportion of these populations.</td></tr>
<tr><td>Important Habitat Evaluation</td><td>Specific guidance on important habitat is available for Latham’s snipe and the common sandpiper. Important habitat for these species is defined as:
areas that have previously been identified as internationally important for the species; or
for Latham’s snipe, areas that support at least 18 individuals of the species;
for common sandpiper, areas that support at least 0.1 per cent of the flyway population (i.e. at least 25 individuals) (Commonwealth of Australia 2015).
As these species have not been recorded within the Survey Area, and there is only one record of each species within 10 km of the Survey Area in the past 10 years, it is considered unlikely that the Survey Area would support the required number of species to be considered important habitat.

For eastern great egret, cattle egret and Australian reed warbler, guidance is provided in the SIG 1.1. Based on this guidance, the Survey Area is considered unlikely to provide important habitat for these species, as:</td></tr>
</table>

Species	Migratory Wetland Species	
	Australian Reed-Warbler *Acrocephalus australis* | Common Sandpiper *Actitis hypoleucos* | Latham's Snipe *Gallinago hardwickii* | Eastern Great Egret *Ardea modesta* | Cattle Egret *Ardea ibis*	
	• habitats for these species within the Survey Area are limited to habitat type typical of agricultural landscapes in eastern Australia (e.g. low lying pasture and farm dams); • the Survey Area is not at the limit of these species range; and • there is no evidence to indicate that these species are declining in the region.	
Conclusion	*Section D1* Areas within Section D1 containing dams or watercourses, as well as areas of low-lying pasture with long grass may provide suitable habitat for these species, however are not considered to provide important habitat for these species.	*Section D2* Areas within Section D2 containing dams or watercourses, as well as areas of low-lying pasture with long grass may provide suitable habitat for these species, however are not considered to provide important habitat for these species.
References	Commonwealth of Australia (2015) *EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species*. Accessed 22 March 2016 from: http://www.environment.gov.au/system/files/resources/67d7eab4-95a5-4c13-a35e-e74cca47c376/files/shorebirds-guidelines.pdf. DoE (2016) *Species Profile and Threats Database*. Accessed 7 March 2016 from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.	

Short-Beaked Echidna

Species	Short-beaked Echidna (*Tachyglossus aculeatus*)	
Conservation Status	*EPBC Act:* - *NC Act:* Special Least Concern *Back on Track:* -	
Background	Found in most of Australia from alpine regions to rainforests and deserts with no particular habitat requirements other than a supply of ants and termites. The species usually shelters under thick bushes, in hollow logs, under piles of debris, or occasionally in burrows.	
Records	*Field:* Signs of echidna activity, including fresh feeding signs, were observed at 20 of 45 habitat assessment sites. Echidna signs were generally observed in wooded or forested areas within or contiguous with large patches of vegetation such as Curra State Forest, Woondum State Forest and the Gympie North area. Specifically, echidna signs were observed in Section D1 at PD16, PD22, PD23, PD27, PD28, PD30, PD40, PD42 and PD45. Feeding were observed in Section D2	*Databases:* ALA: 10 records within 10 km of the alignment, the most recent being within Curra State Forest adjacent to the Survey Area (2006). Other records include: • five records in Woondum National Park (1997) <10 km east of the southern end of the alignment; • two records in Gunalda (1998, 2001) 5-8 km north of the northern end of the alignment; • one record in Mothar Mountain

Species	Short-beaked Echidna (*Tachyglossus aculeatus*)	
	at PD5, PN7, PD9, PD15, PD29, PD32, PD33, PD35 and PD44. Refer to *Figure 3*, Annex A for the locations of all echidna feeding signs. No observation records were reported in the REF however the REF considered short-beaked echidna likely to occur in all remnant vegetation.	(2001) <5 km east of the southern end of the alignment; and • one record on Gympie-Tin Can Bay Road (2003) 7 km east of the alignment at the southern end of Curra State Forest.
Habitat Suitability	Abundant termite and ant colonies, which provide foraging resources for the echidna, were observed throughout the alignment.	
Likelihood of occurrence	*Likelihood from REF* Likely to occur	*Revised Likelihood* Known to occur
Likelihood of Breeding Places	Abundant termite and ant colonies were observed throughout the alignment and signs of echidna activity, including fresh feeding signs, were observed. Breeding places are likely to occur given records of the species within the vicinity and the presence of ant and termite species.	
Conclusion	*Section D1* Species known to occur (previous records in area and suitable habitat and feeding signs observed during field surveys) within footprint.	*Section D2* Species known to occur (previous records in area and suitable habitat and feeding signs observed during field surveys) within footprint.
References	Van Dyck, S., Gynther, I. and Baker, A. eds., (2013) *Field Companion to Mammals of Australia*, Sydney: New Holland Publishers.	

Appendix H – *Targeted Surveys for the Greater Glider, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016c)

Department of Transport and Main Roads

Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Detailed Design Job No. 232/10A/7, Invitation No. WBYD-1335

Targeted Survey for the Greater Glider

November 2016

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1. Introduction

1.1 Background

The Department of Transport and Main Roads (TMR) proposes to upgrade and realign 26 km of the Bruce Highway, including a bypass to the east of Gympie, Queensland. This package of works is termed the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (herein referred to as 'the project'). The project is the final stage of the Cooroy to Curra Upgrade and provides for a new four lane divided highway from Keefton Road to Curra, including a bypass of Gympie, Queensland. The new highway will have a posted speed limit of 110 km/hr and directional separation from Woondum Road to Curra. The project extends for approximately 30 km and will include the acquisition of a project corridor to ultimately accommodate a six lane divided carriageway. Due to the length of the project, for construction purposes the project will be spilt into two contracts.

The works will involve the following key elements:

- Integration with the Woondum Interchange at the northern extent of Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project
- Provision of a new major interchange at the tie in to the existing Bruce Highway at Curra
- Realignment and crossing of local roads via bridges and underpasses to retain local road connectivity
- Provision of numerous bridges crossing key waterways
- Construction of high embankments and deep cuts, including associated drainage provision
- Provision of heavy duty pavements
- Provision of fauna connectivity structures to maintain connectivity along the project
- Inclusion of water quality and spill containment treatments to assist in maintaining water quality
- Waterway diversions at specific locations, including Tannery Creek, Tamaree Creek and Banks Creek

A Southern Contract will extend from the northern tie in to the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project, just south of Keefton Road, to approximately 200 m north of Sandy Creek Road. At approximately 12 km in length the Southern Contract will involve the following additional work elements:

- Provision of new interchanges at Penny Road / Noosa Road and Gympie Connection Road
- Provision of bridges crossing Six Mile Creek, Tannery Creek, Deep Creek and Moody Creek (north and south)
- Construction of a new single span bridge over the existing North Coast Rail Line
- Acquisition of areas of Woondum State Forest
- Provision of fauna connectivity structures through the Woondum State Forest

A northern Contract of approximately 18 km in length will extend from just north of Sandy Creek Road to Curra and will involve the following key elements:

- Construction of multi-span bridges over Banks Creek, Tamaree Creek, Upper Curra Creek, Keliher Creek, Curra Creek overflow and Curra Creek north
- Acquisition of an area of Curra State Forest
- Provision of fauna connectivity structures through Curra State Forest

1.2 Previous ecological assessments

Between 2015 and 2016, TMR commissioned surveys to assess the ecological values in and adjacent to the project. These included general ecological surveys and targeted surveys to identify fauna and flora species protected under the Queensland *Nature Conservation Act 1992* (NC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The first ecological assessment was undertaken by Biodiversity Assessment and Management Pty Ltd (BAAM) in 2015 as part of the Review of Environmental Factors (REF) prepared for the project by Jacobs SKM (Jacobs SKM, 2016). This initial terrestrial ecology survey was undertaken over a five-day period in March 2015, within an area that included the project area but extended to encompass the land between 50 – 100 m either side of the January 2015 project alignment, referred to as the survey area (refer to Figure 1). The survey included a combination of general methods and targeted surveys to detect the presence of species listed under the NC Act and EPBC Act. A number of listed species were confirmed present and others were considered likely to occur. BAAM prepared a likelihood of occurrence assessment, predicting the likely occurrence of species listed under the NC Act and EPBC Act and mapped the distribution of suitable habitat for species known or considered likely to occur within the survey area.

A second ecological assessment was undertaken in January – February 2016 by Environment, Resource Management Pty Ltd (ERM). This was a targeted assessment for terrestrial fauna species listed under the NC Act and EPBC Act. This was required to support the preparation of documentation to assist the Commonwealth and State environmental approval process. Based on the results of their survey, ERM confirmed the presence of several additional listed species, revised the likelihood of occurrence assessment undertaken by BAAM in 2015 and produced updated mapping of potentially suitable habitat for each listed species confirmed present or considered likely to occur, including details on potential/suitable habitat locations for the greater glider (*Petauroides volans*).

1.3 Requirement for greater glider surveys

On 25 May 2016, subsequent to the completion of ecology surveys undertaken for the project, an additional species, the greater glider (*Petauroides volans*), was listed as vulnerable under the EPBC Act. The greater glider has been previously recorded within the eastern section of Curra State Forest (DSITI, 2016), and therefore has the potential to occur within the project area. Based on the quality of habitats observed and the presence of historical records of the species, areas of potentially suitable habitat for the greater glider were mapped within the project area by ERM (ERM, 2016). Across the length of the survey area, ERM identified that suitable habitat for the greater glider was restricted to Curra State Forest. While suitable habitat (i.e. areas of mature forest with hollow-bearing trees) also occurs within Woondum State Forest in the southern extent of the project, the species is not expected to occur in this area of remnant forest, given the State forest's relatively small size, lack of connectivity and the absence of any historical records of the species (ERM, 2016).

While general spotlighting surveys had been undertaken for arboreal mammals during the BAAM (2015) surveys and ERM (2016) surveys, no targeted greater glider surveys have been undertaken for the project to date. In June 2016, TMR commissioned GHD to undertake targeted surveys for the greater glider within the survey area to provide a consistent level of assessment for all EPBC Act listed species with a likelihood of occurrence within the project area. The results of these surveys will provide technical information to support the preparation of the EPBC Act referral and other Commonwealth environmental approval documentation for the project.

1.4 Additional ecological investigations

In addition to the targeted surveys the assessments within Curra State Forest provided the opportunity to gather opportunistic information on the potential occurrence and distribution of two additional conservation significant fauna species: the black-breasted button-quail (*Turnix melanogaster*) and tusked frog (*Adelotus brevis*).

1.4.1 Black-breasted button-quail

Recent flora surveys undertaken by GHD in July 2016 (GHD, 2016) identified characteristic platelets of button-quails in Curra State Forest. Platelets are not diagnostic of the black-breasted button-quail and could be attributed to either the painted button quail (*Turnix varius*) which is of least concern conservation significance or black-breasted button-quail listed as vulnerable under the EPBC Act and vulnerable under the NC Act. Although habitats in Curra State Forest are generally not consistent with typical habitat for the black-breasted button-quail, (i.e. vine thicket and microphyll and notophyll vine forest), the black-breasted button-quail is known to occur in spotted gum woodland, particularly areas with a dense lantana understorey (Morecombe, 2004). As such the potential occurrence of the black-breasted button-quail within Curra State Forest could not be discounted. Cameras were located within the vicinity of observed platelets to gather additional information on the likelihood of occurrence of the black-breasted button-quail within Curra State Forest.

1.4.2 Tusked frog

As with all frog species, detectability of the tusked frog increases significantly when males are actively calling. Thus while targeted surveys previously undertaken within Curra State Forest by BAAM (2015) and ERM (2016) confirmed the occurrence of tusked frog in two locations (Keliher Creek and Curra Creek), additional opportunistic survey effort could confirm the species' presence in other areas of Curra State Forest. Opportunistic records of tusked frogs were recorded throughout the current survey to broaden understanding of the species distribution and utilisation of habitats within Curra State Forest.

1.5 Scope and limitations

This report presents the methods and results of the targeted greater glider survey undertaken for the project. The specific aims of the survey were to:

- Assess the value of habitat for the greater glider within areas of Curra State Forest within 200 m of the project area
- Provide updated information on the likely occurrence of the greater glider within the vicinity of the project area
- Identify key habitat resources for the species (i.e. potential den sites)
- Assess the likely importance of habitat along the project area, relative to other areas within Curra State Forest
- Provide supporting information to refine the likelihood of occurrence of the black-breasted button-quail in Curra State Forest through the use of remote cameras

- Record additional locations of tusked frog.

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Site conditions (including the presence of conservation significant species and/or their supporting habitat) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Methods

2.1 Approach

A combined desktop assessment and field survey were used to assess the greater gliders' likelihood of occurrence, spatial distribution and utilisation of habitats within the project area.

2.2 Desktop assessment

2.2.1 General

The desktop assessment combined a review of historical records, information on the species habitat requirements and the quality of habitats within the project area.

2.2.2 Review of historical databases

Historical records of the greater glider were obtained for a search area within a 10 km radius of the project area using the following database sources:

- Wildlife Online database - historical records maintained by the Queensland Department of Science, Information, Technology and Innovation (DSITI, 2016)
- Atlas of Living Australia (ALA) database – a national collaborative database of historical biodiversity records as part of NCRIS National Research Infrastructure for Australia
- Queensland Museum Records – database of historical records maintained by the Queensland Museum
- Regional ecosystem mapping (DNRM, 2016).

2.2.3 Literature review

A brief literature review was undertaken to:

- Document the ecology of the greater glider and its potential habitat utilisation within the project area
- Review current survey guidelines for the species, based on the Victorian Department of Sustainability and Environment *Approved Survey Standards for the Greater Glider, Petauroides volans* (DSE, 2011)
- Review existing project information to optimise survey efficiency. In particular, possible den sites were identified from spatial information on the location of large hollow-bearing trees obtained from BAAM (2015), ERM (2016) and the GHD flora survey (2016).

2.3 Field assessment

2.3.1 Survey dates

Targeted surveys for the greater glider were undertaken by two ecologists over five days and nights between 22 – 27 August 2016. For the purposes of this assessment, the survey area included sites predominantly within or immediately adjacent to the project area. However, surveys were also undertaken at an additional four remote sites, located approximately 500 m east of the project area, within the vicinity of historical records of the greater glider (Figure 1).

2.3.2 Greater glider survey guidelines

At the time of survey, there were currently no Commonwealth survey guidelines for the greater glider. However, the Victorian Department of Sustainability and Environment have prepared

Approved Survey Standards for the Greater Glider, Petauroides volans (DSE, 2011). These were used as the basis for field survey methodology and detail a number of acceptable methods.

Acceptable methods

Spotlighting transects. Direct observation of individuals by experienced observers is the best method of confirming the presence of greater gliders. Spotlighting should be undertaken on-foot within suitable habitat, with two experienced observers walking 50 m apart along a 1 km transect. To increase detectability, spotlighting should be undertaken on warm nights with little wind, rain or moonlight. Where greater glider surveys are conducted under optimal conditions (high habitat quality, warm temperatures with no rain, fog or bright moonlight) a minimum of two repeat visits is recommended for a 40 min / 2 ha transect (sensu Wintle *et al*., 2005). In areas containing lower quality habitat and/or under colder temperatures, five or more repeat visits of the 40 min / 2 ha transect are needed to provide an equivalent probability of detection of greater gliders (Wintle *et al*., 2005). The latter method was used in the current survey for a period of five days and is described in detail in Section 3 below.

Non-acceptable methods

Detection of greater glider remains in predator scats. These generally do not represent conclusive evidence of local occurrence, as the individuals may have been consumed in another part of the predators' home range. This method was used as a supplemental source of information as detailed in Section 3 below.

Collection of hairs using hair-tubes. This provides evidence of local presence but cannot provide any information on local population densities. Due to the low strike-rate and labour-intensive nature of this method, this method was not used in the current survey.

2.3.3 Methods used to target greater gliders in this assessment

Targeted surveys for the greater glider used the following methodologies:

- Habitat assessments to document habitat quality and the presence of possible den sites
- Targeted searches for faecal pellets to confirm the species' presence
- Targeted surveys for indirect evidence of occurrence from predator scats
- Direct spotlighting surveys to confirm the species' presence

Information on each of the above methods is detailed below.

Habitat assessments

Habitat assessments were undertaken at 26 survey sites within Curra State Forest (refer to Figure 1). Survey sites were located within the project area along areas previously mapped by ERM as suitable habitat for the species (ERM, 2016). Areas with high densities of potential den sites were also specifically targeted using data on hollow-bearing trees obtained from BAAM (2015), ERM (2016) and the GHD flora survey (2016). At each habitat assessment site, the following characteristics were documented:

- Regional ecosystem community (version 8.0) (DNRM, 2016)
- The height, density and diversity of canopy tree species
- Presence and relative abundance of hollow-bearing trees
- Presence and relative abundance of flowering tree species
- Information on local topography including slope, aspect and altitude.

Additional habitat assessments were also undertaken at four sites in areas away from the project area but within 1.5 km of historical records of the greater glider within Curra State Forest. These were used to provide a comparison of habitat quality between areas within the project area and nearby areas of confirmed habitat for the species.

Targeted searches for faecal pellets

The greater glider has distinctive faecal pellets. Targeted searches were undertaken for greater glider faecal pellets using a variation of the Spot Assessment Technique (SAT) used to detect koalas (Phillips and Callaghan, 2011). A total of 26 SAT surveys were undertaken at representative locations along the length of the project area within Curra State Forest (refer to Figure 1). At each location, two observers searched for faecal pellets beneath 30 trees for a period of 30 minutes (i.e. 2 minutes per tree). Each search was centred around a possible den site in a large hollow-bearing tree. Any faecal pellets found were photographed and collected for independent verification by a specialist firm. The location of all confirmed greater glider faecal pellets was recorded with a handheld GPS.

Spotlighting transects

Two experienced ecologists spent a total of 50 observer hours of spotlighting over five nights between 22 and 26 August, 2016. Each night, spotlighting was undertaken between 7 pm and 1 1 am. Spotlighting activities were undertaken at:

- Seven transects located within the project area in Curra State Forest
- Four transects within the vicinity of historical records in the centre of Curra State Forest (approximately 500 m east of the project area) (Figure 1).

Each transect was 1 km in length and generally followed a forestry access track through an area of potentially suitable habitat as identified during the afternoon habitat assessments. Positioning the transects along forestry tracks maximised the time spent searching for the greater gliders and minimised the time spent navigating obstacles and undergrowth. Each night, spotlighting was undertaken along three transects; two along the project area and one in the vicinity of historical records. At each transect, two observers spent 100 minutes walking 50 m apart and searching for eye-shine with a handheld 30 Watt spotlight. Any individuals observed were photographed and their location marked with a handheld GPS. Transects adjacent to the project area were surveyed at least twice over the course of the week. Transects located away from the project area (within the vicinity of historical greater glider records) were surveyed once each. The distribution of spotlighting, habitat assessments and targeted searches for faecal pellets is shown in Figure 1.

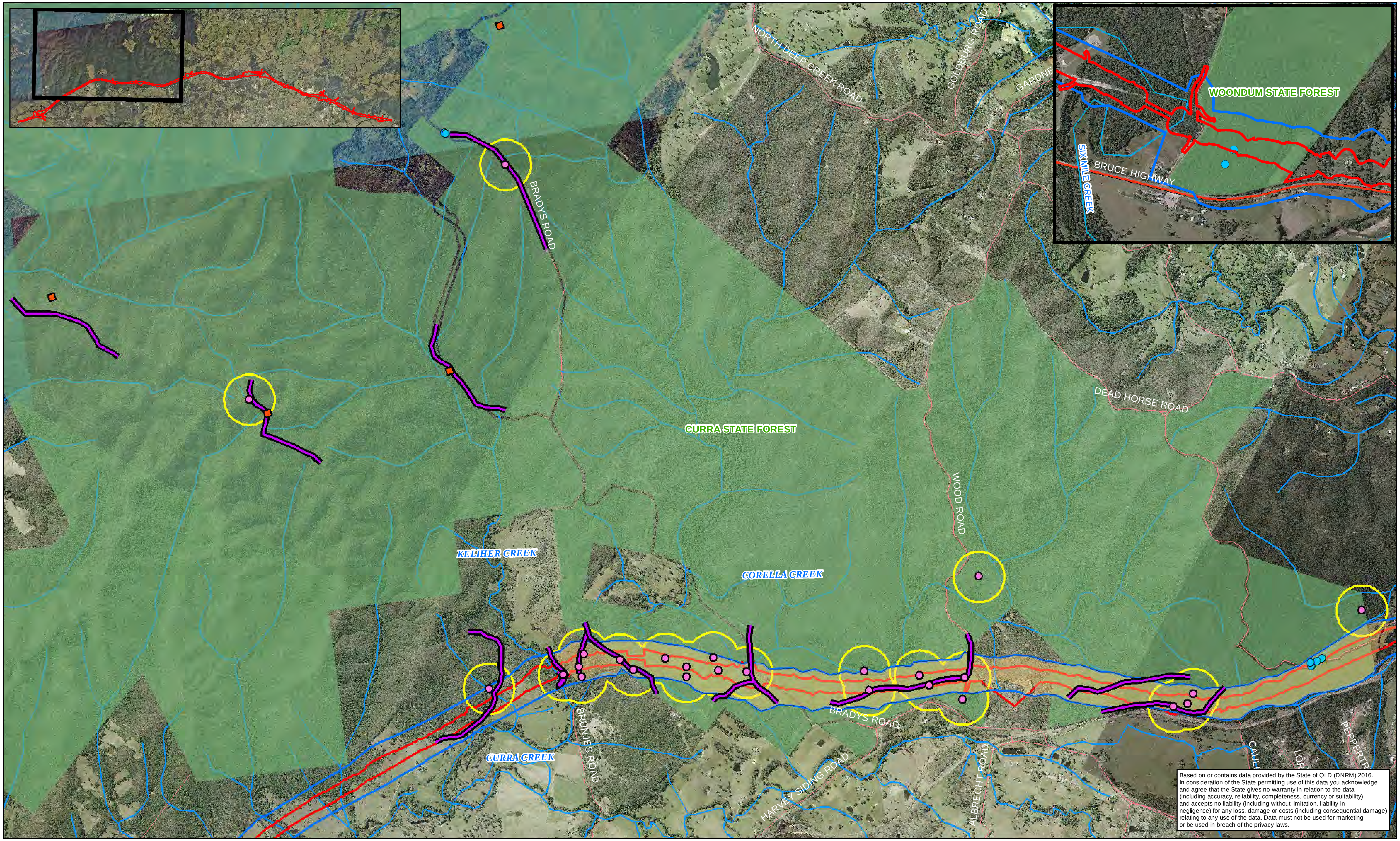
2.3.4 Additional surveys for black-breasted button-quail

During survey activities, targeted searches were undertaken to identify the locations of button-quail platelets. Remote cameras were then set in the vicinity of identified platelets to confirm species' presence. Cameras were baited with finch seed, a known preferred food for aviary-kept button-quails. Four cameras were set for three days (216 recording hours) within the project area, with an additional two cameras set for two additional days (96 recording hours) outside the project area. Cameras were set at two locations within Curra State Forest (Figure 1). Two cameras were also set within Woondum State Forest for one day (48 recording hours) to confirm the presence of black-breasted button-quails at that location as the quail had been identified as occurring in Woondum State Forest by ERM (2016) (refer to insert on Figure 1).

Plate 1 Button-quail platelets in Curra State Forest (left) and remote camera (right)

2.3.5 Incidental surveys for tusked frog

At all creek crossings encountered during field surveys, several minutes were spent listening for tusked frog calls. Call playback was also undertaken to encourage calling activity. The locations of four confirmed tusked frog observations were recorded with a hand-held GPS (refer to Figure 2).



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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

- Habitat Assessment Site
- Camera Location
- Historic Greater Glider Record
- Spotlighting Transect
- Watercourses
- Greater Glider Habitat (ERM, 2016)
- Street/Local Road
- Project Area
- Survey Area
- Faecal Pellet Searches
- State Forest

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	A
Date	02 Nov 2016

Distribution of targeted greater glider surveys within Curra State Forest

Figure 1

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Data source: TMR: ERM Greater Glider Habitat, Project Area, Survey Area (2016), Imagery (2014); DNRM: Cadastre, Watercourse, Road Network (2015). GHD: Faecal Pellet Search, Habitat Assessment site, Spotlighting transect, Camera Location (2016). Created by: RB

3. Results

3.1 Desktop assessment

3.1.1 Historical greater glider records

Nineteen historical records of the greater glider occur within 10 km of the project area:

- 13 records of the species within the Wildlife Online database
- Six records of the species within the ALA database

While habitat for the greater glider was identified by BAAM (2015() and ERM (2016), no direct observation of this species was noted in either report.

Greater glider records within Curra State Forest

Four of the ALA records were recorded within Curra State Forest in 1997 by the Queensland Parks and Wildlife Service. These records are all located in relatively heterogeneous terrain associated with ridgetops and gullies in the centre of Curra State Forest, approximately 3 km east of the project area.

3.1.2 Greater glider habitat requirements

The greater glider is restricted to eucalypt forests and woodlands, typically occurring in highest abundance in taller, montane, moist eucalypt forests with an abundance of mature, hollow-bearing trees (Andrews *et al*., 1994; Smith *et al*., 1994, 1995; Kavanagh, 2000; Eyre, 2004; van der Ree *et al*., 2004; Vanderduys *et al*., 2012). The species has a specialist folivorous diet, feeding predominantly on leaves and occasionally on flowers (Kehl and Borsboom, 1984; Kavanagh and Lambert, 1990; van der Ree *et al*., 2004). The species displays strong seasonal food preferences and therefore favours forests that contain a diversity of eucalypt tree species, and provide consistent access to foraging habitat throughout the year (Kavanagh, 1984). The species utilises large hollows in mature trees as a diurnal refuge (Henry, 1984; Kehl and Borsboom, 1984; Lindenmayer *et al*., 1991; Smith *et al*., 2007; Goldingay, 2012). The availability of mature hollow-bearing trees appears to be a limiting factor for the species. In south-east Queensland, greater gliders require between two to four live den trees for every 2 ha of suitable habitat (Eyre, 2002). The species has a relatively small home range, typically 1 – 4 ha (Henry, 1984; Kehl and Borsboom, 1984; Comport *et al*., 1996; Gibbons and Lindenmayer, 2002; Pope *et al*., 2005). Given the species' limited capacity for dispersal, and reluctance to cross vegetation gaps, the species is relatively sensitive to habitat fragmentation (McCarthy and Lindenmayer, 1999ab; Lindenmayer *et al*., 2000; Eyre, 2006; Taylor and Goldingay, 2009). Greater gliders are generally unlikely to persist in small forest remnants. Modelling suggests the species requires patches of remnant forest that are at least 160 km^2 (16,000 ha) in size (Eyre, 2002).

3.2 Field survey results

3.2.1 Greater glider habitat assessments

Habitat within the project area

Preliminary greater glider habitat mapping previously provided by ERM (2016) was further categorised as a result of the current targeted surveys. Categorises used in this assessment included the following:

- **Low value logged/burnt areas** – Woodland areas where mature canopy trees occur in low density due to recent fire and past logging practices and in which suitable foraging habitat and den sites in hollow-bearing trees are generally absent.
- **Suitable foraging habitat** – Forest and woodland areas where mature canopy trees occur in moderate to high density and include a mix of preferred food trees, but in which suitable den sites in hollow-bearing trees are generally absent or present in very low densities.
- **Suitable denning habitat** – Forest and woodland areas where mature canopy trees occur in moderate to high density and include a mix of preferred food trees and in which suitable den sites in hollow-bearing trees are present in moderate to high local densities.

Suitable foraging habitat for the greater glider occurs throughout much of Curra State Forest. The distribution of potential greater glider habitat within the project area was recorded in the field and is mapped in Figure 2. A mix of the greater gliders' preferred food tree species was recorded along the project area including *Corymbia citriodora*, *Eucalyptus propinqua*, *E. moluccana*, *E. crebra*, *Lophostemon suaveolens* and *L. confertus*. Riparian vegetation along waterways supported an abundance of mature *L. suaveolens* and *E. tereticornis* and are likely to represent nutrient-rich foraging habitat for the greater glider. The diversity of tree species observed within the project area indicates the species is likely to have year-round access to flowering vegetation.

While suitable foraging habitat and hollow bearing trees were observed along much of the project area (as shown on Figure 2), very few mature hollow-bearing trees were observed. The abundance and distribution of suitable den sites is therefore limited to two locations and are generally along waterways within the project area (refer to Plate 2). These were located in two distinct areas at the southern and northern extents of the project area within Curra State Forest (refer to Figure 2). Given the greater glider has a relatively small home range (Gibbons and Lindenmayer, 2002; Pope *et al*., 2005), areas of accessible habitat for the greater glider along the project area are likely to be limited to localised areas within several hectares of potential den sites (refer to Figure 2).

Areas in the centre of the project area within Curra State Forest have been extensively logged and recently burnt (refer to Plate 3) due to the ongoing management regime associated with this State Forest. Due to the absence of hollow-bearing trees and the relatively open, fragmented nature of woodland habitats in this area, the greater glider is less likely to utilise these areas.

Plate 2 Suitable den habitat for the greater glider within the project area

Plate 3 Logged and burnt habitat within the project area

Habitat within the vicinity of historical records

Habitats in the interior of Curra State Forest (outside of the project area) are expected to have substantially higher value for the greater glider compared with those observed within the project area (especially areas within the project area that have been logged and burnt). Forest in the interior of Curra State Forest supported a similar mix of native tree species to those observed along the project area. However, the terrain is substantially steeper and more heterogeneous with steep ridges and gullies compared with the more low-lying, gently undulating terrain present along the project area. The greater glider is known to occur in highest densities in montane habitat (Andrews *et al*., 1994; Smith *et al*., 1994, 1995; Kavanagh, 2000; Eyre, 2004; van der Ree *et al*., 2004; Vanderduys *et al*., 2012). Habitats in the interior of Curra State Forest are therefore more consistent with higher value habitat for the greater glider. Areas in the interior of Curra State Forest were observed to have also been subject to lower logging pressures and retained a significantly higher abundance and density of mature, hollow-bearing trees (refer to Plate 4). Accordingly, the abundance and distribution of suitable den sites was substantially higher than observed within the project area.

Plate 4 High value greater glider habitats in the interior of Curra State Forest

3.2.2 Targeted searches for greater glider pellets

Only one greater glider faecal pellet was found during targeted pellet searches of Curra State Forest. This was found beneath a greater glider observed during spotlighting in the interior of Curra State Forest, approximately 5 km north-east of the project area, refer to Figure 2 for the location of the recorded greater glider. No faecal pellets were observed within the project area or survey area. The absence of pellets within the project area suggests the species generally does not occur in high local densities along the project area. The lack of faecal pellets is also likely to be partially attributed to low detectability. Woodland areas within much of the project area had a dense ground layer of leaf litter and fallen bark. This is likely to have reduced the ability to detect faecal pellets of the greater glider. However, the absence of greater glider pellets from burnt areas in the project area, where detectability was substantially higher, suggests the greater glider does not occur in high densities in these locations.

3.2.3 Spotlighting for greater gliders

Two greater gliders were observed during spotlighting surveys, one within the project area and the other, in the vicinity of historical records in the interior of Curra State Forest (refer to Figure 2 and Plate 5). The greater glider observed within the project area was found along a tributary of Corella Creek in an area dominated by *Eucalyptus tereticornis* and *Lophostemon suaveolens*, within several hundred metres of a cluster of hollow-bearing trees (refer to Figure 2 and Plate 6).

Plate 5 Greater gliders observed during spotlighting

Plate 6 Habitat at the site of greater glider sighting within the project area

A number of other gliders and arboreal mammals were observed during spotlighting over the course of the week. These included five squirrel gliders (refer to Plate 7), one unidentified Petaurid glider, seven common brushtail possums (refer to Plate 8) and two common ringtail possums (refer to Plate 8).

Plate 7 Squirrel gliders observed within the project area

Plate 8 Common brushtail possum (left) and common ringtail possum (right)

3.3 Additional fauna survey results

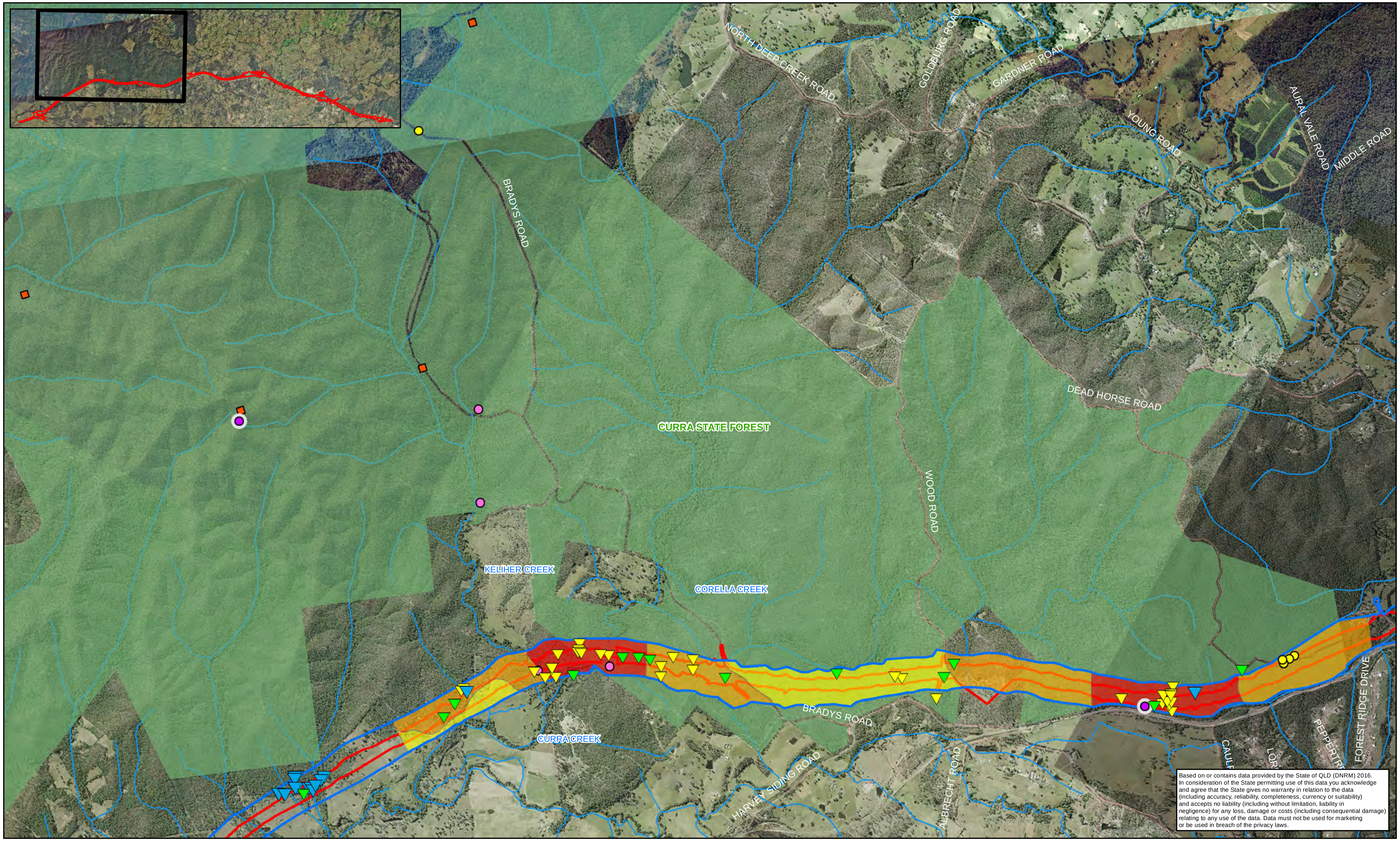
3.3.1 Black-breasted button-quail

Button-quail platelets were observed from two locations within Curra State Forest; one along the project area at the southern end of Curra State Forest, and the other in montane habitat within the interior of Curra State Forest (refer to Figure 2). Remote cameras set at both locations within Curra State Forest confirmed the presence of the painted button-quail (refer to Plate 9).

Painted button-quails were also observed within Curra State Forest during survey activities (refer to Plate 10). Given the abundance of painted button-quails and the general unsuitability of habitats for the black-breasted button-quail, platelets within Curra State Forest are likely attributed to the painted button-quail. The black-breasted button-quail is considered unlikely to occur within Curra State Forest. This supports the findings of BAAM (2015) and ERM (2016). Remote cameras set in Woondum State Forest did not confirm the presence of either species of button-quail. Given the suitability of habitat for the black-breasted button-quail and historical records available for the area (two previous records within 10 km of the project area, one within riparian vegetation of Six Mile Creek and another within Woondum National Park east of the project area), the black-breasted button-quail is still considered likely to occur in Woondum State Forest.

Plate 9 Remote-camera photos of painted button-quails in Curra State Forest

Plate 10 Painted button-quails observed during surveys of Curra State Forest



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Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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LEGEND

- Greater Glider Observation
- Tusked Frog
- Painted Button-quail
- Historic Greater Glider Record
- Watercourses
- **Hollow Bearing Trees**
  - HBT (ERM)
  - HBT (GHD)
- HBT (BAAM)
- Street/Local Road
- Project Area
- Survey Area
- **Greater Glider Habitat**
  - Low Value Logged/Burnt Area
  - Suitable Foraging Habitat
  - Suitable Denning Habitat
- State Forest

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	A
Date	28 Sep 2016

Greater glider habitat and fauna records

Figure 2

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6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: Atlas of Living Australia: Historic Greater Glider Record (2016); TMR: BAAM HBT, ERM HBT, Project Area, Survey Area (2016), Imagery (2014); DNRM: Watercourse, Cadastre (2015), Road Network (2015). GHD: Tusked Frog, Painted Button-quail, Greater Glider Habitat & Observation, HBT (2016). Created by: sc

3.3.2 Tusked frog

The tusked frog was actively calling throughout the survey. The species was confirmed from four locations within Curra State Forest including Keliher Creek, Curra Creek and associated tributaries as shown in Figure 2. The quality of habitats along Keliher Creek and Curra Creek were particularly high, with an abundance of suitable calling sites provided by the undercut banks and overhanging vegetation (refer to Plate 11 for tusked frog habitats along Keliher Creek). Tusked frogs appeared to be heavily utilising this area, with male frogs calling at locations spaced at 4-5 m intervals along Keliher Creek. A tusked frog was observed along Curra Creek.

Plate 11 Tusked frog habitats along Keliher Creek

4. Conclusion

4.1 Distribution and habitat use by the greater glider

Targeted surveys have confirmed that the greater glider occurs within Curra State Forest and utilises habitats within the project area (refer to Figure 2). Large areas of the Curra State Forest within the project area that were previously mapped as potential greater glider habitat have been intensively logged and recently burnt due to the designation of this bushland as an actively managed State Forest. These areas retain very few hollow-bearing trees that could provide den sites for the greater glider. This has reduced the value of refugial habitat for the species, particularly in lowland areas along the western boundary of Curra State Forest. Woodland in these areas has been substantially thinned and fragmented by historic logging. Given the greater glider is typically reluctant to cross vegetation gaps and sensitive to habitat fragmentation (McCarthy and Lindenmayer, 1999ab), the foraging values of this central area are expected to be limited.

Suitable denning habitat for the greater glider was identified in two locations within the project area. These were located along waterways in the north and south of Curra State Forest (refer to Figure 2). In these locations, mature hollow-bearing trees have been retained from active logging and provide suitable den sites for the greater glider. The sighting of one greater glider individual in the vicinity of the southern area during spotlighting confirmed the species' presence within this area. Given the greater glider typically maintains a small home range of between 1 and 4 ha (Henry, 1984; Kehl and Borsboom, 1984; Comport *et al*., 1996; Gibbons and Lindenmayer, 2002; Pope *et al*., 2005) and utilises several den sites within their range (Eyre, 2002), all hollow-bearing trees within the vicinity of the recorded sighting should be considered potential den sites.

In general, lowland areas along the western extent of Curra State Forest, including within the project area have been subjected to higher intensity logging than montane areas within the interior of Curra State Forest (and outside of the project area). Montane areas in the interior of Curra State Forest retained a larger abundance and density of mature hollow-bearing trees and are consistent with preferred habitat for the species.

4.2 Distribution and habitat for the black-breasted button-quail

The surveys have confirmed that platelets observed in Curra State Forest belong to the least concern painted button-quail (refer to Figure 2 for locations). Habitats within Curra State Forest are considered too dry for the black-breasted button-quail. Surveys in Woondum State Forest did not confirm the presence of black-breasted button-quail. However, the presence of platelets within the species' preferred vine forest habitat strongly suggest this black-breasted button-quail is likely to occur in Woondum State Forest.

4.3 Distribution and habitat use by the tusked frog

Opportunistic surveys have indicated a number of streams within Curra State Forest have high habitat value for the tusked frog. The species was confirmed present in four locations in Curra Creek, Keliher Creek and associated tributaries (refer to Figure 2 for locations). Areas of particularly high habitat value are waterways in wetter eucalypt forest in the northern end of Curra State Forest associated with Keliher Creek. The species should be considered likely to occur along any semi-permanent creeks within Curra State Forest wherever undercut banks and overhanging riparian vegetation provide sufficient microhabitat complexity to create suitable calling and sheltering refuges upon which the species depends.

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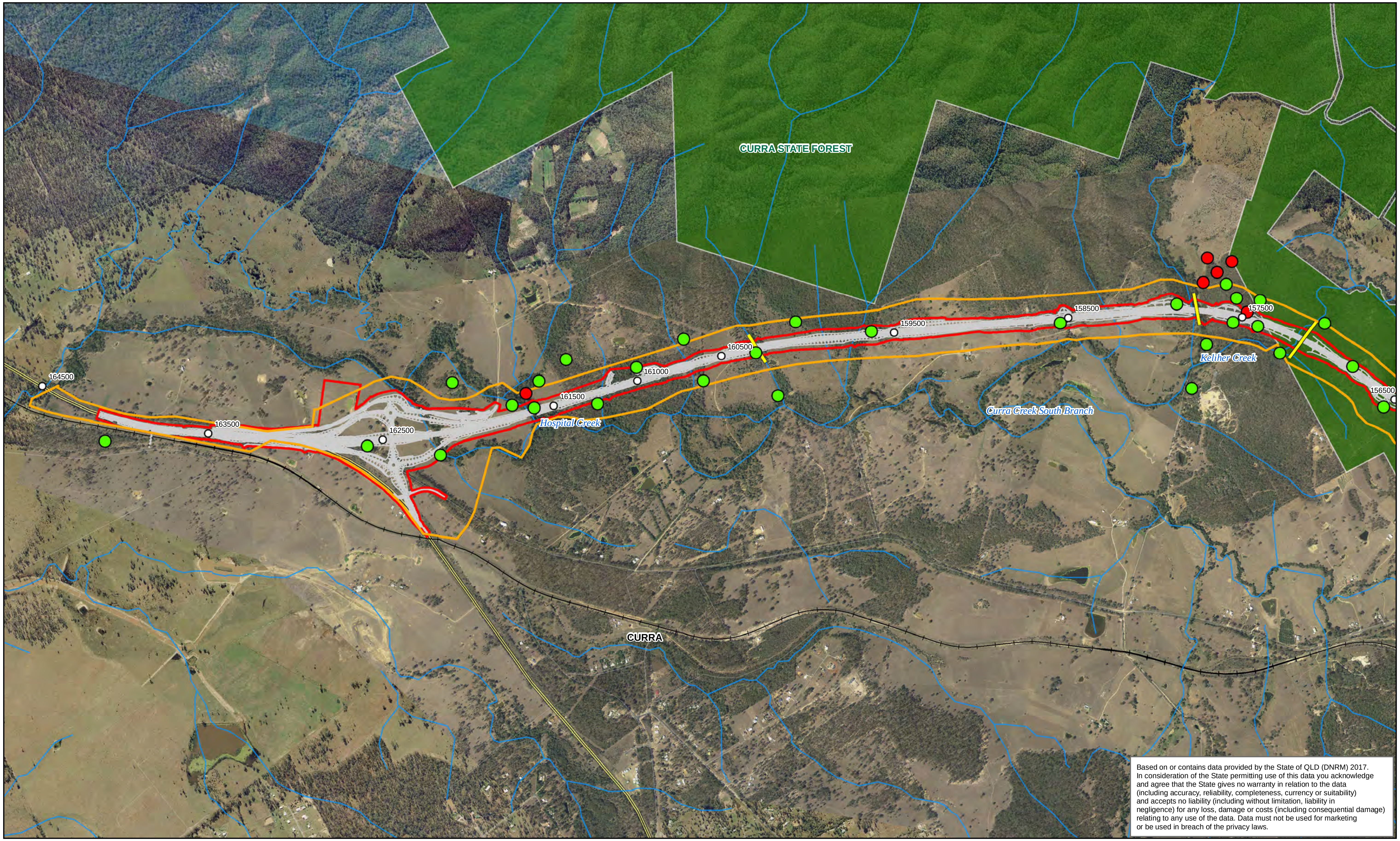
Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S. Hodgkison	D. Willis		I. Brodie		11/11/2016

Appendix I – USC Koala Data Mapping



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Town
- 1 km Chainage
- Railway
- Watercourses
- Fauna Connectivity Structure
- Survey Area
- Protected Areas

Project Area

- Contract 1
- Contract 2

USC Survey Sites

- Absence
- Presence

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
Revision	0
Date	24 Mar 2017

Appendix I
Sheet 1 of 4

USC Koala presence and absence survey

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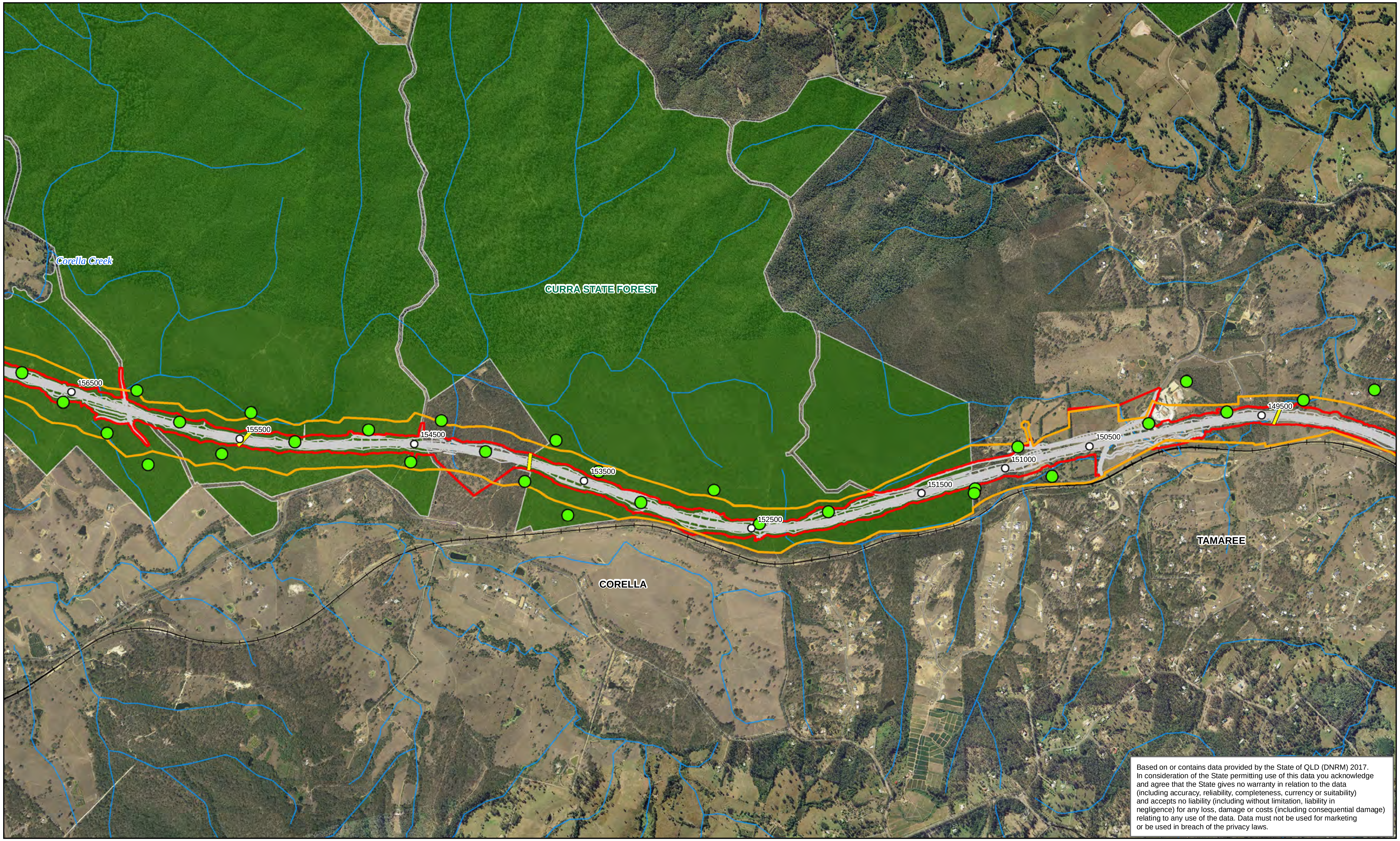
Data source: DNRM: Rail (2014), Roads (2016), Towns (2015), Protected Areas (2014); TMR: Imagery, Survey Area, Chainage (2016). GHD: Project Area (March2017), Road Design (November 2016). USC: Koala Evidence Present (2016). Created by:schadwick



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Horizontal Datum: GDA 1994
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Appendix I

USC Koala presence and absence survey

Sheet 2 of 4

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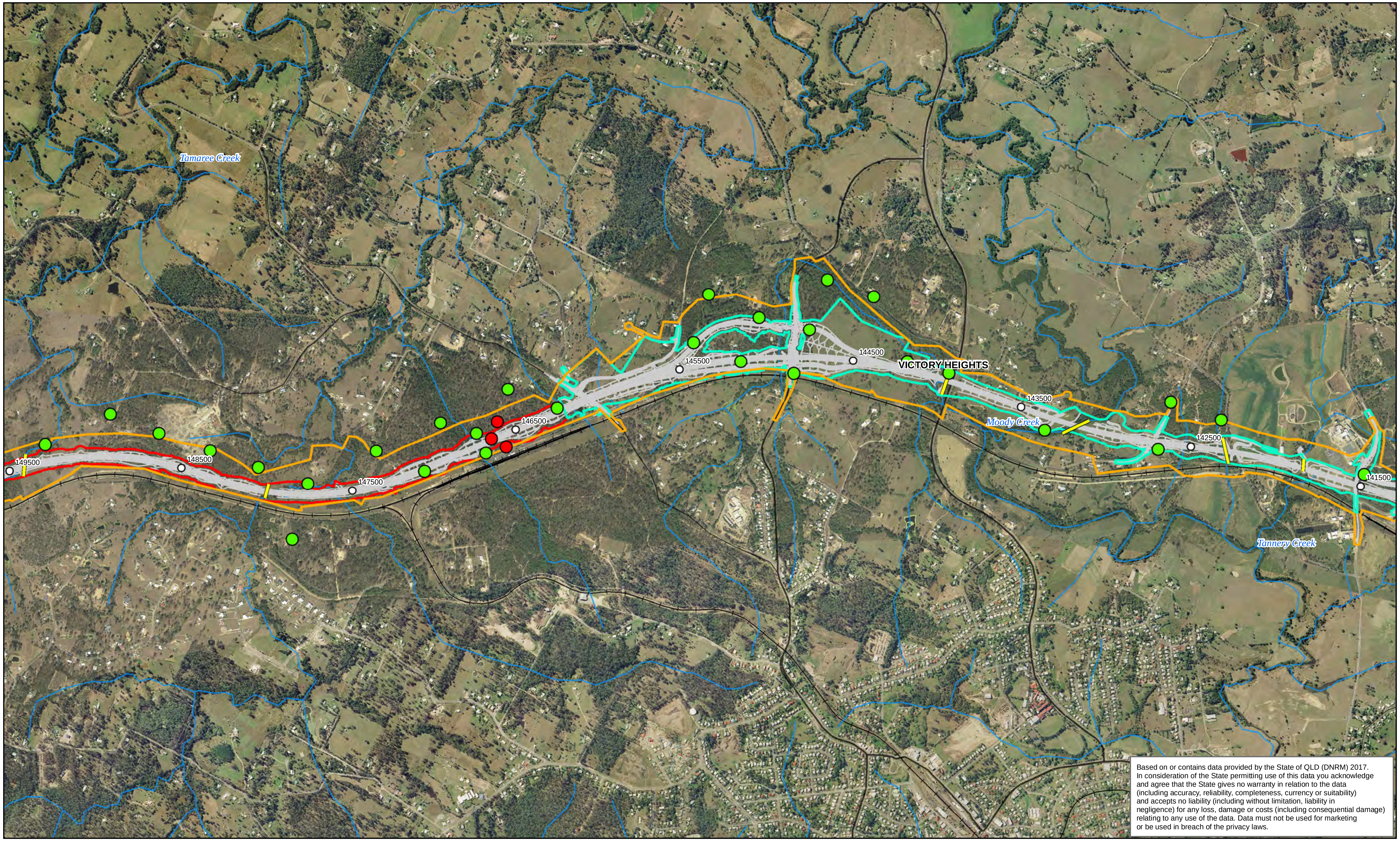

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USC Koala presence and absence survey

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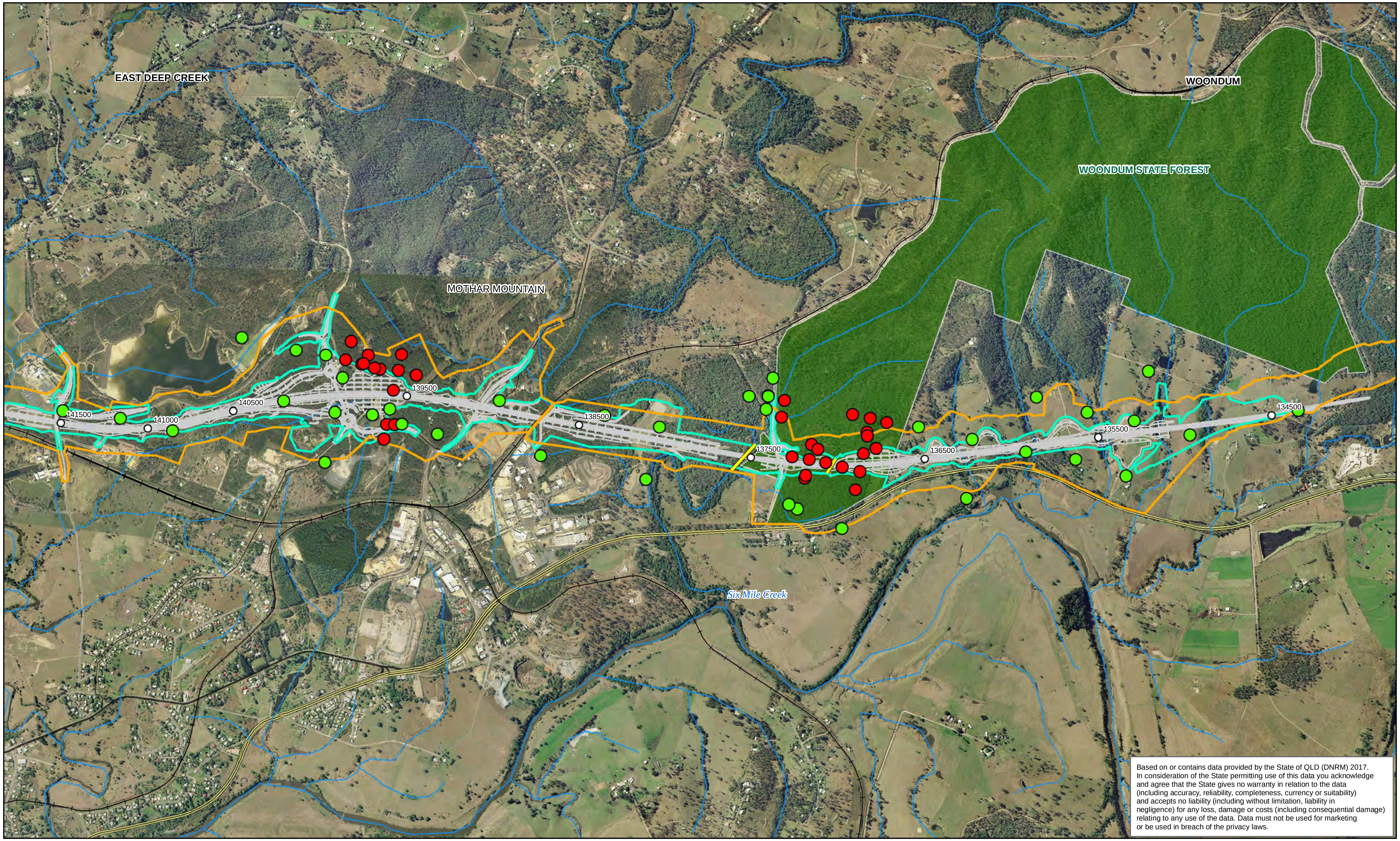

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USC Koala presence and absence survey

Appendix I
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Appendix J – Koala Surveys (Final), *Bruce Highway (Cooroy to Curra) Project Section D* (USC, 2016)

Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project

Koala surveys (Final)

Prepared for the Queensland Department of Transport and Main Roads (TMR)

This report was prepared by Dr Celine Frere and Dr Romane Cristescu
University of the Sunshine Coast (USC)
October 2016

University of the Sunshine Coast

Written by:	Dr Romane Cristescu
Position:	Postdoc
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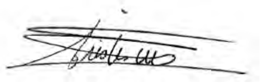
Signature:	
Approved by:	Dr Celine Frere
Position:	Research Fellow
Date:	26/10/2016
Signature:	

Disclaimer

This report was prepared in accordance with the scope of work agreed with the Queensland Department of Transport and Main Roads (the Client) and is subject to the specific time, cost and other constraints as defined by the scope of work.

To prepare this report, USC relied on information supplied by the Client and Third Parties, and does not accept responsibility for the accuracy or completeness of this information. USC also relied on information gathered at particular times and under particular conditions, and does not accept responsibility for any changes or variances to this information which may have subsequently occurred. Accordingly, the authors of the report provide no guarantee, warranty or representation in respect to the accuracy, adequacy or completeness of the information, whether generally or for use or reliance in specific circumstances. To the extent permitted by law, the authors exclude any liability, including any liability for negligence, for any loss, damage, injury, illness howsoever caused, including (with limitation) by the use of, or reliance upon, the information, and whether arising from errors or omissions or otherwise.

Executive Summary

Purpose

The purpose of this study was to determine the presence / absence and habitat utilisation of koalas (*Phascolarctos cinereus*) in an area defined by the Queensland Department of Transport and Main Roads (TMR) in the context of the highway upgrade project: "Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)". The proposed Section D highway upgrade ranges from Woondum to Curra and includes the Gympie bypass. The results reported here provide information regarding koala presence and habitat utilisation rate relevant to the study period and make no conservation recommendations.

Survey methods

Sites selected for koala surveys followed a grid pattern based on a random start point projected inside a 200 meters' buffer zone around the proposed highway expansion. The surveys focused on koala habitat based on vegetation types (as defined in Jacobs, 2015), however, sites were added outside koala habitat to ensure no koala population was missed. Koala scat surveys were primarily conducted using detection dogs trained to locate koala scats (faecal pellets).

Field surveys were conducted between February to September 2016. Fieldwork was momentarily stopped (June/July 2016) due to 1080 dog baiting undertaken across the Gympie Council area.

Limitations

The sites were surveyed only once, therefore the results presented here provide a snapshot of the population during this period and it can be noted that evidence of koalas found within the study area are likely to change with increased sample size as well as seasonally.

A negative site might reflect that koalas are not using the area (true negative) or that koalas are using the area but the survey failed to detect any scat (false negative), which could occur for example if koalas have not deposited any scat in the 30 trees searched during the survey or if scats have decayed before the survey occurred.

Summary of findings

Of the 155 sites surveyed, 35 were found to be positive for koala presence based on the detection of their scats during scat surveys (23%). In addition, we had eight opportunistic positive sightings for koala presence (7 scats, 1 koala).

Our data showed that koala presence was found within previously verified koala habitat, unverified koala habitat as well as outside of koala habitat.

We systematically searched 4560 individual trees and koala scats were found under a total of 173 trees. The average utilisation rate for all surveys was 3.8% (± 9.4%). In positive sites, the number of trees with at least one scat present varied from 1 to 16, with an average of 4.9 trees with scats (± 3.9). The utilisation rate per site in this study ranged from 0 % (not utilised) to 53%.

Our results show that koalas are utilising habitat in five regions located within the impact zone. Of these, the utilisation rate appears to be the highest at two areas in the southern end of the Section D impact zone (Mothar Mountain and the north-east corner of Woondum State Forest).

The age of koala scats found during the surveys indicated both recent and historical use of the habitat within the impact zone.

Table of Content

1- Introduction

The Queensland Department of Transport and Main Roads contracted the University of the Sunshine Coast (USC) to confirm presence / absence of koalas (*Phascolarctos cinereus*) in an area associated with the highway upgrade project: “Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)”, which ranges from Woondum to Curra and includes the Gympie bypass.

USC researchers have used the most efficient method to confirm koala presence and identify koala habitat, by utilising detection dogs specifically trained on the odour of koala scats. The detection dog method has been shown to be over 150% more accurate in koala scats detection, and 20 times more efficient (faster) when compared with human-only method (Cristescu, Foley et al. 2015).

2- Methods

2.1- Definition of the impact zone

A single study area was designated around the projected highway expansion design provided by the Queensland Department of Transport and Main Roads (Figures 1A, 1B, 1C and 1D). This area, referred to as the impact zone, consisted of a 200 meter buffer, which was generated around the proposed road design using ArcGIS 10.3.1.

2.2- Sampling design

The impact zone, defined above, was overlaid with survey sites spread 300 meters apart following a grid pattern starting from a randomly selected GPS location. From these, survey sites were selected to cover three koala habitat categories, each of which varies in its probability to contain koalas based on the vegetation types present (Figures 2A, 2B, 2C and 2D).

Koala Habitat Category 1: Verified koala habitat

Here, survey sites were selected in areas previously identified as high probability koala habitat based on vegetation types as described in Jacobs (2015), and as per the ArcGIS layer BAMM_SpeciesHabitat2015_Koala_MGA56 provided by TMR (N=37). These vegetation types were verified in-field by a botanist consultant for The Queensland Department of Transport and Main Roads (see ground-truthing in Jacobs, 2015).

Koala Habitat Category 2: Unverified koala habitat

Here, survey sites were located in areas previously identified as high probability koala habitat based on the same vegetation types as above, but, in contrast with Category 1, these have not been verified by a botanist (N=39).

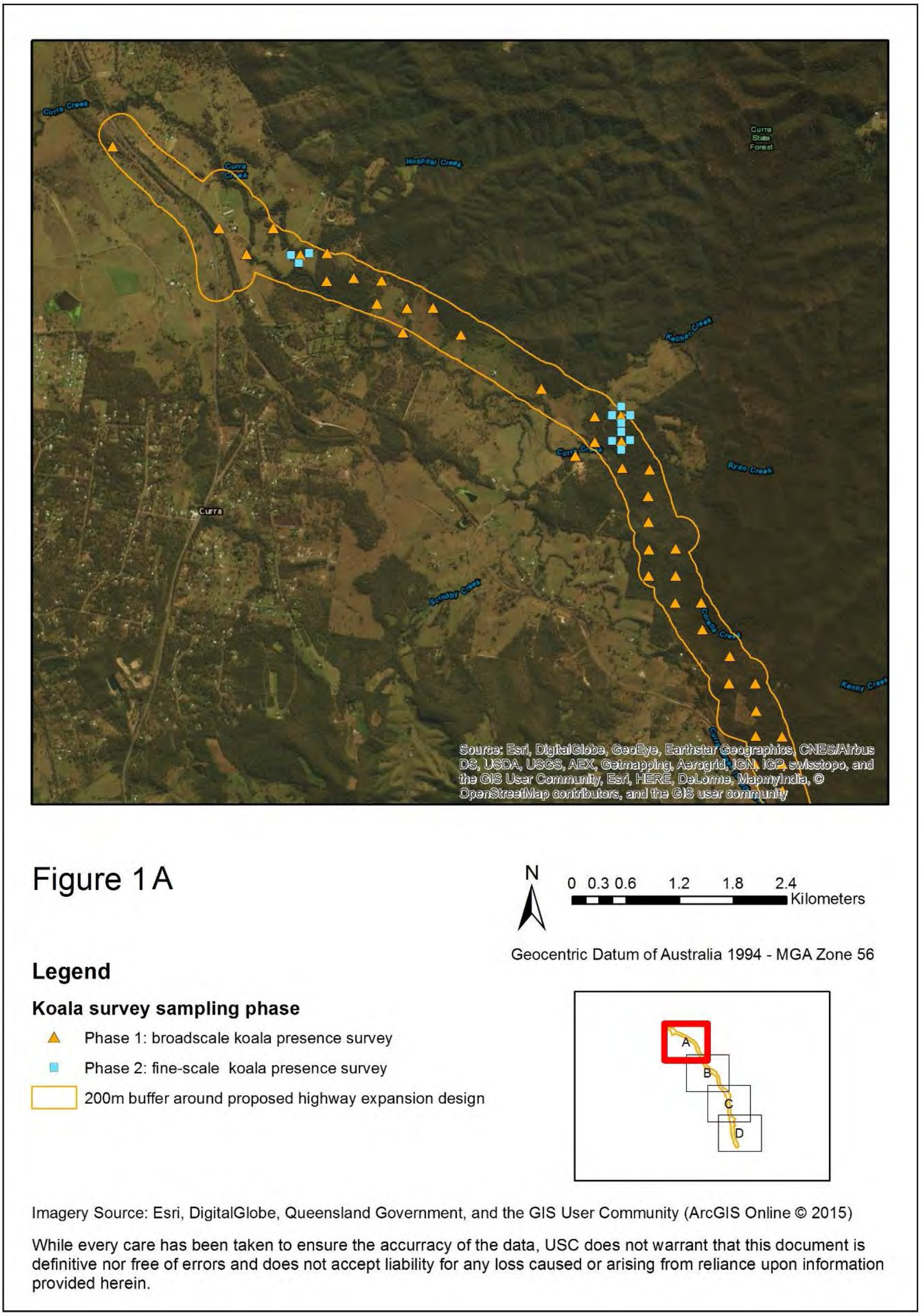


Figure 1A. **Sampling locations and 200 m buffer zone.**

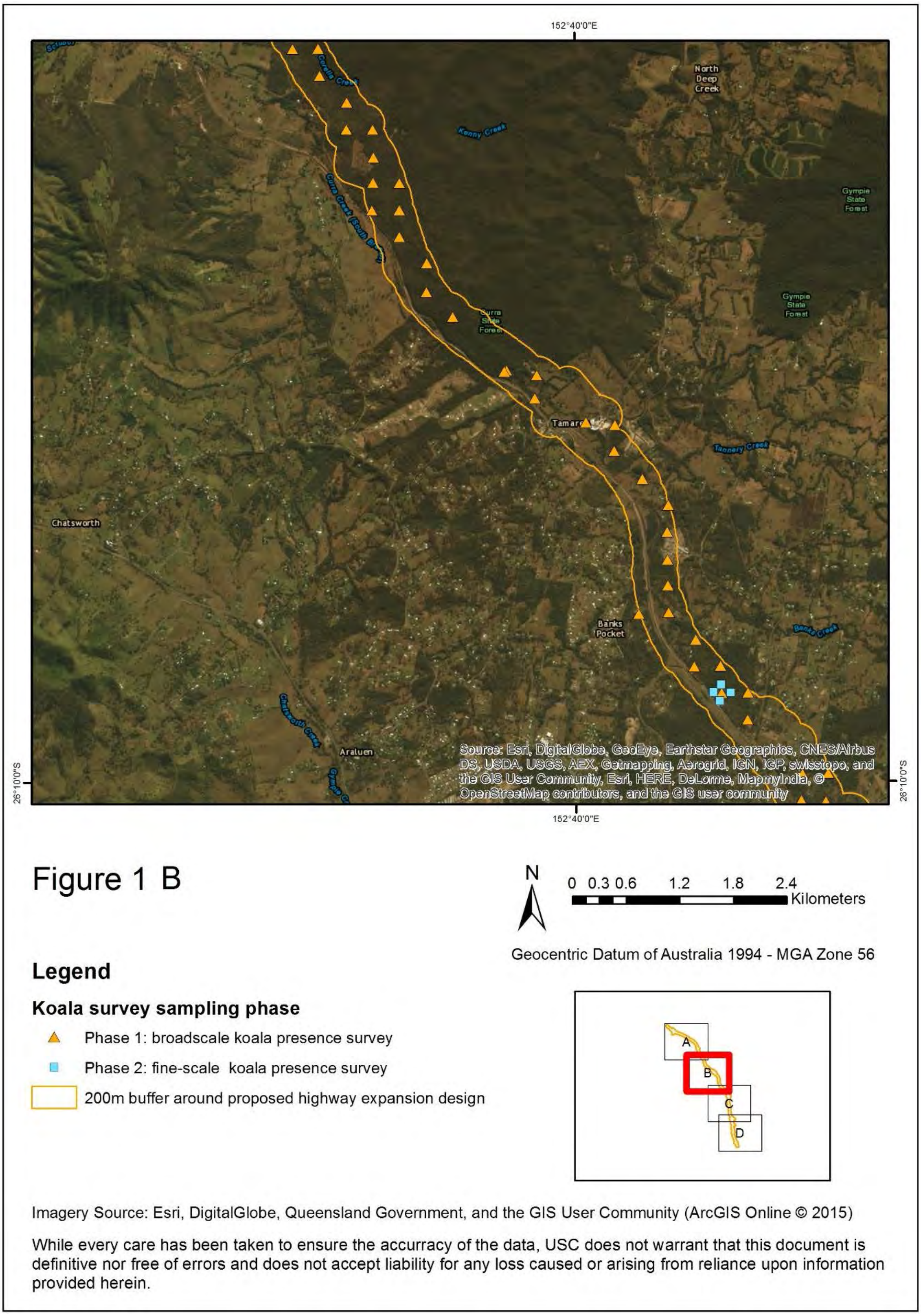


Figure 1B. **Sampling locations and 200 m buffer zone.**

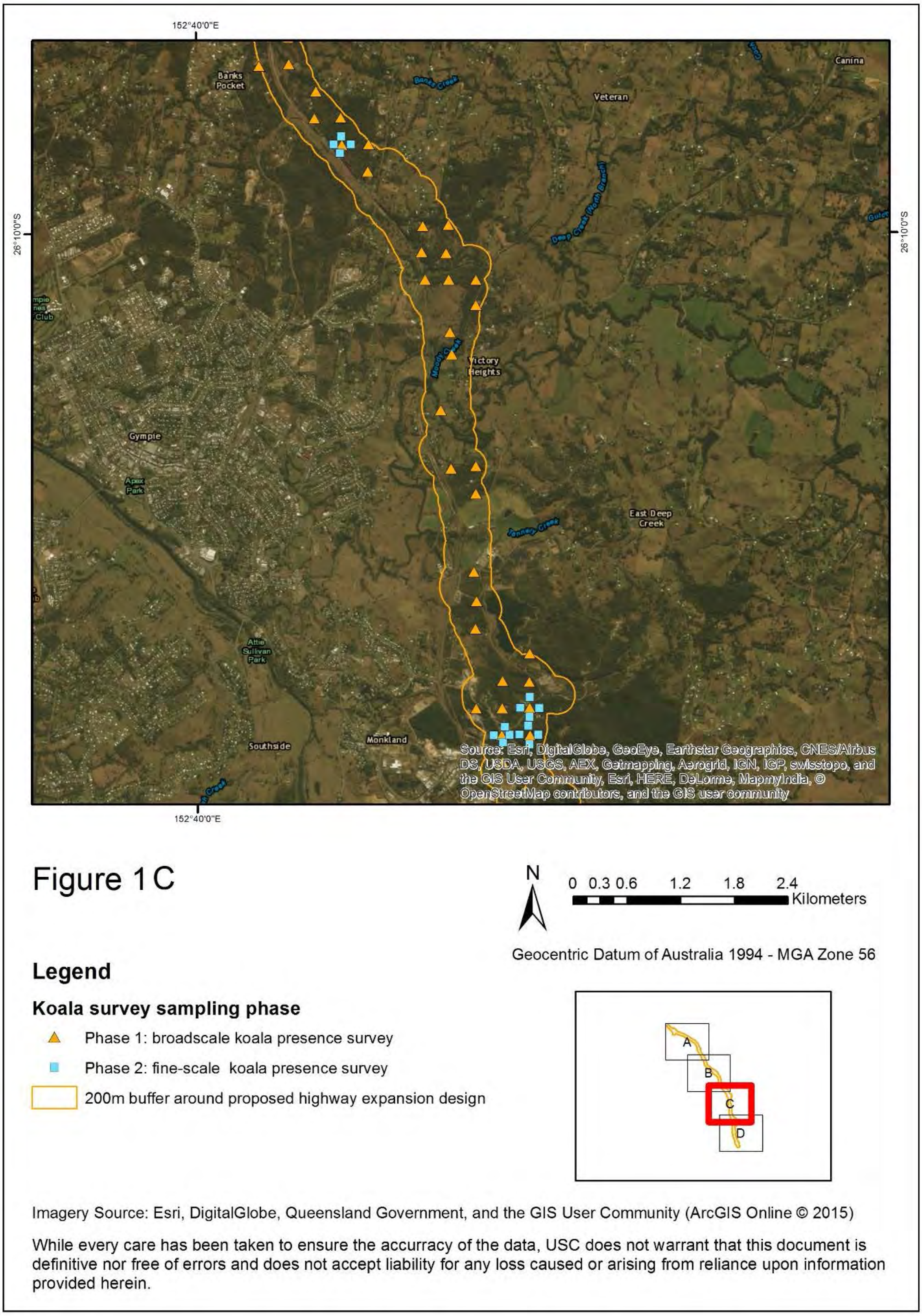


Figure 1C. **Sampling locations and 200 m buffer zone.**

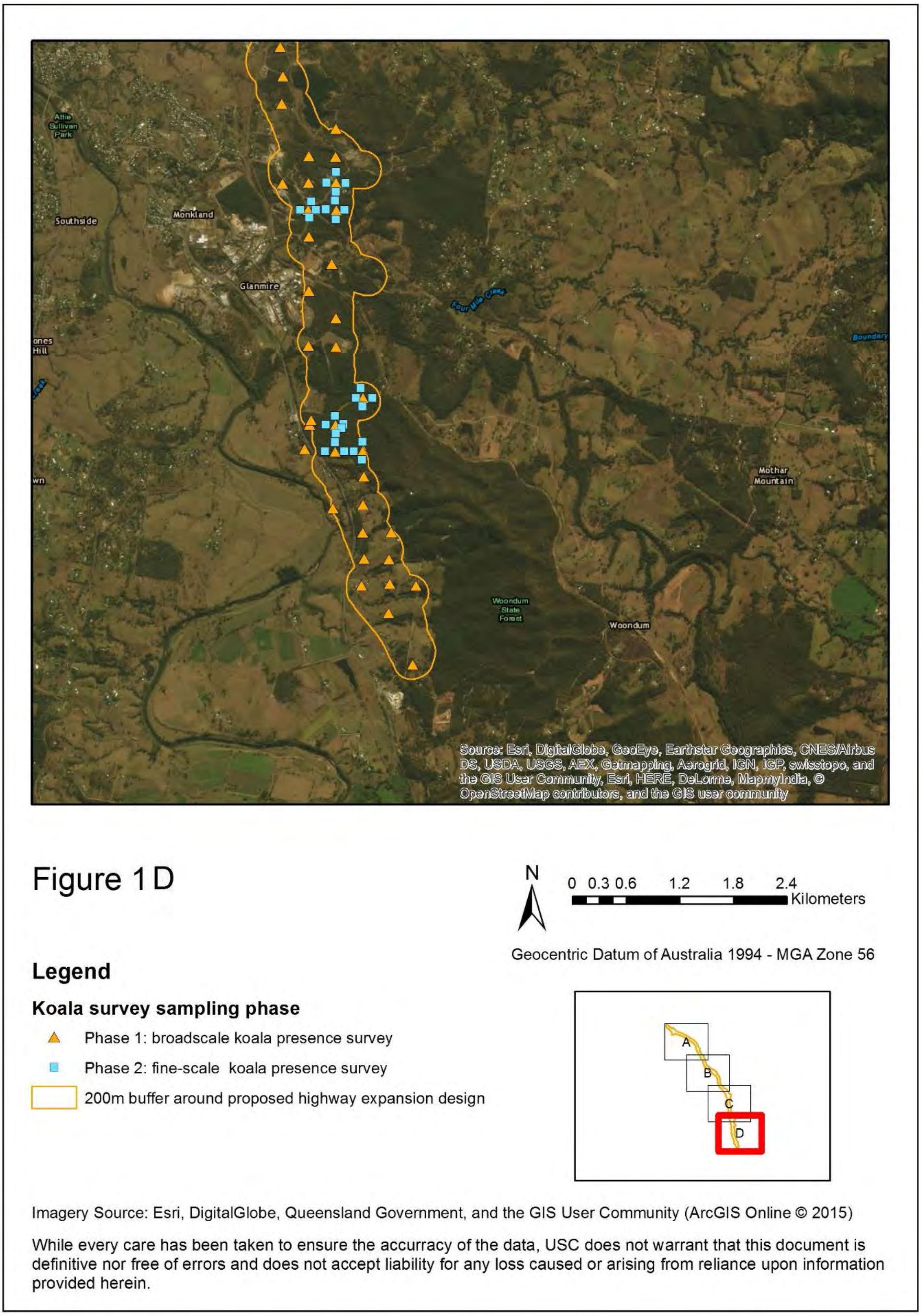


Figure 1D. Sampling locations and 200 m buffer zone.

Koala Habitat Category 3: Areas outside of high probability of koala habitat

Here, survey sites were located in areas outside of both verified and unverified koala habitat contained within the impact zone. Survey sites outside of koala habitat were retained in the experimental design to ensure that koala populations were not potentially missed (N=37).

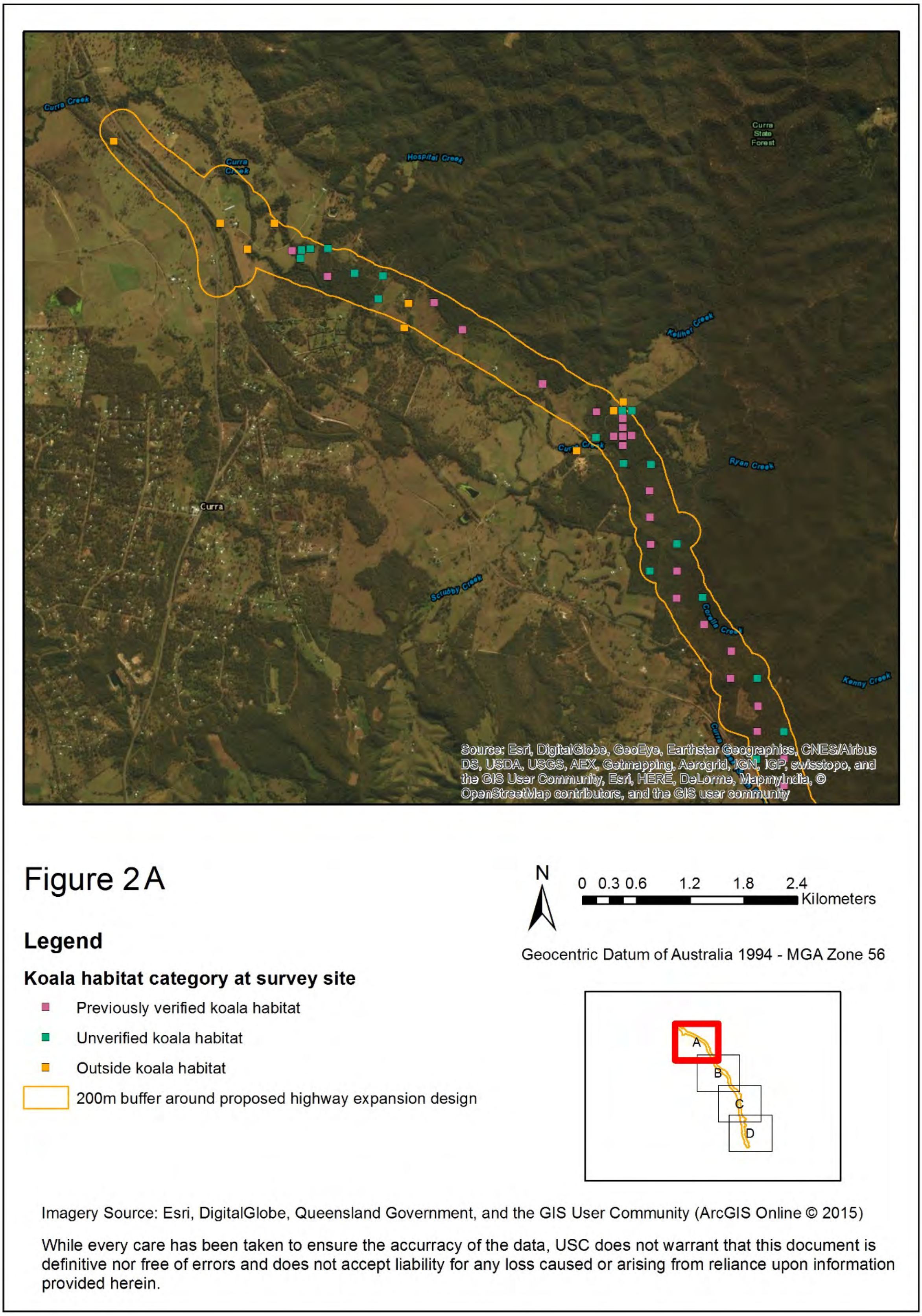


Figure 2A. **Survey site locations and koala habitat type present.**

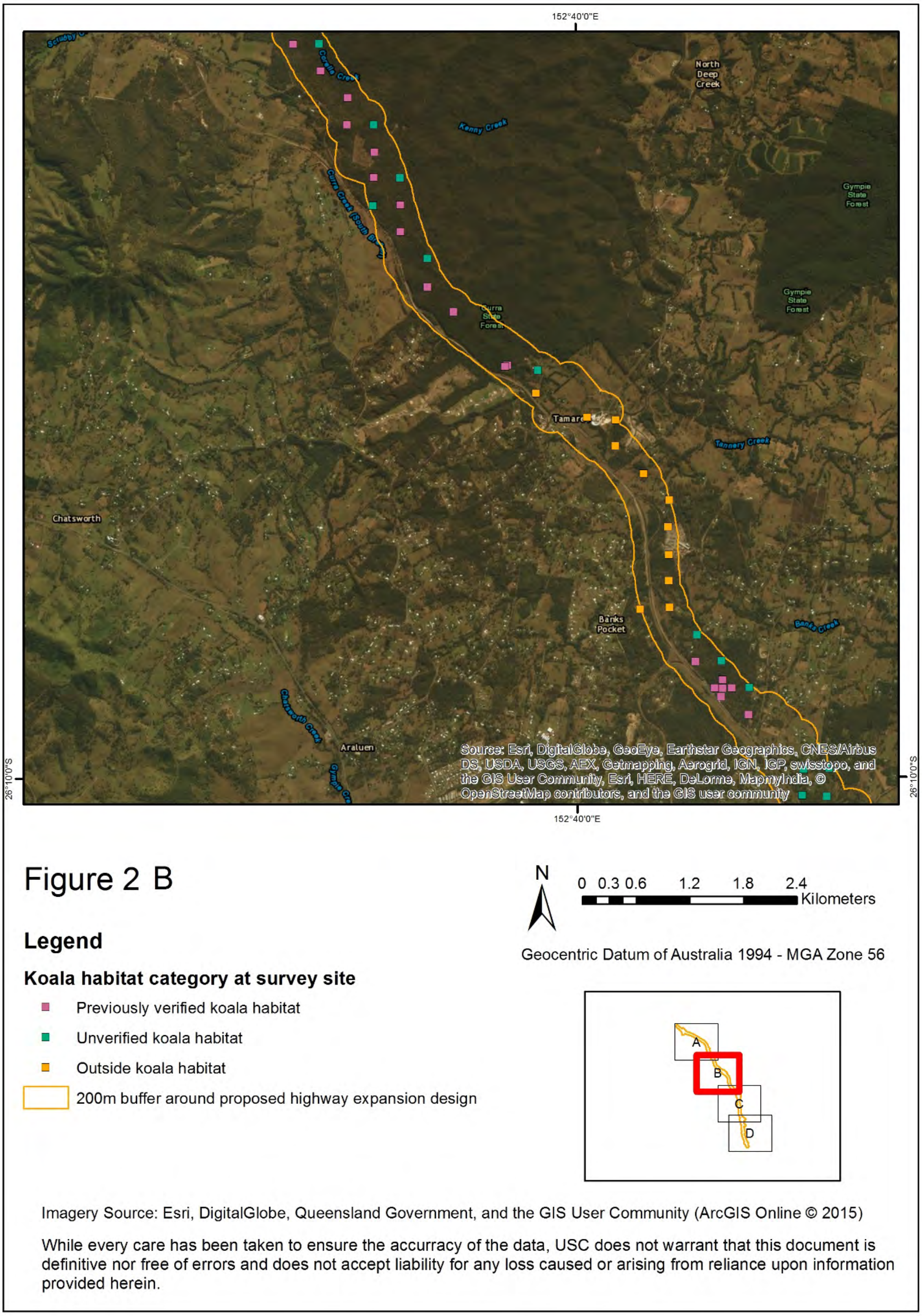


Figure 2B. **Survey site locations and koala habitat type present.**

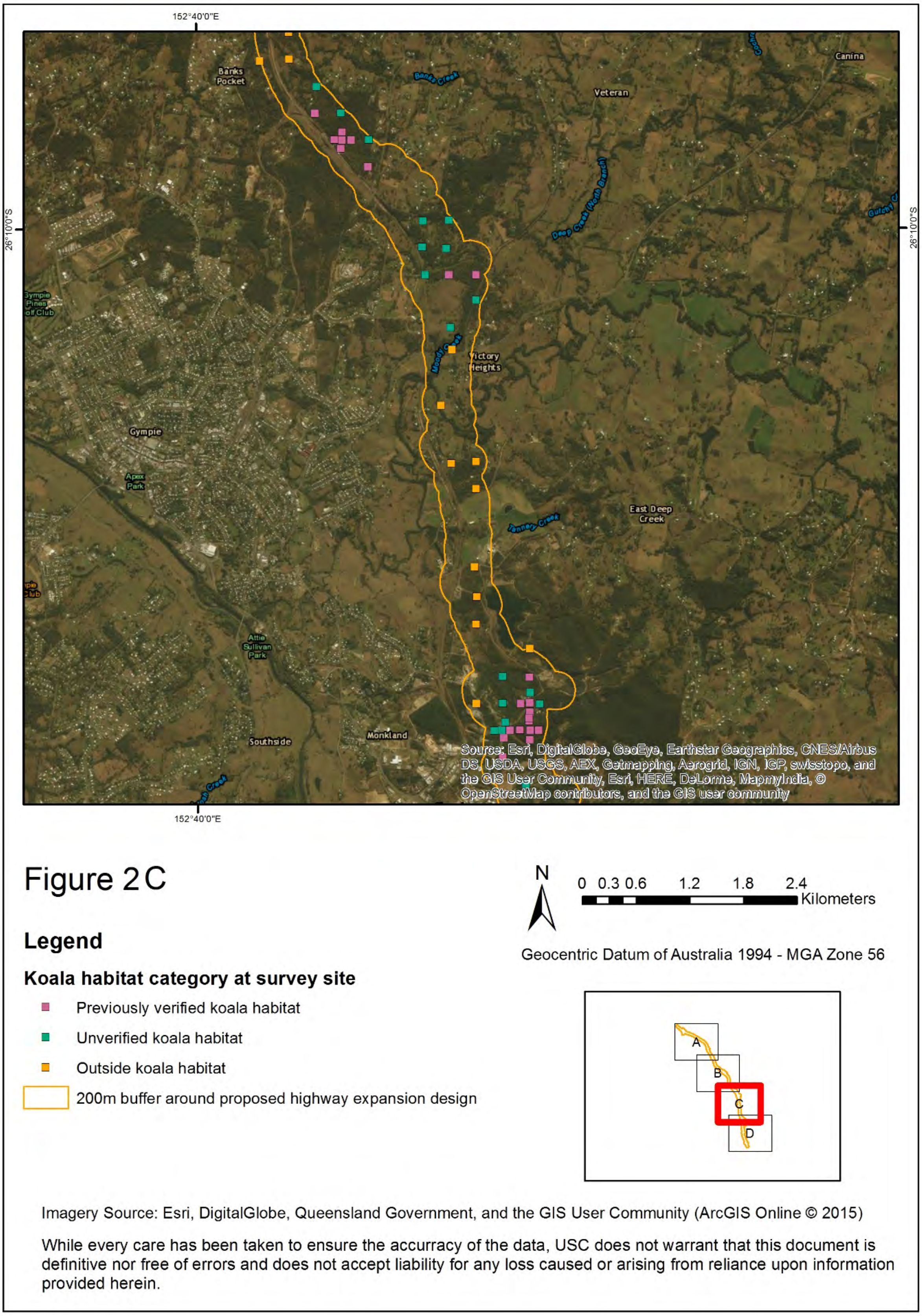


Figure 2C. **Survey site locations and koala habitat type present.**

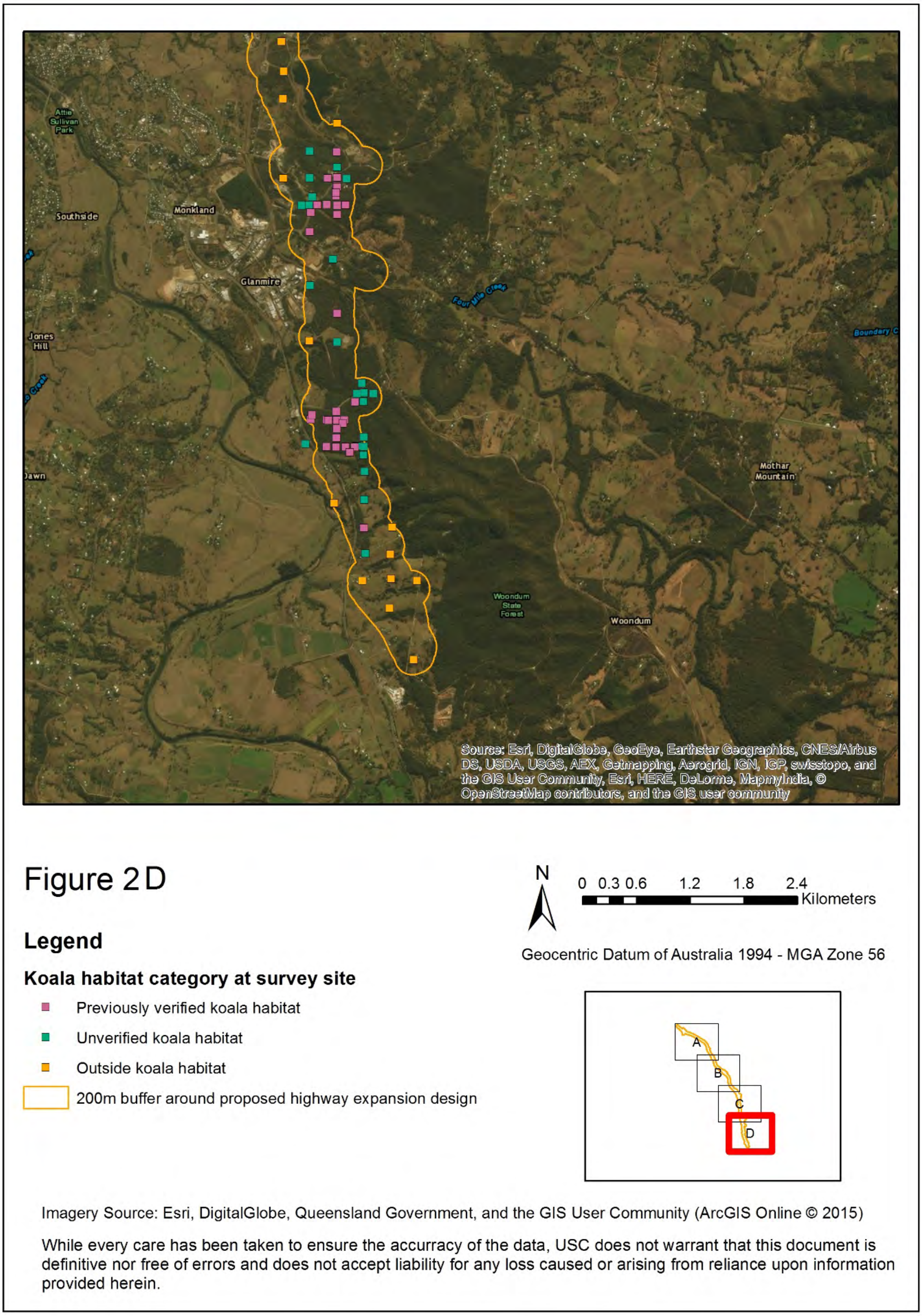


Figure 2D. Survey site locations and koala habitat type present.

3- Health and safety

This project operates under the University of the Sunshine Coast Animal Ethics Approval Number AN/A/14/91 and the following scientific permits from the Queensland Government: WITK16401215 and WISP11677512.

All field researchers are qualified to administer First Aid (including CPR) and at least one team member with accredited training in 4WD recovery was present during field operations.

The detection dogs deployed during field surveys are professionally trained not to be a threat to humans, domestic pets, livestock or wildlife. The dogs are also regularly checked and treated against ticks, as well as being insured in the possible event of a snake bite.

The Detection Dogs for Conservation team, TMR and the Gympie Regional Council have been in constant communication to ensure that no 1080 baiting had occurred in the areas where field surveys were conducted.

To ensure that no weeds, or their seeds, were transported between locations, the detection dogs were brushed thoroughly before entering new properties/sites.

To minimise the risk of dog injury or loss during field surveys, deployed detection dogs were fitted with a GPS collar, and remained in full view of the handler and assistants at all times, with dog movements controlled by voice commands.

4- Survey methodology

4.1- General methodology

The primary dog handler and ecologist in charge of field surveys was Dr Romane Cristescu. Three additional dog handlers assisted Dr Cristescu with field surveys: Anthony Schultz (PhD candidate, University of the Sunshine Coast), Dan Nugent (Research assistant, University of the Sunshine Coast) and Russell Miller (Research assistant, University of the Sunshine Coast).

Upon arrival at the survey site and prior to the dog deployment, the location name and waypoint number (from the survey design) were recorded and the site and understorey complexity were photographed.

Most of the survey effort during this study involved the deployment of two koala scat detection dogs. The survey protocol follows the Koala Rapid Assessment Method (KRAM), which has been adapted for use with a detection dog as per Cristescu *et al.* (2015). At each survey site, 30 trees with a diameter at breast height of more than 10cm were searched for the presence of koala scats using the detection dog.

4.3- Scat identification

Dr Cristescu has 10 years of experience in conducting koala scat searches and has published a paper focusing on koala scats (Cristescu, Goethals et al. 2012). This allows high certainty in koala scat identification in the event of a detection. Typical koala scats have the following characteristics (Figure 3): symmetrical and bullet shaped (not jelly bean shaped), generally about 15 x 5 millimetres (adult koala scat size), evenly sized and composed of fine plant matter particles with an absence of insect parts (koalas do not eat insects) and well compacted.

Figure 3. Koala scats (A.) and their different widths (B.).

Utilisation rates for each site were calculated by dividing the number of trees identified to have koala scats by the total number of trees searched (N = 30).

The age class of scats and size were recorded to build a picture of when sites were last used by koalas (recently or not) as well as whether individuals of different sizes used the sites. Scats found during surveys were also photographed.

Figure 5. Fresh scats

5- Data Analyses

All mapping products such as koala presence/absence locations and habitat utilisation rates have been generated using ArcGIS 10.3.1 to allow geographical interpretation of the results. Utilisation rate (number of trees where scat was detected / 30 trees searched) proportions were generated using Microsoft Excel 2016 and subsequently presented in ArcGIS 10.3.1 for interpretation. All additional descriptive statistics have been generated using Microsoft Excel 2016.

6- Results

6.1- Field work surveys

We surveyed a total of 155 sites within the impact zone for the presence of koala scats, in addition to which we had eight opportunistic / incidental sites.

Surveys were located in verified koala (64 sites), in unverified koala habitat (52 sites) or outside of koala habitat (39 sites).

6.2- Koala presence

Across the 155 sites surveyed, we identified 35 sites positive for koala scat presence (23%), and, by definition, the eight incidental sightings had koala presence (Figures 6A, 6B, 6C and 6D).

Sites in verified koala habitat had koala presence detected in 34.4% of them (22 positive sites, 64 sites searched), 21.2% of sites in unverified koala habitat had koala presence (11 positive sites, 52 sites searched) and 5.1% of sites outside of koala habitat had koala presence (2 positive sites, 39 sites searched).

We searched 4560 individual trees. Koala scats were found across a total of 173 trees. In positive sites, the number of trees with at least one scat present varied from 1 to 16, with on average 4.9 trees with scats (± 3.9). Of the 173 trees with koala scats, 121 trees (69.9%) were located in verified koala habitat, 50 trees were located in unverified koala habitat (28.9%) and two were located outside of koala habitat (1.2%).

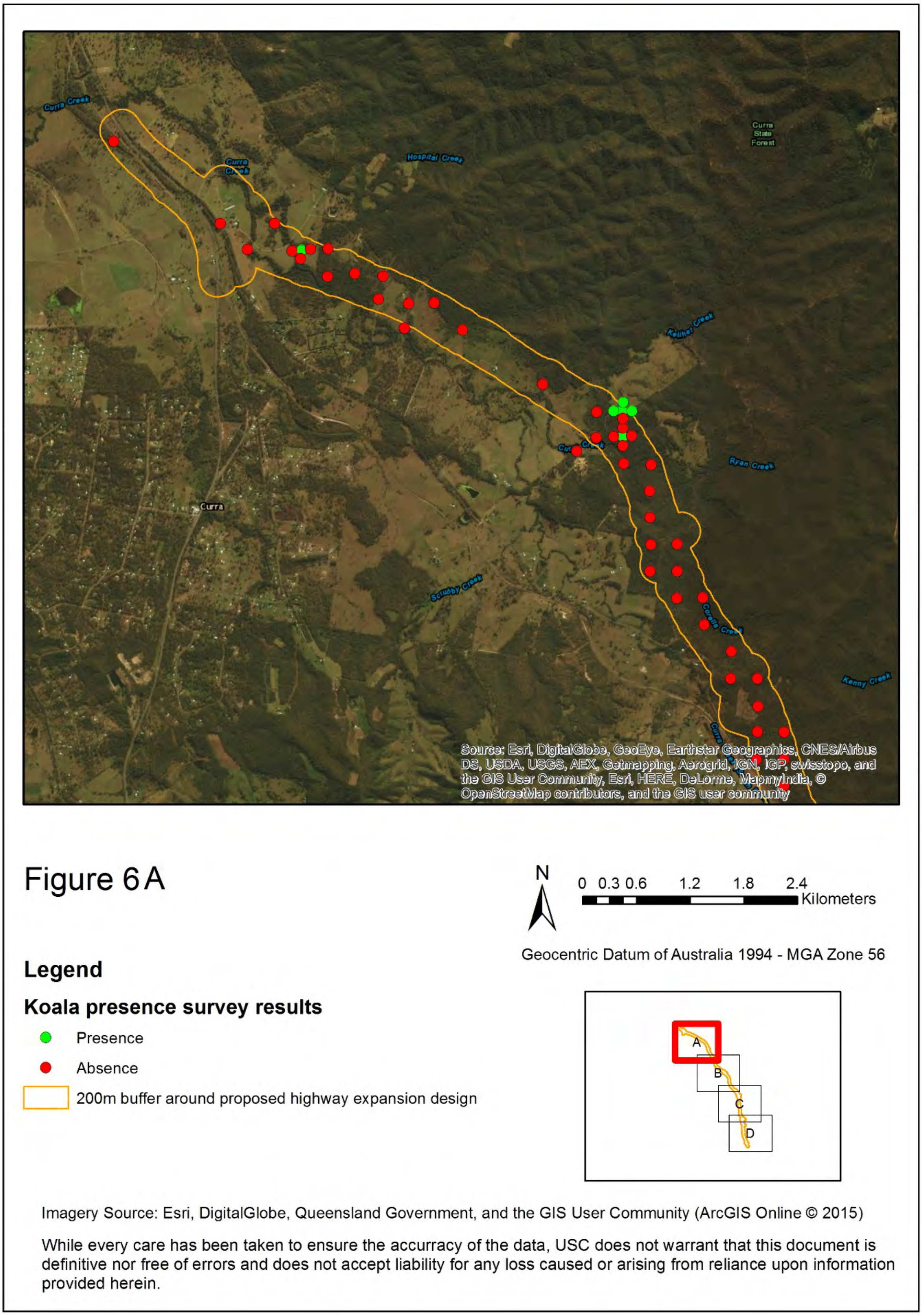


Figure 6A. **Survey site locations of koala presence (green) and absence (red).**

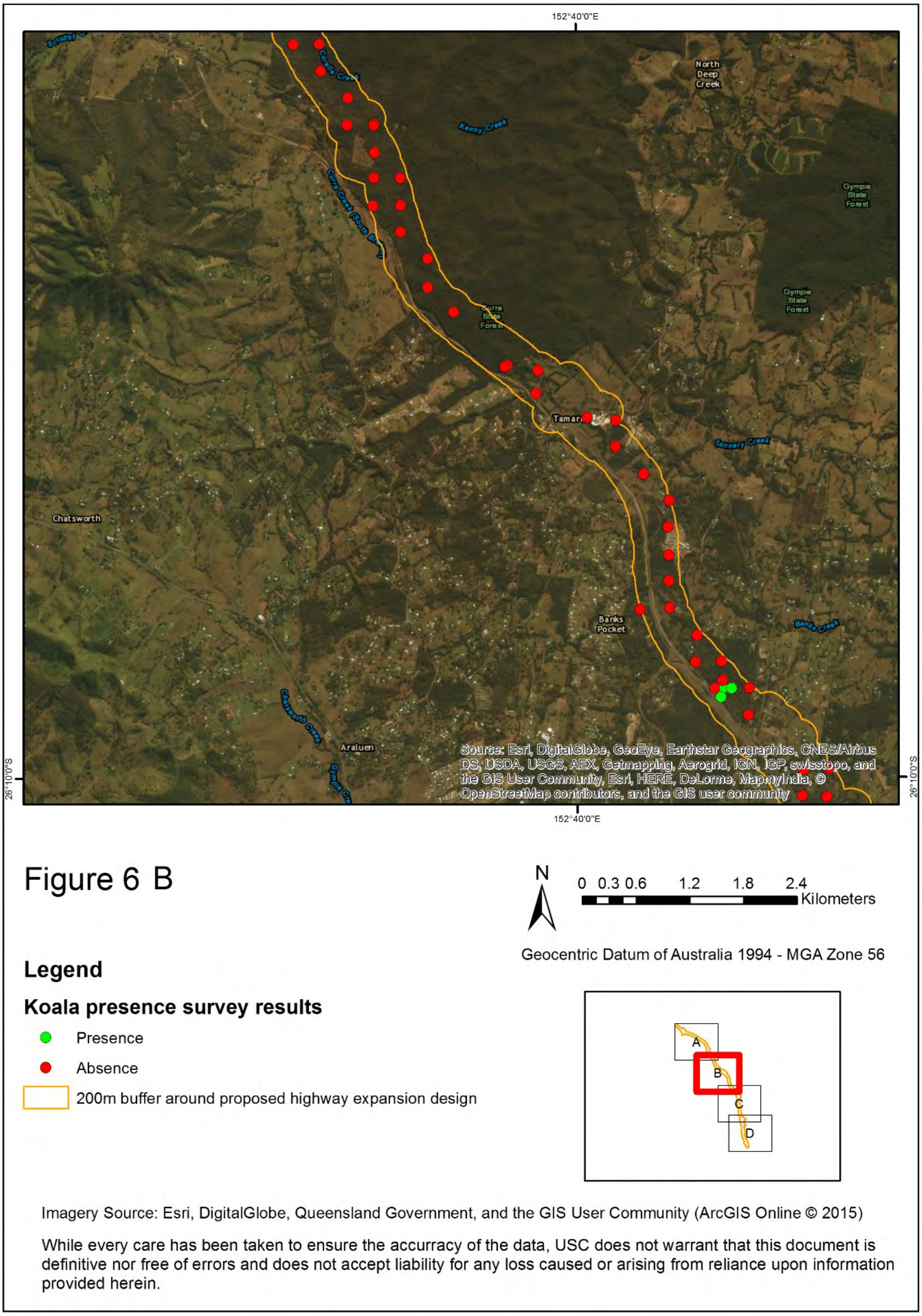


Figure 6B. **Survey site locations of koala presence (green) and absence (red).**

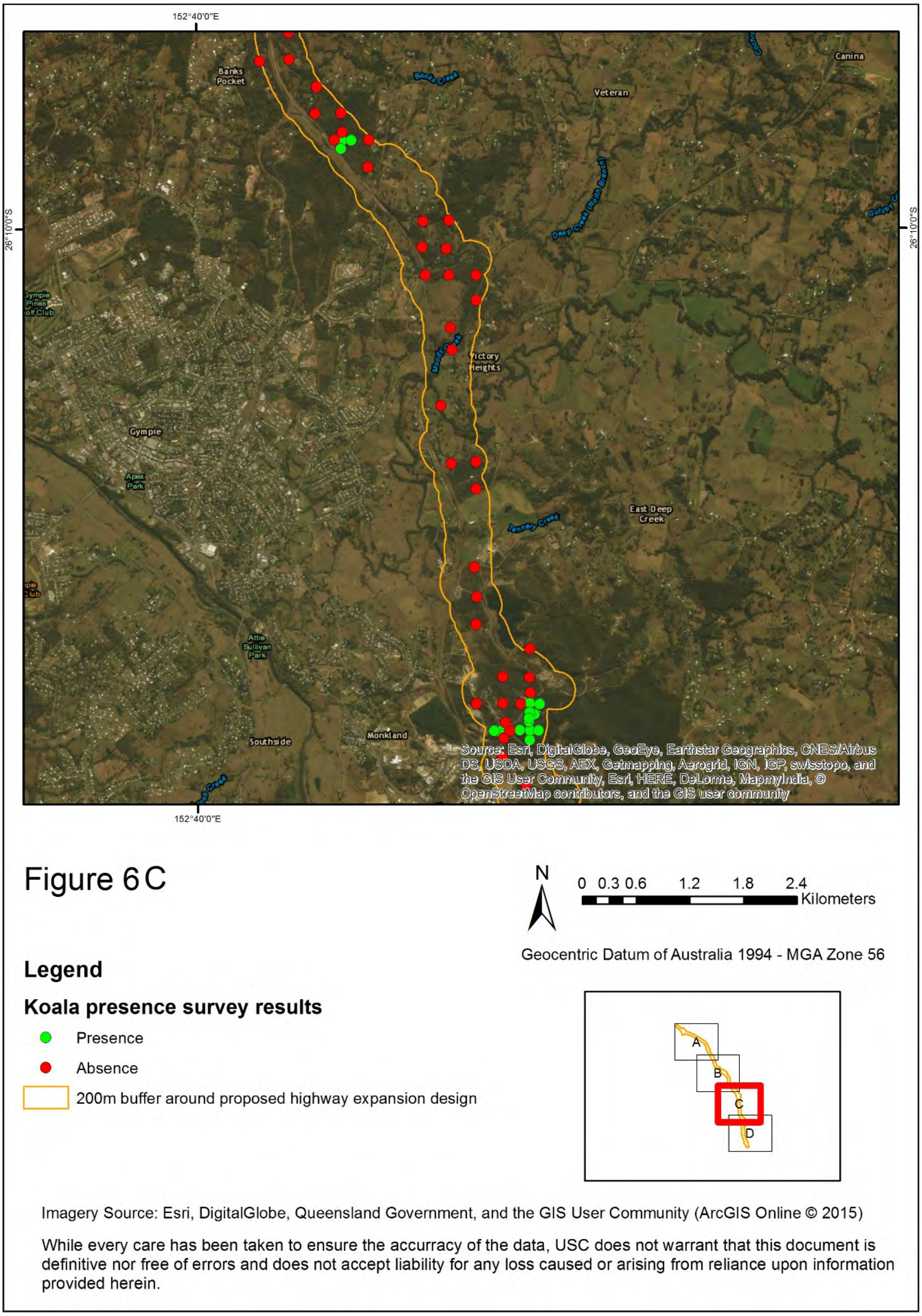


Figure 6C. **Survey site locations of koala presence (green) and absence (red).**

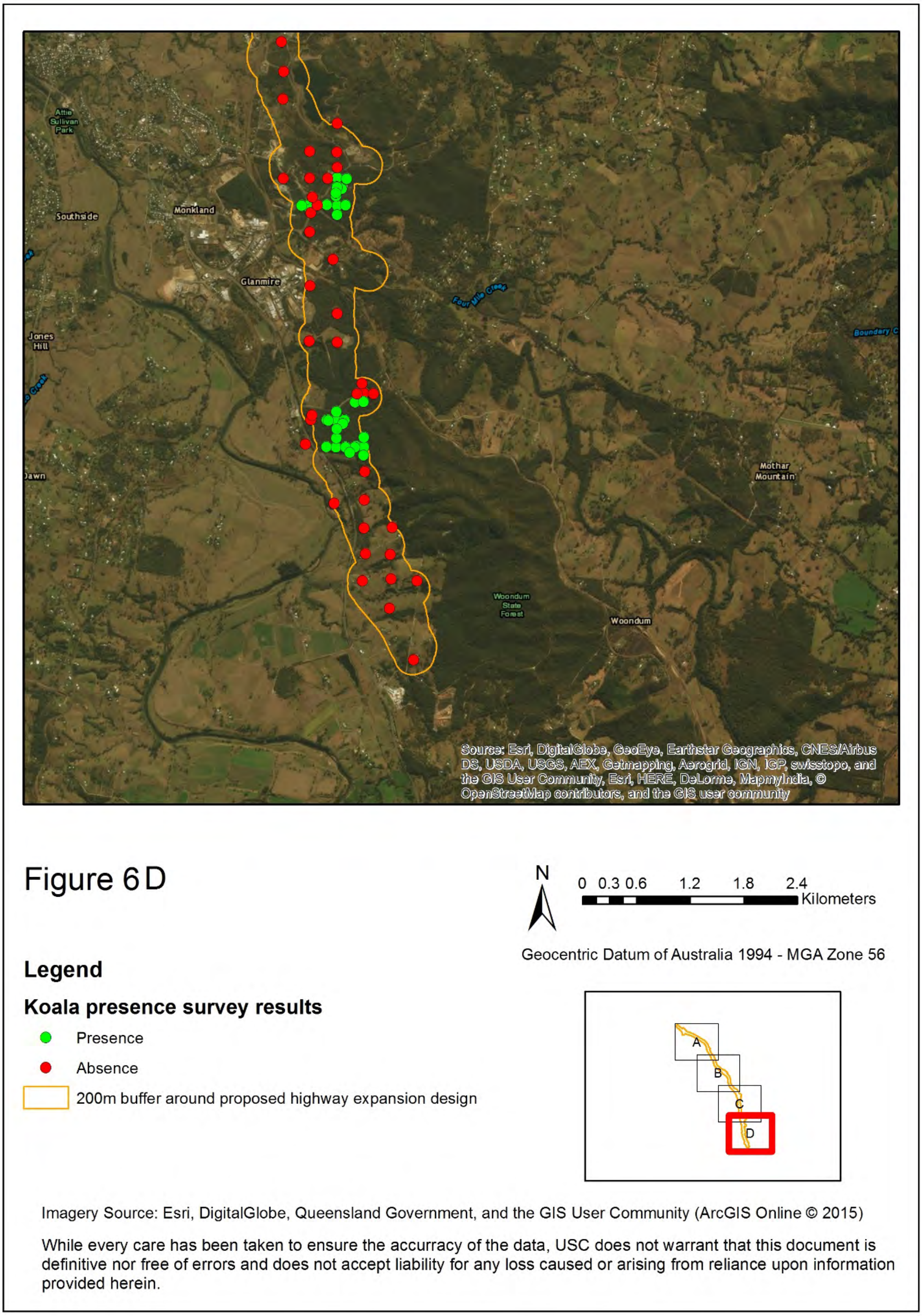


Figure 6D. **Survey site locations of koala presence (green) and absence (red).**

6.3- Utilisation rates

In koala surveys, the utilisation rate (sometimes referred to as "activity level" (Phillips and Callaghan 2011)) is defined as the number of trees under which scats are found (that is, trees that are utilised by koalas for either shelter or food), divided by the total number of trees searched per site, here N=30). The utilisation rate per site ranged from 0% (not utilised) to 53% (Figures 7A, 7B, 7C and 7D). The average utilisation rate for surveys was 3.8% (± 9.4%).

Utilisation rates were 6.3% in verified koala habitat, 3.2% in unverified koala habitat and 0.2% outside of koala habitat.

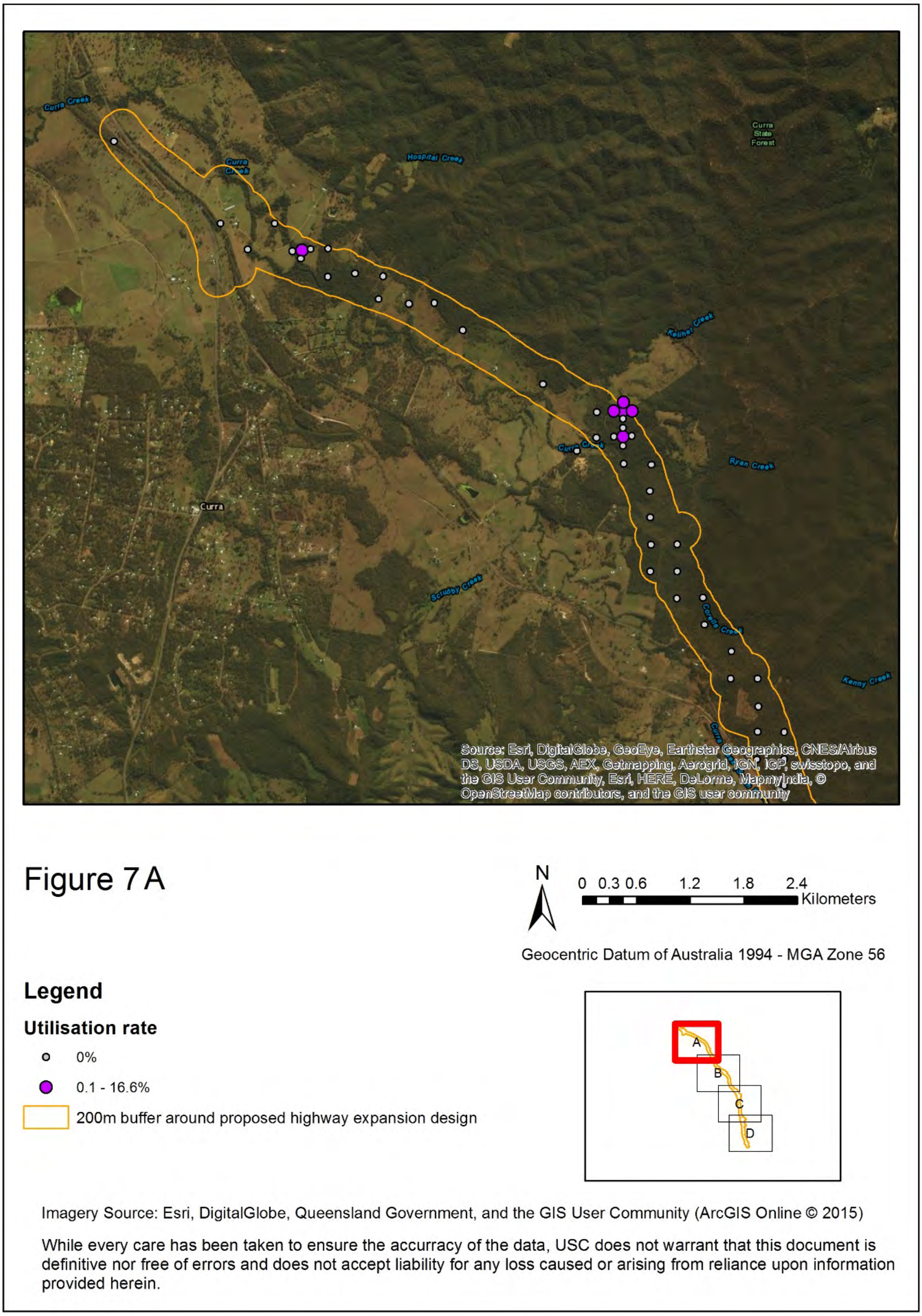


Figure 7A. **Koala habitat utilisation rates.**

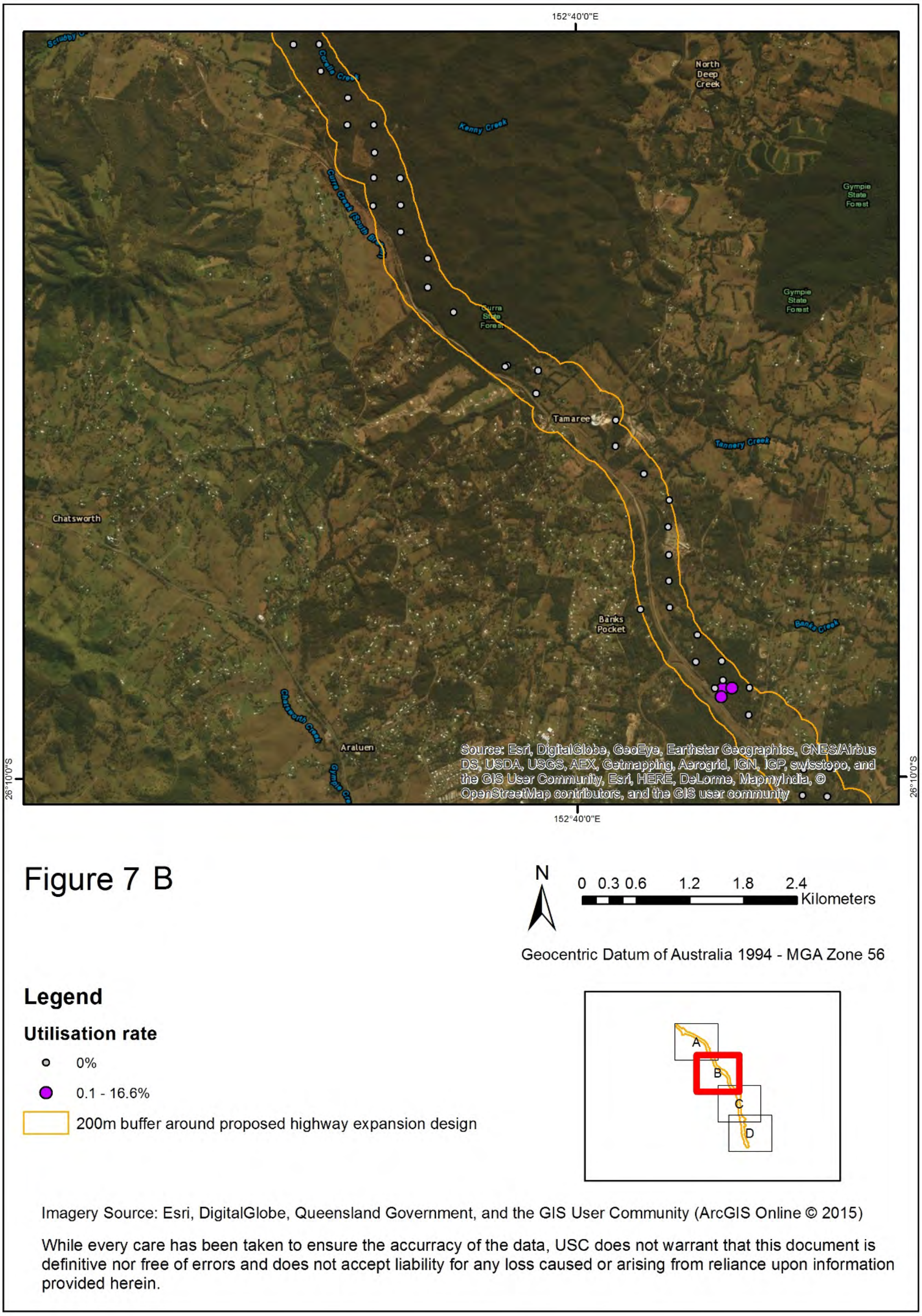


Figure 7B. **Koala habitat utilisation rates.**

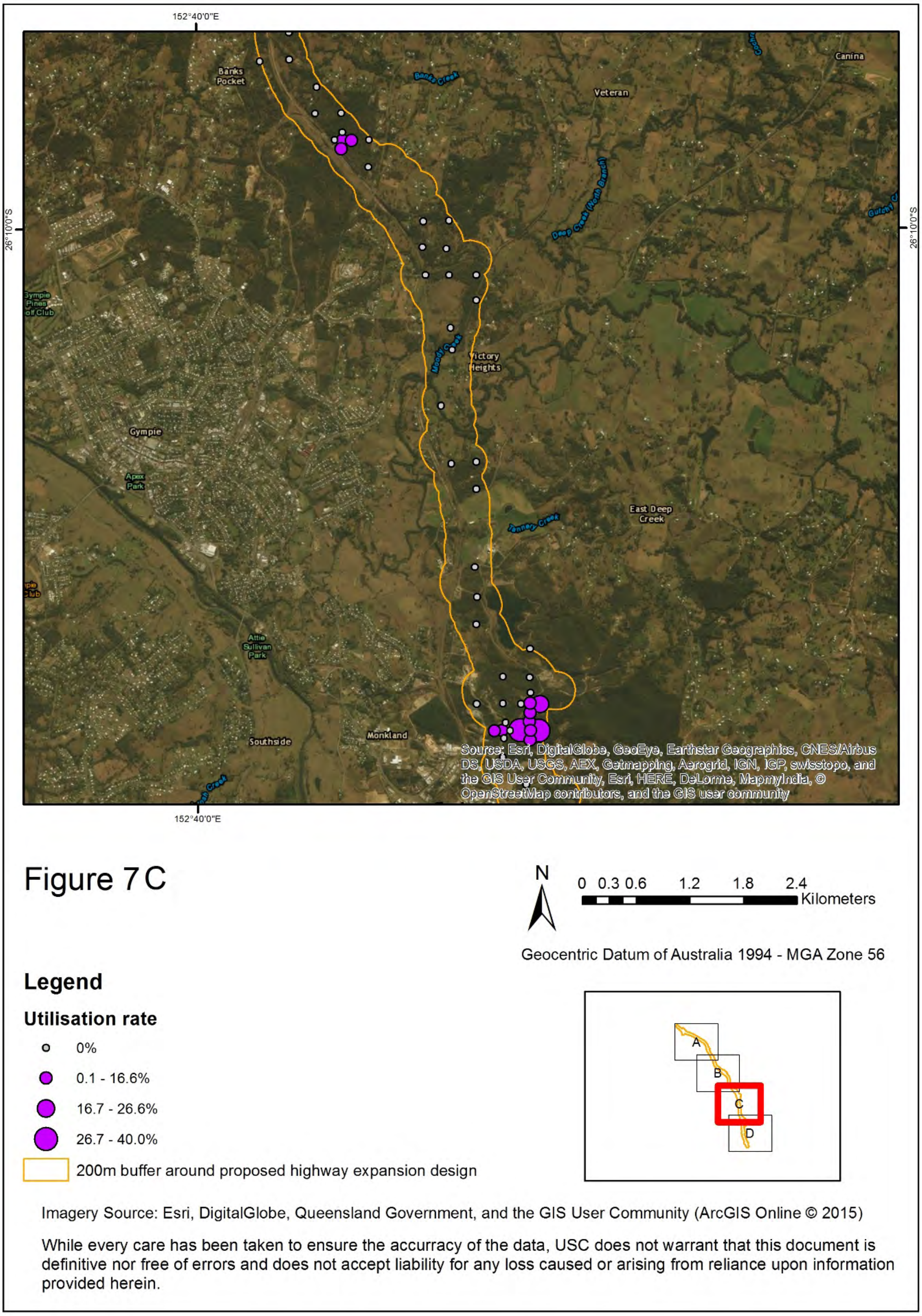


Figure 7C. Koala habitat utilisation rates.

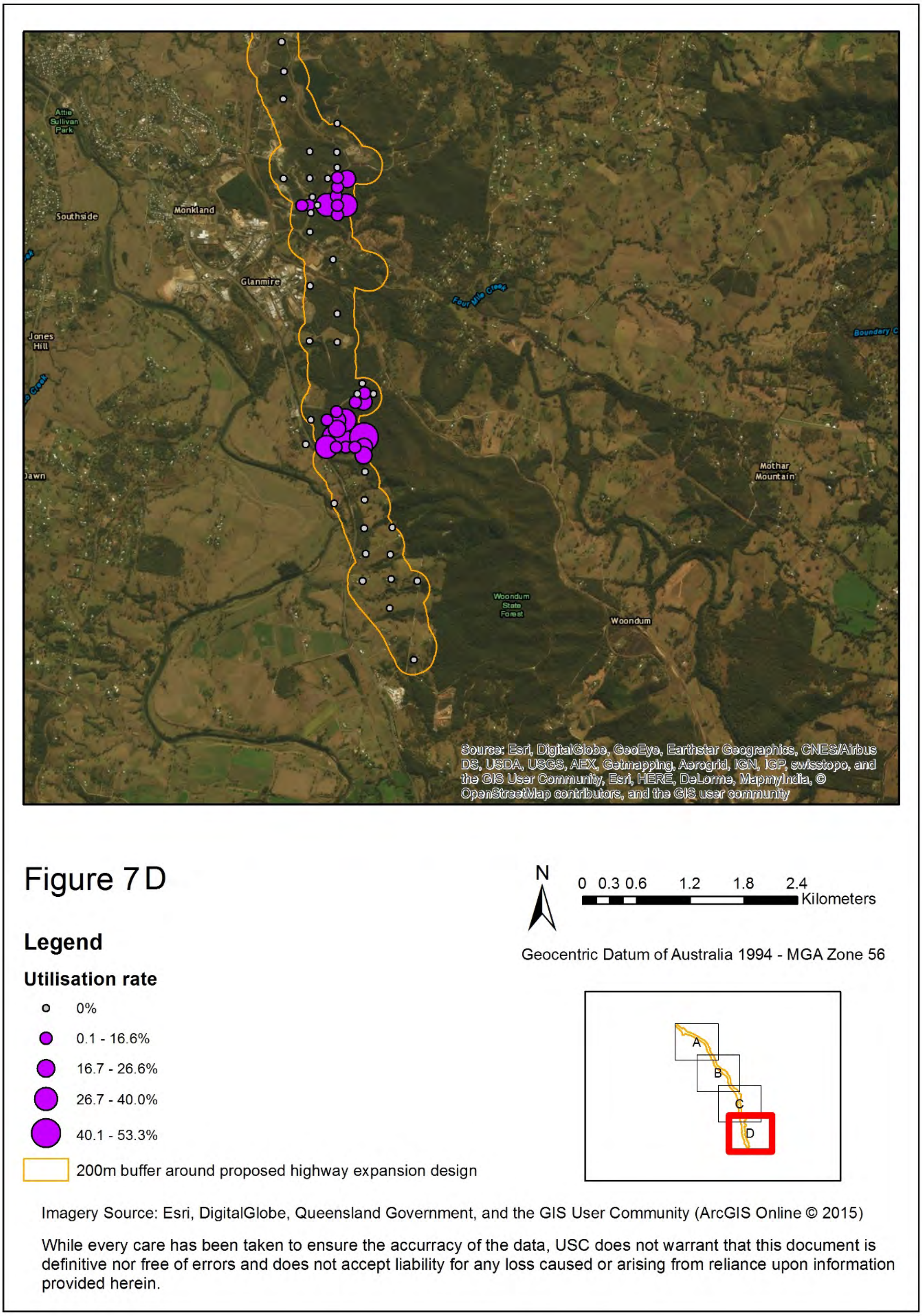


Figure 7D. **Koala habitat utilisation rates.**

Our results show that koalas are utilising habitat in five regions located within the impact zone (Figures 7A, 7B, 7C and 7D). Of these, utilisation rate appears to be highest at four locations (from north to south):

- Curra State Forest (close to Curra Creek, especially private properties along Brunjes road, Figure 8A),
- A property in Banks Pocket (between Belvedere and Sandy Creek roads, Figure 8B),
- Two areas in the southern end of the Section D impact zone: these locations include private properties along Penny Road (Mothar Mountain, Figure 8C) and the north-east corner of Woondum State Forest along and South of Keefton Road (Figure 8D).

The two most southern locations are the most extensively used.

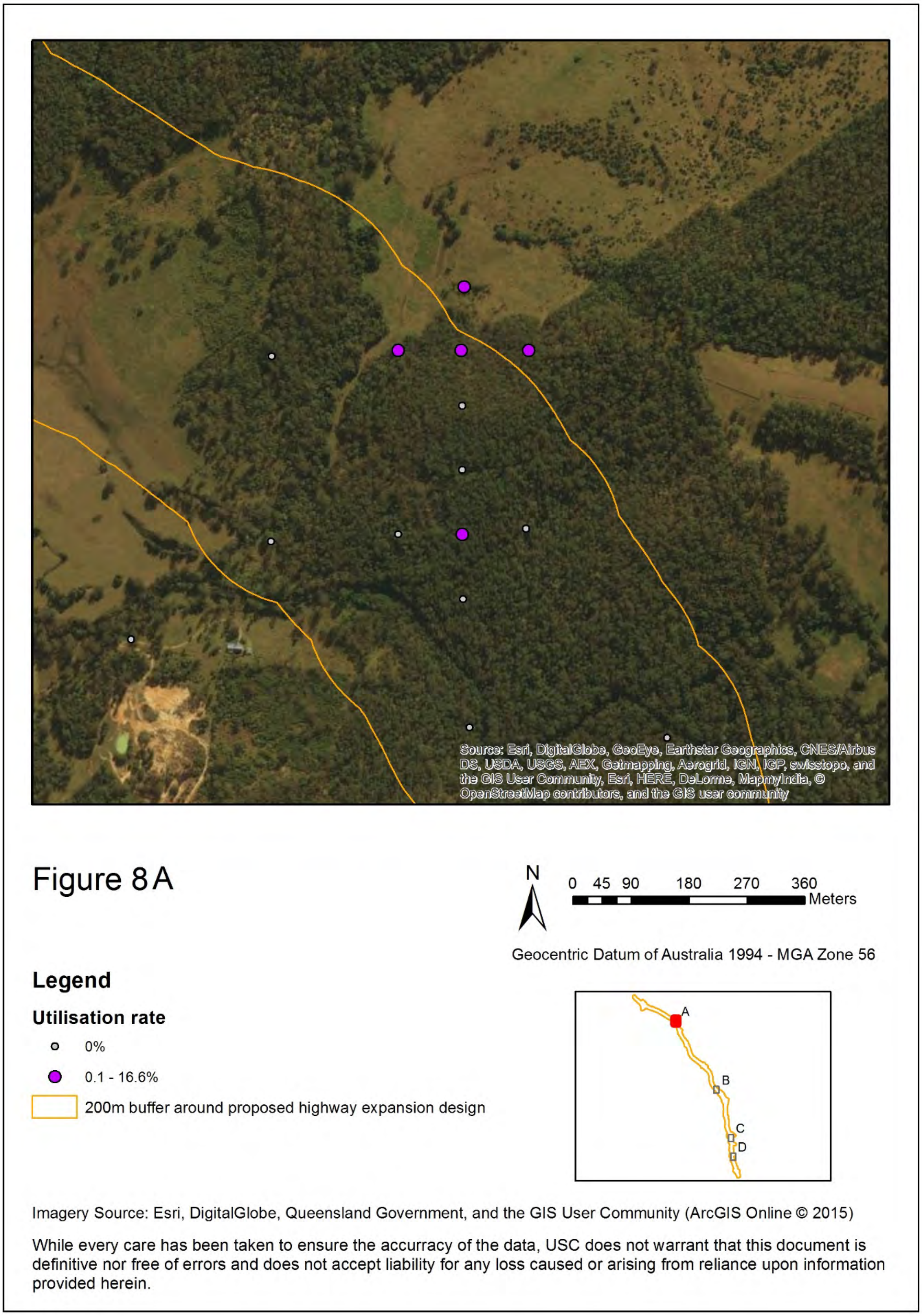


Figure 8A. **Survey site locations where highest koala habitat utilisation was found.**

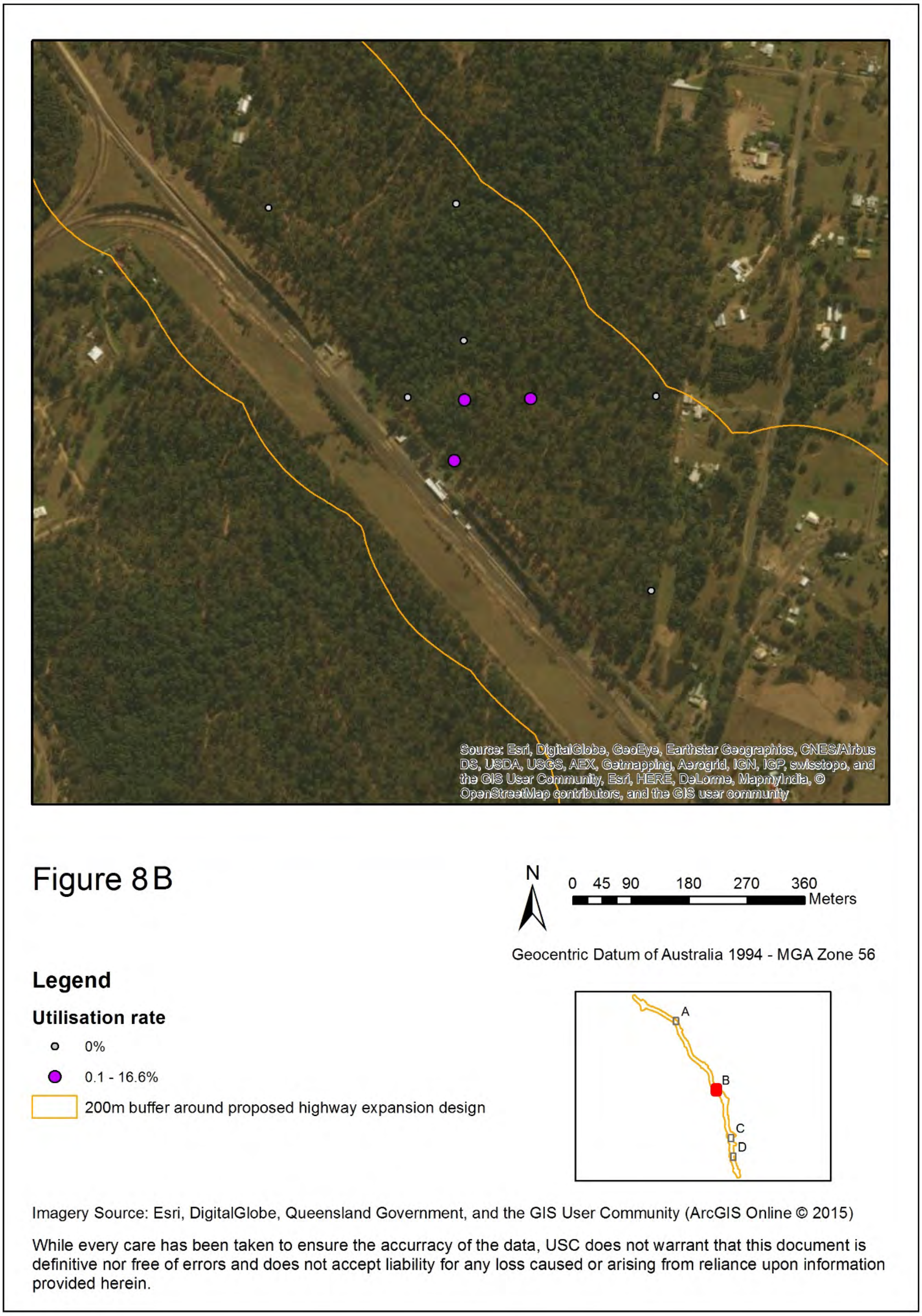


Figure 8B. **Survey site locations where highest koala habitat utilisation was found.**

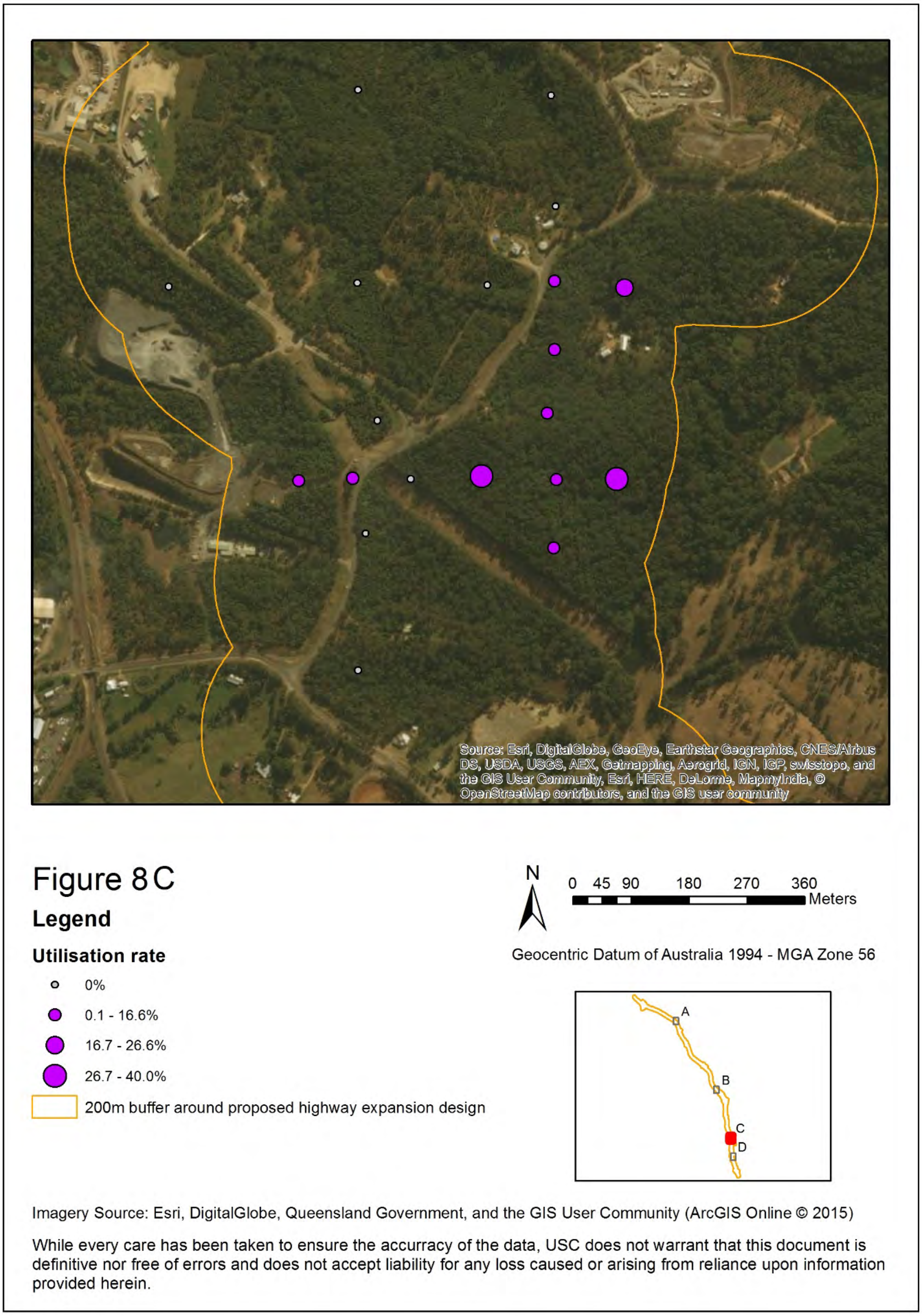


Figure 8C. **Survey site locations where highest koala habitat utilisation was found.**

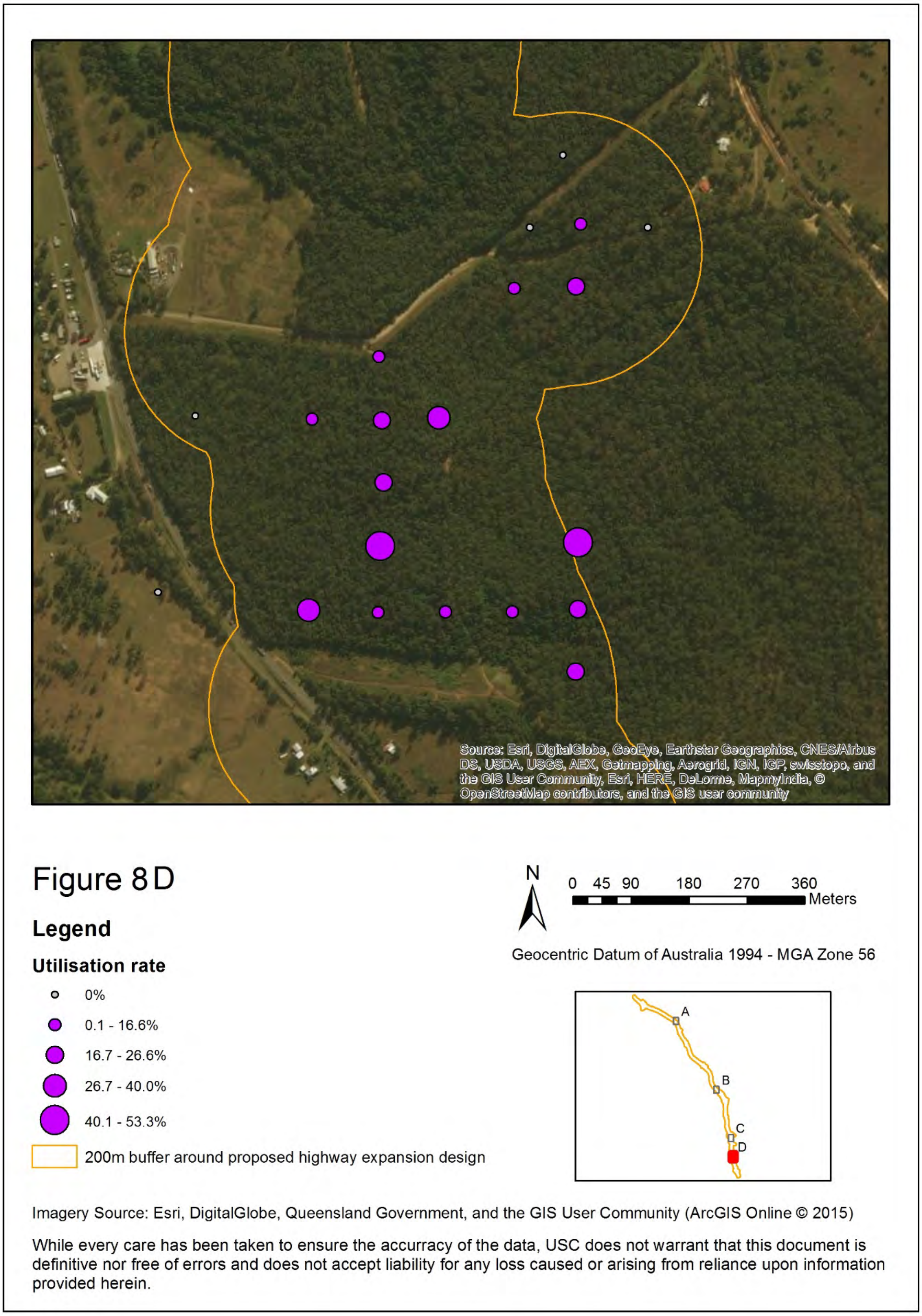


Figure 8D. **Survey site locations where highest koala habitat utilisation was found.**

6.4- Scat density and characteristics

The age of scats found during these surveys have ranged from extremely fresh to very old and discoloured, indicating both recent and historical use within the impact zone (Figures 9A, 9B, 9C and 9D). In particular, we found 20 sites (57.1% of all positive sites) with signs of repetitive use in time (e.g. old and fresh koala scats).

The age of the scats also showed that 18 sites (11.7 % of all sites) were found to have either fresh or extremely fresh scat, which indicates very recent use by koalas.

For the trees that had more than one pellet, the scats were of different sizes in 9% of the cases, indicating that these trees might have been used by different individual koalas.

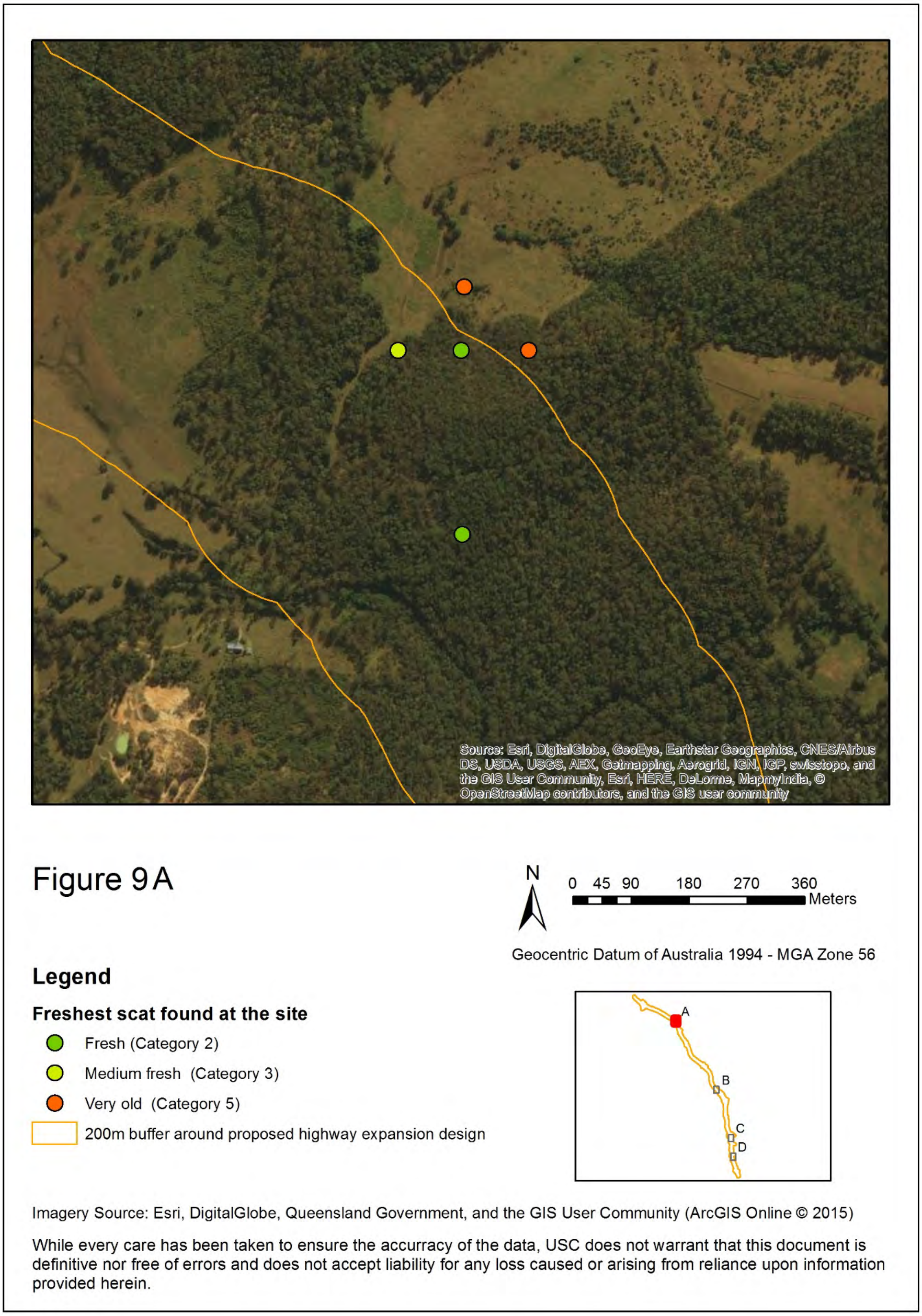


Figure 9A. Ages of the scats in the four main locations where koalas were present.

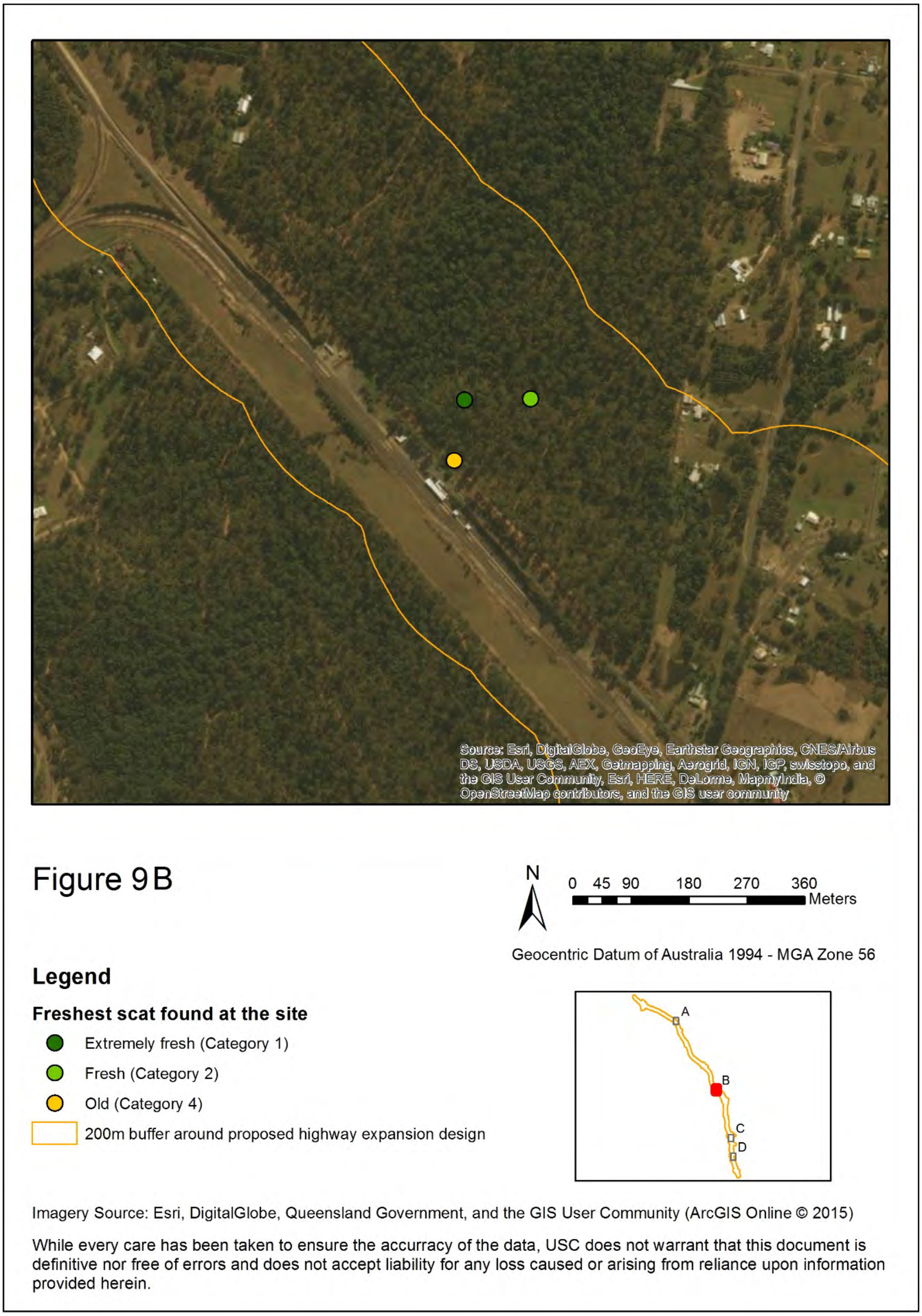


Figure 9B. **Ages of the scats in the four main locations where koalas were present.**

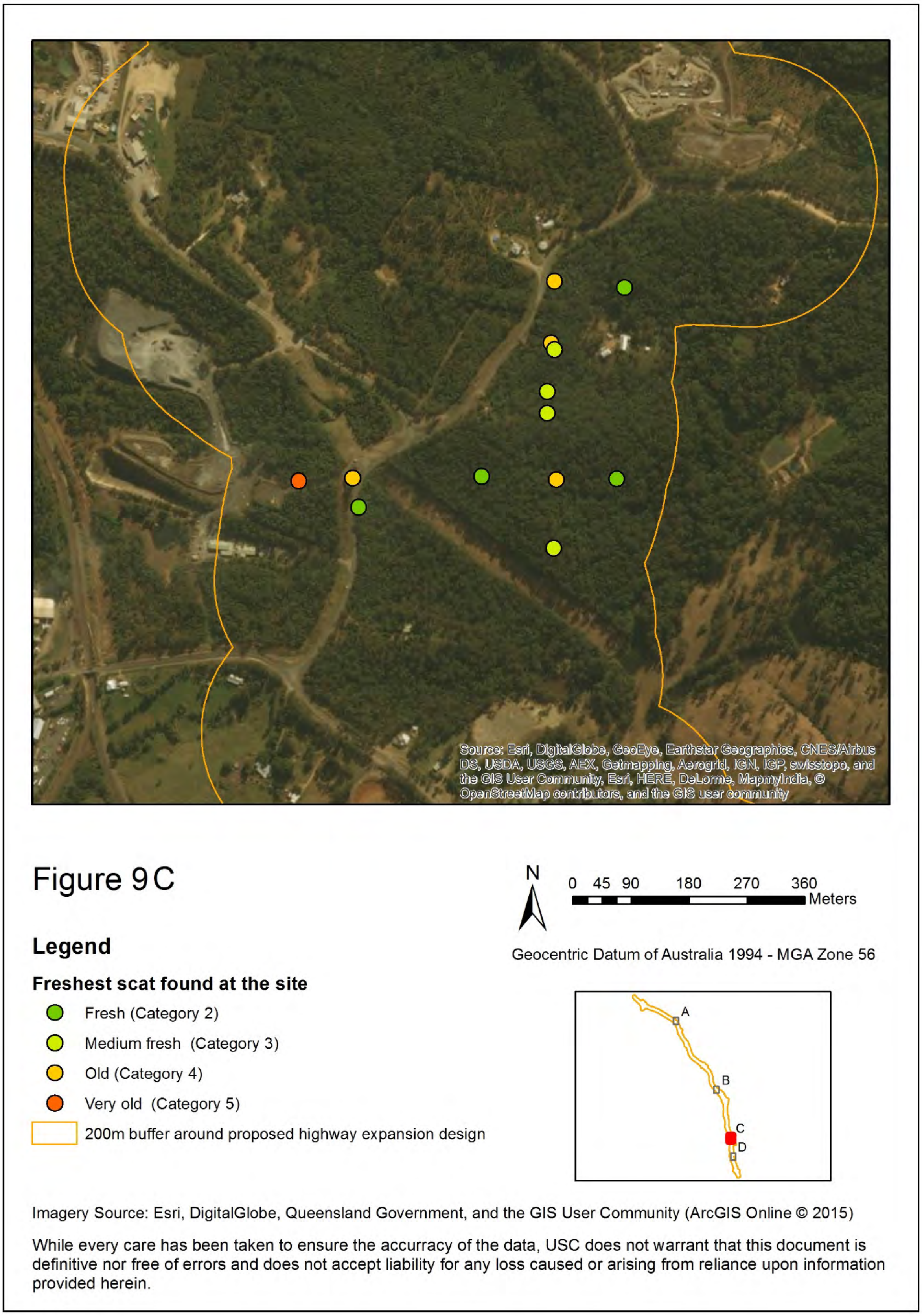


Figure 9C. **Ages of the scats in the four main locations where koalas were present.**

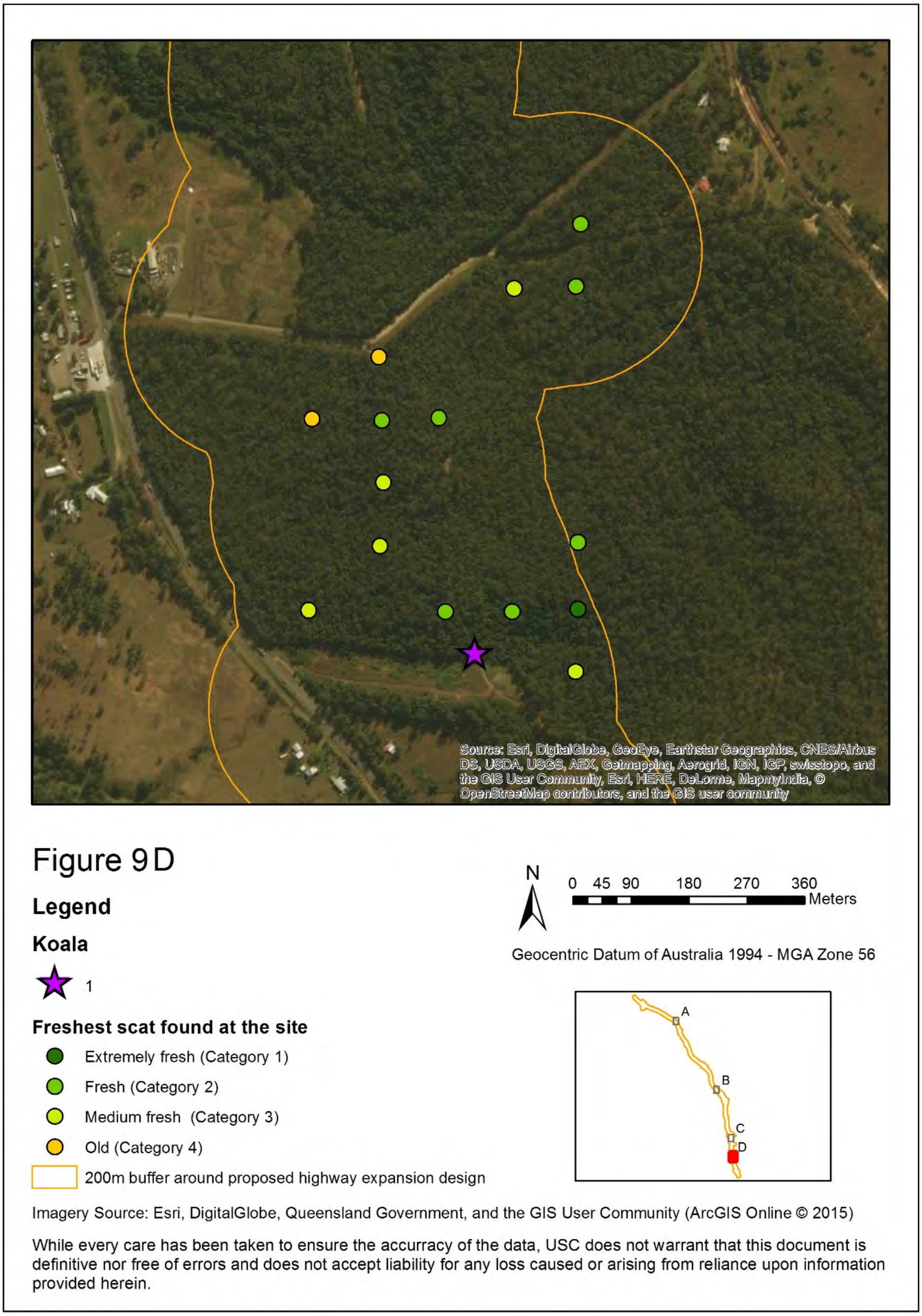


Figure 9D. **Ages of the scats in the four main locations where koalas were present.**

6.5- Koala sightings

Despite the presence of koala scats at 35 of the 155 sites surveyed, no koala was physically observed at any of the sites surveyed, though this is not unusual given their cryptic nature. One koala was observed in between survey sites on the 21st August 2016 in Woondum State Forest (Figure 10).

Figure 10. Koala observed in Section D

References

Cristescu, R. H., E. Foley, A. Markula, G. Jackson, D. Jones and C. Frère (2015). "Accuracy and efficiency of detection dogs: a powerful new tool for koala conservation and management." Scientific Reports **5**.

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JACOBS (2015). Flora and Fauna. In Review of Environmental Factors (Business Case). Report prepared for the Queensland Department of Transport and Main Roads (TMR).

Phillips, S. and J. Callaghan (2011). "The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas *Phascolarctos cinereus*." Australian Zoologist **35**(1): 774-780.

Appendix K – *MNES Significant Impact Assessment Report*, *Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016d)

Department of Transport and Main Roads

Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)
Job No. 232/10A/7, Invitation No. WBYD-1335

MNES Significant Impact Assessment Report

April 2017

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Appendices

Executive summary

The Department of Transport and Main Roads has submitted an *Environment Protection and Biodiversity Conservation Act 1999* referral prepared for the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project. This *Matters of National Environmental Significance (MNES) Significant Impact Assessment Report* has been prepared to support the referral by presenting all available data relating to each of the matters of national environmental significance 'known' or 'likely' to occur within the survey area. Each section includes a detailed synopsis of the following information for each MNES:

- General information on the conservation status, distribution, habitat preferences and population estimates.
- A summary of the targeted field survey effort undertaken for flora, fauna and aquatic MNES over the course of the project to date.
- Records of each MNES from either baseline ecological surveys (BAAM, 2015; FRC Environmental in Jacobs, 2016) or targeted 2016 surveys (ERM, 2016; BAAM, 2016; GHD, 2016a; GHD, 2016b; USC, 2016) and available online database records.
- Suitability and extent of habitat within the project area and survey area for MNES.
- A description of breeding, foraging and dispersal habitat for MNES fauna species.
- Whether habitat within the project area has been assessed as 'habitat critical to the survival of the species' in accordance with the National recovery plan for the species (where available).
- Whether the survey area contains an 'important population' of a species in accordance with the National recovery plan for the species (where available).
- A description of measures for avoidance, reduction of impacts or mitigation measures applicable to each species.
- An assessment against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) to confirm if the project is anticipated to result in a significant residual impact on individual MNES after the application of mitigation measures.
- A description of offset strategies applicable to a species where a significant residual impact is anticipated to occur. As stated in the *EPBC Act Environmental Offsets Policy, 2012* a residual impact is the remaining impact following avoidance and mitigation measures (DSEWPC, 2012). Offsets are only required where the residual impact is significant (DSEWPC, 2012).

The results of the significant impact assessments identified that the project has the potential to have a significant impact on the following MNES and therefore offset strategies have been proposed for each of the following MNES:

- Black-breasted button-quail (*Turnix melanogaster*)
- Koala (*Phascolarctos cinereus*)
- Lowland Rainforest of Subtropical Australia TEC

A summary of whether the project area supports habitat critical to the survival of the species, whether the locally occurring population is considered an important population for the species, and whether the project will result in a significant impact to the MNES is provided in Table 1 below.

Table 1 Significant impact assessment summary

Matter of National Environmental Significance	Habitat critical to the survival of the species within the project area	Important population present	Significant impact	Offset proposed
Black-breasted button-quail	Yes (loss of 8.14 ha)	Unlikely	Yes	Yes
Koala	Yes (loss of 138.44 ha)	Yes	Yes	Yes
Greater glider	Unlikely	Unlikely	Unlikely	No
Grey-headed flying-fox	Unlikely	No	Unlikely	No
Migratory species	Unlikely	No	Unlikely	No
Mary River cod	Yes (Six Mile Creek)	Yes	Unlikely	No
Mary River turtle	Unlikely	Unlikely	Unlikely	No
White-throated snapping turtle	Unlikely	Unlikely	Unlikely	No
Macrozamia pauli-guilielmi	Yes (loss of 7.85 ha)	Yes	Unlikely	No
Lowland rainforest of subtropical Australia TEC	Yes (loss of 5.49 ha at Six Mile Creek and 0.52 ha at Woondum State Forest)	N/A	Yes	Yes

1. Introduction

1.1 Purpose of this report

This *MNES Significant Impact Assessment Report* has been prepared to support the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral prepared for the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project (herein referred to as the 'project' and shown in Figure 1). The purpose of this document is to individually present all available data relating to each of the matters of national environmental significance (MNES) 'known' or 'likely' to occur within the survey area (as defined in the EPBC Act referral documentation to which this report forms an appendix). Each section includes a detailed synopsis of the following information for each MNES:

- General information on the conservation status, distribution, habitat preferences and population estimates.
- A summary of the targeted field survey effort undertaken for flora, fauna and aquatic MNES over the course of the project to date.
- Records of each MNES from either baseline ecological surveys (BAAM, 2015; FRC Environmental in Jacobs, 2016) or targeted 2016 surveys (ERM, 2016; BAAM, 2016; GHD, 2016a; GHD, 2016b; USC, 2016) and available online database records.
- Suitability and extent of habitat within the project area and survey area for MNES.
- A description of breeding, foraging and dispersal habitat for MNES fauna species.
- Whether habitat within the project area has been assessed as 'habitat critical to the survival of the species' in accordance with the National recovery plan for the species (where available).
- Whether the survey area contains an 'important population' of a species in accordance with the National recovery plan for the species (where available).
- A description of measures for avoidance, reduction of impacts and specific mitigation measures applicable to each species.
- Generic mitigation measures have been included in Appendix A, Appendix B and Appendix C for terrestrial fauna, aquatic fauna and terrestrial flora respectively.
- An assessment against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) to confirm if the project is anticipated to result in a significant residual impact on individual MNES after the application of mitigation measures.
- A description of offset strategies applicable to a species where a significant residual impact is anticipated to occur. As stated in the *EPBC Act Environmental Offsets Policy, 2012* a residual impact is the remaining impact following avoidance and mitigation measures (DSEWPC, 2012). Offsets are only required where the residual impact is significant (DSEWPC, 2012).

1.2 Applicable species

This report addresses the following MNES that were assessed as either 'known' or 'likely to occur' in the project area during technical studies commissioned for the project (ERM, 2016; BAAM, 2016; GHD, 2016a; GHD, 2016b; USC, 2016).

The species assessed during field investigations as having either the 'potential to occur' or being 'unlikely to occur' within the survey area have a lower probability of being impacted by the proposed works, as the species has not been recorded within 10 km of the project (based on desktop assessments) or the project is not within the species distribution. In this regard, the impacts to these species are anticipated to be insignificant and no further assessment of the potential impacts to these species is provided in this document. The species applicable to this document include:

Terrestrial fauna

Known to occur

- Black-breasted button-quail (*Turnix melanogaster*)
- Koala (*Phascolarctos cinereus*)
- Greater glider (*Petauroides volans*)

Likely to occur

- Grey-headed flying-fox (*Pteropus poliocephalus*)

Migratory birds

Known to occur

- Spectacled monarch (*Symposiachrus trivirgatus*)
- Rufous fantail (*Rhipidura rufifrons*)
- Rainbow bee-eater (*Merops ornatus*)
- Fork-tailed swift (*Apus pacificus*)
- Cattle egret (*Ardea ibis*)

Likely to occur

- Black-faced monarch (*Monarcha melanopsis*)
- White-throated needletail (*Hirundapus caudacutus*)
- Common sandpiper (*Actitis hypoleucos*)
- Latham's snipe (*Gallinago hardwickii*)
- Eastern great egret (*Ardea modesta*)

Aquatic fauna

Known to occur

- Mary River cod (*Maccullochella mariensis*)
- White-throated snapping turtle (*Elseya albagula*)

Likely to occur

- Mary River turtle (*Elusor macrurus*)

Flora

Known to occur

- *Macrozamia pauli-guilielmi* (pineapple zamia)

Threatened ecological communities

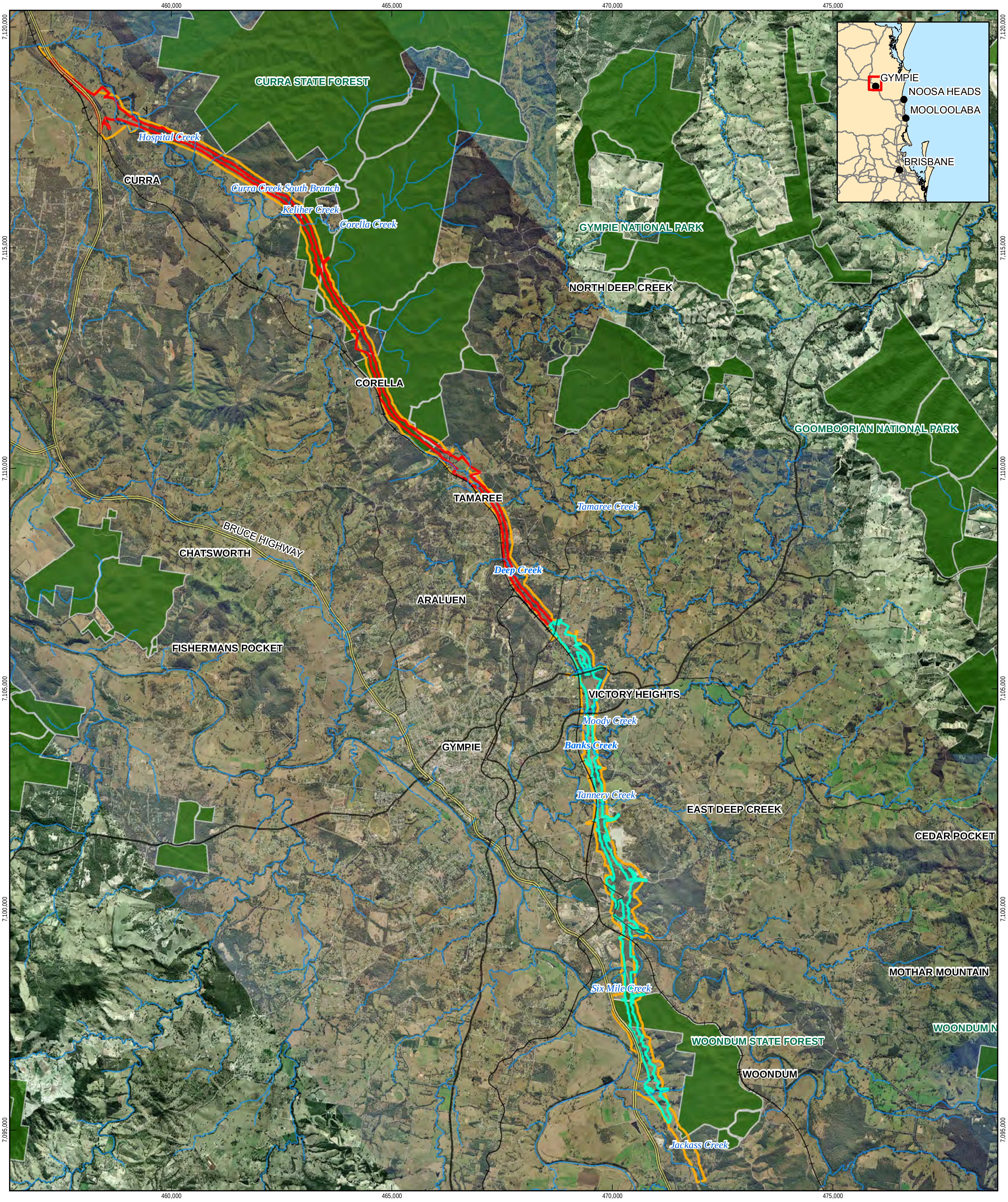
Known to occur

- Lowland Rainforest of Subtropical Australia

1.3 Scope and limitations

This report has been prepared by GHD for the Department of Transport and Main Roads (TMR) and may only be used and relied on by TMR and the Department of the Environment and Energy for the purpose agreed between GHD and TMR as set out in Section 1.1 of this report. GHD otherwise disclaims responsibility to any person other than TMR arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. GHD has prepared this report on the basis of information provided by TMR and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.



LEGEND

Town	Secondary Road	**Project Area**
Watercourse	Local Connector Road	Contract 1
Railway	Street/Local Road	Contract 2
Highway	Survey Area	Protected Areas

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number | 41-29914
Revision | 0
Date | 12 Apr 2017

Locality Plan

Figure 1

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6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: GA: Town (2014); TMR: Aerial Imagery (2016), Survey Area (2016); DNRM: Railway, Watercourse (2014), Road (2016). GHD: Project Area (March 2017). Created by: SC

2. Black-breasted button-quail (*Turnix melanogaster*)

2.1 Conservation status and documentation

2.1.1 Conservation status

The black-breasted button-quail (*Turnix melanogaster*) is listed as 'vulnerable' under the EPBC Act. The species' vulnerable status is attributed to the species' restricted area of occupancy and the historical loss and ongoing threat to its' habitat.

2.1.2 Threats to the species

Historically, the black-breasted button-quail has been subject to widespread habitat loss resulting from vegetation clearing for agriculture. This has resulted in a loss of approximately 90% of the species' habitat across its range, being reduced from several hundred thousand to only a few thousand hectares by the 1960's (Hamley *et al*., 1997). This species is endemic to eastern Australia, its known distribution extends from Byfield north of Rockhampton, south to the New South Wales border (DEE, 2016b). Given the extent of its habitat loss, it is considered likely that the remaining habitats across its distribution are highly fragmented.

Current threats to the species are attributed to degradation of habitat by livestock and feral pigs (*Sus scrofa*), degradation and loss of habitat due to inappropriate fire regimes (i.e. high intensity or frequency) and predation by feral animals such as feral pigs (*Sus scrofa*), cats (*Felis catus*) and foxes (*Vulpes vulpes)* (Mathieson and Smith, 2009).

2.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessments for this species:

- *EPBC Act Survey Guidelines for Australia's Threatened Birds* (DEWHA, 2010a)
- *Terrestrial Vertebrate Survey Guidelines for Queensland* (DSITIA, 2014)
- *The National Recovery Plan for the Black-breasted button-quail* (Mathieson and Smith, 2009)

2.2 Targeted survey effort

2.2.1 Recommended survey methods

The species is usually detected by observation of birds that flush or walk away after being disturbed. Birds may also be detected by the sound of their scratching when foraging in the leaf litter. Platelets may indicate presence of this taxon but is not conclusive as these are also made by other button-quail species (M. Mathieson & G. Smith, pers. comm.). Call playback has been used to survey for black-breasted button-quail, but the effectiveness of this method is uncertain.

EPBC Act Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010) for the species recommends land-based area searches to flush individuals and detect platelets. A survey effort of 15 person hours over at least three days is recommended for areas less than 50 ha.

2.2.2 Survey effort

Targeted surveys for the black-breasted button-quail were undertaken by BAAM (2015) within the project area and survey area during baseline ecological surveys and by ERM (2016) and

GHD (2016c) during targeted terrestrial fauna surveys. Targeted surveys for the species combined systematic area searches to flush individuals and locate feeding platelets, opportunistic searches for feeding platelets, dawn watches to identify foraging individuals, diurnal bird census surveys (i.e. 20 minute, 2 ha surveys) and the placement of remote surveillance cameras within suitable habitat. Targeted survey effort for the black-breasted button-quail is summarised in Table 2.

Table 2 Summary of survey effort for black-breasted button-quail

Survey methods	Survey	Survey effort undertaken
Methods recommended in EPBC Act survey guidelines		
Land-based area searches Recommended effort is total of 15 person hrs over three days for areas less than 50 ha	ERM, 2016	Total of 18 person hours over three events: • 4 February 2016 (2 ecologists x 2.5 hrs) • 25 February 2016 (4 ecologists x 2 hrs) • 26 February 2016 (4 ecologists x 1.25 hrs)
	BAAM, 2015	Opportunistic area searches in suitable habitat over five days of assessment (2 – 6 March, 2015)
Additional methods		
Point surveys to locate foraging individuals	ERM, 2016	Total of three person hours: (4 ecologists x 45 minutes)
Diurnal bird census (20 min survey of 2 ha area)	BAAM, 2015	Surveys (20 minute x 2 ha) at 39 sites
Remote surveillance cameras in strategic locations within the vicinity of observed platelets baited with finch seed	GHD, 2016c	Four cameras were set for three days (216 recording hours), with an additional two cameras set for two days (96 recording hours) at two locations within Curra State Forest. Two cameras were set for one day (48 recording hours) in Woondum State Forest.
Call play-back is mentioned as an optional method in the survey guidelines; however, the effectiveness of the method is considered uncertain.	Nil	N/A

2.3 Records

2.3.1 Desktop and field records

The black-breasted button-quail has been historically recorded from within the broader region according to Wildnet and Atlas of Living Australia (ALA) records and recently recorded during targeted surveys by BAAM (2015), ERM (2016) and GHD (2016c), refer to Table 3 and Figure 2.

Table 3 Black-breasted button quail records within the region

Source	Record
Wildnet / Atlas of Living Australia	Six Mile Creek Reserve, < 1 km west of the alignment (2006) Woondum National Park, 7.5 km south-east of the project area (1997) One Queensland Museum specimen collected from < 3 km west of the project area
Targeted field survey	Fresh feeding platelets of the black-breasted button-quail were observed within the project area during surveys undertaken by both BAAM (2015) and ERM (2016). Platelets were observed from nine locations within suitable habitat in Woondum State Forest (refer to Figure 2). All platelets were within vine thicket and surrounding woodland dominated by *Eucalyptus* spp. with *Lantana camara* understorey. No individual birds were directly observed during either survey.

2.3.2 Importance of population

The *National Recovery Plan for the Black-breasted button-quail* (Mathieson and Smith, 2009) identifies the following important sub-populations:

- Sub-populations within the Yarraman-Nanango, Jimna-Conondale Range and the Great Sandy region are important due to their large size and state-owned tenure. These populations are located approximately 20 km east of the project area.
- Sub-populations at Palm Grove National Park and Barakula State Forest are important because they represent the last remaining populations in areas in which the species was previously widespread. These populations are located approximately 270 km west of the project area.
- All populations in New South Wales are considered important as they are at the limit of the species range. These populations are located approximately 230 km south of the project area.

The population within Woondum State Forest (occurring approximately 20 km west of the Great Sandy region) is not among those sub-populations formally recognised as important sub-populations of the species. Data collected to date for the project is insufficient to provide an estimate of population densities within Woondum State Forest, however the presence of feeding platelets indicates their presence. The Woondum State Forest population is located within the extent of range for this species and not near the limit of the species' range. As the populations within Woondum State Forest do not meet the criterial listed above, the population is unlikely to be considered an important population of the species.

2.4 Habitat suitability

2.4.1 Species habitat requirements

The species typically occurs in vine thicket rainforests that have a largely closed canopy and deep litter layer in areas that receive 800 – 1200 mm annual average rainfall (Garnett *et al.*, 2011). They also occur in softwood scrubs in the Brigalow belt; vine scrub regrowth; mature *Araucaria cunninghamii* (hoop pine) plantations, especially where there is *Lantana camara* (lantana); dry sclerophyll forest adjacent to rainforest; and *Acacia* and *Austromyrtus* scrubs on sandy coastal soils (Marchant and Higgins, 1993).

2.4.2 Habitat within the project area

Within the project area, potentially suitable habitat occurs in semi-evergreen vine-thicket and surrounding eucalypt woodland with lantana understorey at Woondum State Forest (ERM, 2016). Feeding platelets were confirmed present at this location during both baseline (BAAM, 2015) and targeted (ERM, 2016) surveys within Woondum State Forest. The regional ecosystems (RE) in which these were recorded included:

12.11.3 least concern - *Eucalyptus siderophloia*, *E. propinqua* +/- *E. microcorys*, *Lophostemon confertus*, *Corymbia intermedia*, *E. acmenoides* open forest on metamorphics +/- interbedded volcanics.

12.11.14 of concern - *Eucalyptus crebra*, *E. tereticornis*, *Corymbia intermedia* woodland on metamorphics +/- interbedded volcanics.

The distribution of potential and confirmed habitat for the black-breasted button-quail across the project area is mapped in Figure 2. No suitable habitat (i.e. vine thicket, wet sclerophyll) occurs within the project area outside of the mapped habitat for the black-breasted button quail, including areas within Curra State Forest.

2.4.3 Habitat critical to the survival of the species

The National Recovery Plan for the Black-breasted button-quail (Mathieson and Smith, 2009) identifies habitat critical to the survival of the species as each of the following:

- Vine thickets and rainforest vegetation types that are periodically water-stressed. These include semi-evergreen vine thicket, low microphyll vine forest, Araucarian microphyll vine forest, Araucarian notophyll vine forest and *Brachychiton* scrubs that may incorporate *Brachychiton sp*. (bottle trees), *Acacia harpophylla* (brigalow) and *Casuarina cristata* (belah).
- Low thickets or woodlands with a dense understorey but little ground cover, typically dominated by *Acacia sp*.
- In littoral situations, dry vine scrubs, acacia thickets and areas densely covered in shrubs, particularly *Austromyrtus dulcis* (midgen berry).

Impact on habitat critical to the survival of the species

Within the project area, habitat which falls within the definition of habitat critical to the survival of the species was confirmed in Woondum State Forest within vine thicket and surrounding eucalypt woodland with a lantana understorey. Due to evidence of foraging activity (e.g. feeding platelets) this habitat represents habitat critical to the survival of the species. The project will result in a loss of 8.14 ha of the total 26.83 ha mapped habitat within the survey area.

2.5 Measures to avoid, reduce or mitigate impacts

2.5.1 Avoidance

Avoidance of impacts on black-breasted button-quail and its habitat is not possible due to the required alignment of the project.

2.5.2 Reduction and mitigation

Where possible, a reduction of impacts on the black-breasted button-quail habitat has been achieved through refinement of the project area in Woondum State Forest which is known to support habitat for the black-breasted button-quail.

The following key mitigation measures have been incorporated in the design to address impacts to the black-breasted button-quail:

- Incorporation of a fauna connectivity structure within Woondum State Forest (Chainage 137100 m) to maintain habitat connectivity on the eastern and western sides of the project.
- Erection of fauna fencing along retained bushland and on either side of nominated fauna connectivity structures, including both fauna underpasses and Six Mile Creek bridge.
- Strategic planting adjacent to targeted fauna connectivity structures will occur to improve and maintain habitat connectivity for MNES, where possible. Specifically, for the black-breasted button-quail low shrubs will be considered in the planting list for revegetation adjacent to the proposed fauna connectivity structure.
- Incorporation of vegetation clearing limits, pre-clearing surveys, specific vegetation clearing requirements and methodologies within the contract documentation.
- Development of contract documents to include the establishment of no-go zones.
- Location of ancillary activities within previously cleared areas, where possible.
- Requirement for staged vegetation clearing deemed suitable by the Contract Administrator. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins).

These key mitigation measures as well as other generic management actions have been developed for the project to mitigate potential impacts to the black-breasted button-quail, as shown in Appendix A. These management actions will be documented in the relevant contract documentation required for the project.

2.6 Significance of impact assessment

2.6.1 Significance of impact assessment

Impacts of the project on the black-breasted button-quail have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 4.

Table 4 Significant impact assessment for the black-breasted button-quail

Criteria	Response
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of an important population	**Unlikely.** The population is unlikely to represent an important population of the species, as it is not among the important populations identified within the *National Recovery Plan for the black-breasted button-quail* and is not at the limit of the species range.
Reduce the area of occupancy of an important	**Unlikely.** The population is unlikely to represent an important population of the species, as it is not among the important

Criteria	Response
population	populations identified within the *National Recovery Plan for the black-breasted button-quail* and is not at the limit of the species range.
Fragment an existing important population into two or more populations	**Unlikely.** The population is unlikely to represent an important population of the species, as it is not among the important populations identified within *the National Recovery Plan for the black-breasted button-quail* and is not at the limit of the species range. Therefore, the project will not fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species	**Likely.** 8.14 ha of habitat critical to the survival of the species is planned to be cleared to facilitate the project. In addition to this, the degradation of habitat within edge-affected areas adjacent to the highway has the potential to reduce the value of habitat in the long-term.
Disrupt the breeding cycle of an important population	**Unlikely.** The population is unlikely to represent an important population of the species, as it is not among the important populations identified within *the National Recovery Plan for the black-breasted button-quail* and is not at the limit of the species range. In this regard, the project will not disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent the species is likely to decline	**Likely.** The project will result in the loss of 8.14 ha of foraging and nesting habitat for the black-breasted button-quail. In addition, the project will result in the fragmentation of 10.89 ha of habitat to the west of the project area. This habitat will be fragmented from a contiguous polygon of bushland to the east, which includes Woondum State Forest and privately owned parcels of land. Within this contiguous polygon of bushland to the east of the project area, there is approximately 26.83 ha of potential habitat for the black-breasted button-quail (based on areas of bushland mapped as RE 12.11.3 (i.e. *Eucalyptus* open forest with vine forest species present)). Remaining habitat adjacent to the project area is likely to be substantially degraded in value by edge effects from the highway (i.e. increased ground cover weeds, noise, light, run-off and litter) and fragmentation effects. The vegetation communities impacted are considered habitat critical to the survival of the species in the *National Recovery Plan for the black-breasted button-quail* (Mathieson and Smith, 2009). Localised losses of potential foraging habitat likely to result from the project have the potential to lead to a decline in the local population and contribute to the decline of the species. Fragmentation is considered a serious threat to the viability of populations (Mathieson and Smith, 2009).
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Possible.** As the species nests at ground level, it is susceptible to predation by dogs, cats and foxes (Garnett and Crowley, 2000) with predation by feral animals identified as a threat to the species (Mathieson and Smith, 2009). Although the project itself will not directly result in the establishment of invasive species (e.g. by importing dogs, cats and/or foxes to the area), by developing the area and providing linear corridors, the project has the potential to facilitate the dispersal of dogs and other feral predators to the area. However, given the habitats

Criteria	Response
	impacted occur in close proximity to existing forestry tracks, the area is already likely to be accessible to dogs and other feral predators. Nevertheless, in the absence of mitigation measures, the project has the potential to exacerbate predation pressures on the local black-breasted button-quail population. Mitigation measures have been nominated to assist in the control of feral animals including waste management measures during construction, fauna fencing and financial contributions towards feral animal control. With regard to the mitigation measures proposed, the project has the potential to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat such as wild dogs.
Introduce disease that may cause the species to decline	**Unlikely.** Disease is not considered to be a key threat to the black-breasted button-quail. Given that most potential vectors for disease spread will be controlled through weed hygiene protocols and feral animal control measures, the project is expected to have negligible impact on the species in this regard.
Interfere substantially with the recovery of the species	**Possible.** Protecting key ecosystems/habitat that support populations of black-breasted button quail from human-induced threatened processes (thus maintaining current populations and habitat) is identified as a recovery objective. The project will impact upon habitat that supports a population of black-breasted button-quails, thereby interfering with the recovery plan for the species. However, given that the habitat where the black-breasted button-quail is located on land currently under threat (i.e. due to the right for the State Government to undertake logging activities) as defined under the recovery plan for the species the removal of habitat within the project is unlikely to substantially interfere with the recovery of the species.

Although the significant impact assessment undertaken in Table 4 details that significant impacts are unlikely to be realised for a number of criteria. The project has been identified as impacting habitat critical to the survival of the species and there is a possibility of the project modifying, destroying or isolating the species habitat, the project may have a significant impact on the black-breasted button-quail.

2.6.2 Significant residual impact

Although a number of avoidance measures, mitigation measures and management plans have been developed for the project, the works are anticipated to have a significant residual impact on the species due to the loss of 8.14 ha of habitat critical to the survival of the black-breasted button-quail, refer to Figure 2.

2.6.3 Offset strategies

The identified key threats to the black-breasted button-quail include the following (DEE, 2016b):

- Habitat loss and fragmentation
- Frequent fire regimes impacting on habitat
- Habitat disturbances by cattle, horses and pigs
- Predation by cats, foxes and pigs

The *National recovery plan for the black-breasted button-quail (Turnix melanogaster)* (Mathieson and Smith, 2009) identifies a number of recovery objectives which includes the following:

- Consolidate current knowledge and define assessment and monitoring strategies for black-breasted button-quail, including an assessment of current status throughout its range and a clear definition of the habitats occupied by the species.
- Protect key ecosystems and/or habitats that support populations of black-breasted button-quail from human-induced threatening processes, thus maintaining current populations and habitat.
- Maintain or improve the extent, condition (quality) and connectivity of black-breasted button-quail habitat.
- Reduce the impacts of introduced predators and competitors.
- Increase the understanding of the ecology of black-breasted button-quail.
- Administer and review the operation of the recovery process.

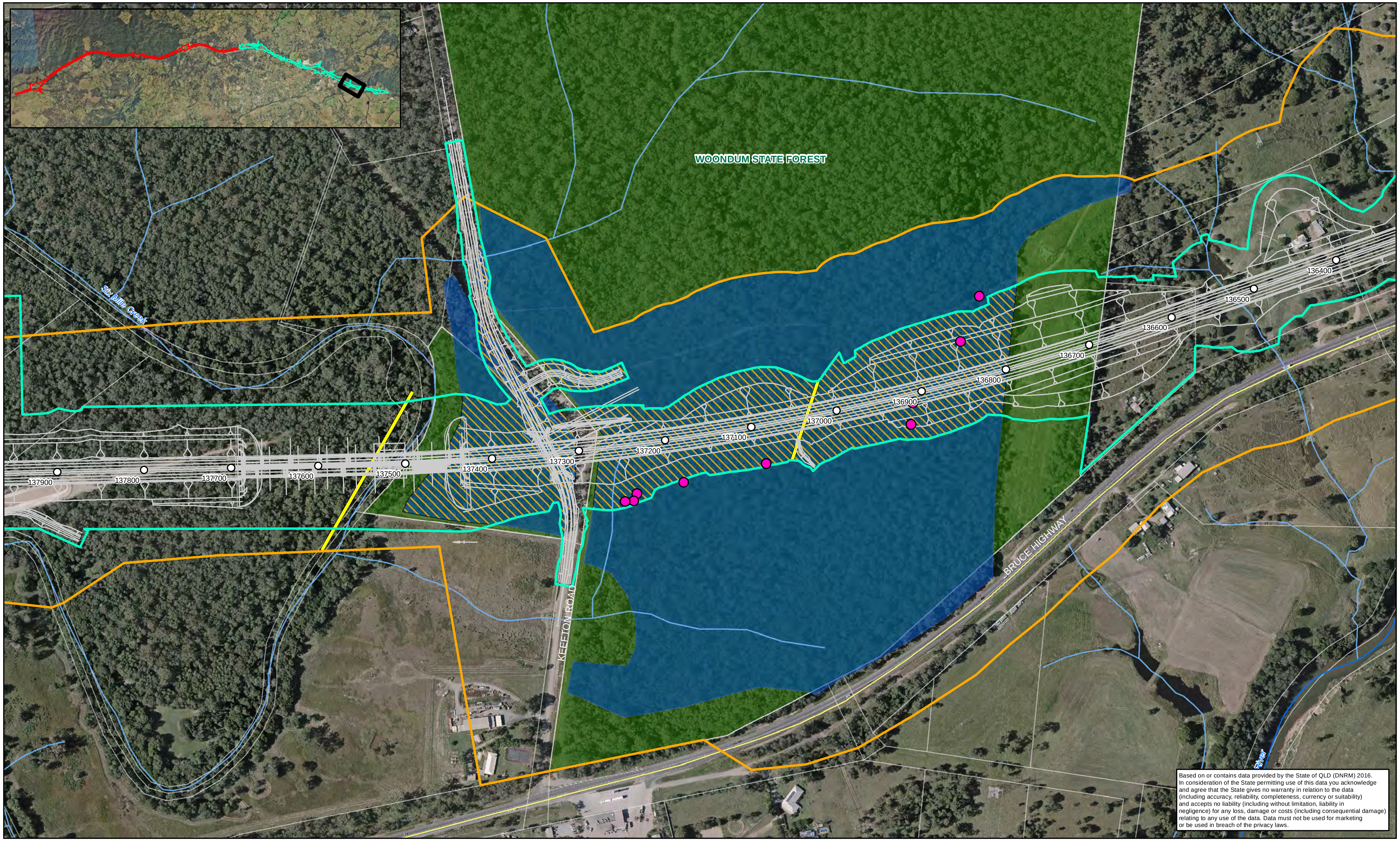
As a result, an appropriate offset will be required to provide for a conservation gain for the black-breasted button quail. A direct offset would achieve two of recovery actions identified in the *National recovery plan for the black-breasted button-quail (Turnix melanogaster)* (Mathieson and Smith, 2009) including:

- Protect key ecosystems/habitat that support populations of black-breasted button-quail from human-induced threatening processes, thus maintaining current populations and habitat.
- Maintain or improve the extent, condition (quality) and connectivity of black-breasted button-quail habitat.

An appropriate direct offset to compensate for the significant residual impact to the black-breasted button-quail is the securement and protection of black-breasted button-quail habitat in close association to the area of impact. The size of an offset site will be determined in an EPBC Act Offsets Proposal in accordance with the EPBC Act Offsets Calculator. TMR currently propose to secure Lot 2 on RP891751 which is located immediately adjacent to Woondum State Forest. Desktop investigations indicate that this property supports remnant vegetation RE 12.11.3 *Eucalyptus siderophloia*, *E. propinqua* +/- *E. microcorys*, *Lophostemon confertus*, *Corymbia intermedia*, *E. acmenoides* open forest on metamorphics +/- interbedded volcanics. This vegetation community matches the vegetation community which will be lost as a result of the project where evidence of black-breasted button-quail has been found (ERM, 2016).

A second direct offset to assist in reducing threats to the black-breasted button-quail is direct financial support for the regional feral animal abatement program. Gympie Regional Council's current feral animal abatement program includes setting traps which target wild dogs but are also known to traps feral cats (Gympie Regional Council, 2014). Funding contribution to this program would be determined based on the outcomes of the EPBC Act Offsets Calculator and will be presented in the EPBC Act Offsets Proposal. Preliminary stakeholder engagement undertaken for this project has indicated that Gympie Regional Council are likely to support direct funding to the current wild dog program due to recent success in the program through TMR's previously supplied funding for the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project. This direct offset would achieve a recovery actions identified in the *National recovery plan for the black-breasted button-quail (Turnix melanogaster)* (Mathieson and Smith, 2009) which includes the reduction of the impacts of introduced predators and competitors.

TMR are developing a draft EPBC Act Offsets Proposal for consideration by the Minister as part of the EPBC Act assessment process. It is anticipated that a final EPBC Act Offsets Proposal will form part of preliminary documentation for the project to be submitted and approved prior to commencement of major civil construction activities.



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0 50 100 200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- 100m Chainage and Project Centreline
- Cadastral Boundary
- Protected Areas
- Survey Area
- **Project Area**
  - Contract 1
  - Contract 2
- Major Watercourse
- Minor Watercourse
- Fauna Connectivity Structure
- BBBQ (Platelets) (ERM 2016; BAAM 2015)
- BBBQ Habitat (ERM, 2016)
- BBBQ Habitat Lost

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	24 Mar 2017

Black-breasted button-quail records and habitat

Figure 2

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6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: GHD: BBBQ Habitat Lost (2016); TMR: Imagery (2014), Survey Area, Chainage, BBBQ Records, BBBQ Habitat (2016); DNRM: Cadastre (2016), Waterways (2015), Protected Areas (2014). GHD: Project Area (March 2017), Road Design (November 2016), BBBQ Habitat Lost (2016), Fauna Connectivity Structures (2016). Created by: sc

3. Koala (*Phascolarctos cinereus*)

3.1 Conservation status and documentation

3.1.1 Conservation status

The koala (*Phascolarctos cinereus*) is listed as 'vulnerable' under the EPBC Act within Queensland, New South Wales and the Australian Capital Territory. Within these jurisdictions, the koala was listed as 'vulnerable' under Criterion 1 of the EPBC Act (decline in numbers). This considers the fact that the species has undergone, is suspected to have undergone, or is likely to undergo in the immediate future a very severe, severe or substantial reduction in numbers.

3.1.2 Threats to the species

Threats to the species vary across the species' range. Within southeast Queensland and other areas where koalas coincide with growing human populations, principal threats to koalas are associated with loss and fragmentation of habitat due to urban expansion, increased mortality from vehicle collisions, dog attacks and mortality and reduced breeding success due to disease (TSSC, 2011a).

3.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessments for this species:

- *The EPBC Act Referral Guideline for the vulnerable koala* (DoE, 2014)
- *The National Koala Conservation and Management Strategy 2009 – 2014* (DEWHA, 2009)
- *Terrestrial Vertebrate Survey Guidelines for Queensland* (DSITIA, 2014)

3.1.4 Recommended survey methods

The EPBC Act Referral Guideline for the vulnerable koala (DoE, 2014), recommends a broad range of direct and indirect koala survey methods including visual surveys using strip transects, faecal pellet surveys, spotlighting, detection dog surveys, call playback, radio tracking and incidental recording of koala scratches. The applicability of methods varies depending on the circumstance of the assessment and on the size, complexity and spatial context of the survey area and the environment in which it occurs. For this reason, specific methods and survey effort are not prescribed by the guidelines. In context to large linear infrastructure projects appropriate survey options for assessment of koalas typically include:

- Vegetation stratification to identify and map the distribution of potential koala habitat based on mapped vegetation communities.
- Systematic surveys of koala habitat for koala pellets using the Spot Assessment Technique (SAT) (Phillips and Callaghan, 2011) or Koala optimised Rapid Assessment Methodology (KRAM) to identify areas of high utilisation by koalas.
- Detailed sighting surveys (strip transects) to provide more detailed information on koala densities, breeding status and incidence of disease.
- Use of detection dogs for faecal pellet detection.

3.2 Targeted survey effort

Targeted koala surveys were undertaken for the project by BAAM (2015), ERM (2016) and the University of the Sunshine Coast (USC) (2016). A summary of each survey methodology is provided below to demonstrate compliance with the recommended survey methods within the *EPBC Act Referral Guideline for the vulnerable koala*

BAAM (2015) targeted koala surveys

BAAM undertook targeted koala surveys within suitable habitat across the project area and survey area over five days (2 – 6 March 2015) using the following methods:

- Visual surveys (strip transects), undertaken in each representative Regional Ecosystem (RE) within the project area. A total of five transects were undertaken, with at least one transect in each RE.
- Koala faecal pellet surveys, undertaken using a targeted version of the SAT methodology. A total of 30 SAT searches (targeted towards koalas) were undertaken across the project area.

ERM (2016) targeted koala surveys

ERM undertook targeted koala surveys of the project area and survey area in February 2016 using the following methods:

- Koala faecal pellet searches using a targeted version of the SAT methodology (centred on a randomly generated location rather than a central food tree), searching for faecal pellets within a 100 cm radius around 30 trees within each SAT site. Trees searched included both food and shelter trees (i.e. not limited to Eucalyptus, Corymbia, Angophora and Lophostemon), based on evidence presented in Woosnam-Merchez et al. (2012).
- Based on the number of trees with faecal pellets, estimates of koala density were determined in accordance with Ellis et al. (2013).

University of the Sunshine Coast (2016) Koala surveys

The USC undertook targeted surveys using detection dogs to determine the presence/absence and habitat utilisation of koalas within the survey area.

Targeted survey effort for the koala is summarised in Table 5 below.

Table 5 Summary of survey effort for koala

Survey methods	Survey	Survey effort undertaken
Methods recommended in EPBC Act survey guidelines		
Koala faecal pellet searches (SAT)	BAAM, 2015	30 SAT searches (March 2015)
	ERM, 2016	42 SAT surveys (February, 2016)
	USC, 2016	155 sites surveyed 4560 individual trees surveyed
Visual surveys (strip transects)	BAAM, 2015	Five strip transects undertaken, with at least one transect per RE community (March, 2015)

3.3 Records

3.3.1 Desktop and field records

The koala has been historically recorded from the region according to Wildnet and ALA records and recently recorded during targeted surveys by BAAM (2015), ERM (2016) and USC (2016) (refer to Table 6). A spatial representation of the evidence of koalas recorded as a result of the targeted surveys is presented in Figure 3.

Table 6 Koala records within the region

Source	Record
Wildnet / Atlas of Living Australia	One Wildnet and ALA record of the species occurs within 10 km of the project area, in Gympie National Park (2013). Numerous records of koalas are known to occur within 5 km of the project area and are not listed on the Wildnet or ALA databases (ERM, 2016).
Koala Tracker (2017)	Two koalas (alive) west of the project area at Mother Mountain One koala (injured by dog) recorded along East Deep Creek Road, west of the project area
Targeted field survey (BAAM, 2015)	Koala faecal pellets were recorded from two transects on the southern half of the project area within remnant bushland around the Penny Road Interchange. One characteristic scratch mark was found on a tall *Eucalyptus grandis* (flooded gum), within Curra State Forest, in the northern half of the project area.
Targeted field survey (ERM, 2016)	Koala pellets were found at 12 of 42 SAT sites surveyed (refer to Figure 3). Pellets were found in large patches of remnant vegetation within Curra State Forest in the north of the project area, Woondum State Forest in the south of the project area and the East Deep Creek and Mothar Mountain area immediately north of Woondum State Forest. Pellets were found under 2% of trees surveyed (28 of 1230), indicating that koalas are likely to occur in very low densities within the project area (approximately 0.2 koalas/ha).
Targeted field survey (USC, 2016)	155 sites were surveyed, with 35 found to be positive for koala presence based on the detection of koala faecal pellets in addition to eight opportunistic positive sightings for koala presence (seven pellets, one koala). A total of 4,560 individual trees were surveyed with koala faecal pellets identified under a total of 173 trees. The average utilisation rate for all survey sites was 3.8% (± 9.4%). Based on the outcomes of the surveys, koalas were found to utilise habitats in five regions located within the project area; with the highest utilisation rates at Mothar Mountain and the north-east corner of Woondum State Forest.

3.3.2 Importance of population

The *EPBC Act Referral Guidelines for the vulnerable koala* (DoE, 2014) do not specify important populations of the koala, as there is currently insufficient information to adequately identify and separate important populations from the species across its range. The koala is known to occur from Cooktown in the north, west to Longreach and south into Victoria (DoE, 2014). As a result, the project is well within the species range. The *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) defines an important population as a population that is necessary for a species long-term survival and recovery.

Information from SAT faecal pellet surveys suggest that koalas are likely to occur at very low densities (0.2 koalas/ha or 3.8 % average utilisation rate) within the project area (ERM, 2016; USC, 2016). No information on genetic diversity or incidence of disease is available and no evidence of breeding was recorded during surveys.

As a result, the population present is unlikely to constitute an important population as it is unlikely to be a key source population for breeding or dispersal, maintaining genetic diversity and is not near the limit of the species range.

3.4 Habitat suitability

3.4.1 Species habitat requirements

Koala habitat can be broadly defined as any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. Koala food trees are typically species of *Eucalyptus*, *Corymbia*, *Angophora* and *Lophostemon*. The distribution of this habitat is largely influenced by land elevation, annual temperature and rainfall patterns, soil types and the resultant soil moisture availability and fertility. Preferred food and shelter trees are naturally abundant on fertile clay soils. Access to shelter habitat (i.e. non-food trees) is also important for thermoregulation (Crowther *et al*., 2013).

3.4.2 Habitat within the project area

Koalas have the potential to occur within any eucalypt woodland habitat across the project area. Habitat suitability was assessed and mapped for the project area (ERM, 2016), using the following categories for koala habitat:

- **Category 1 - Generally unsuitable** – e.g. waterbodies, cleared land and mature regrowth not containing koala food trees
- **Category 2 - Regrowth** – mature regrowth containing recognised koala food tree species
- **Category 3 - Remnant vegetation with less frequent detection of koala or signs** – mapped REs where koala pellets were recorded in less than 50% of SAT locations
- **Category 4 - Remnant vegetation with more frequent detection of koala or signs** – mapped REs where koala pellets were recorded at greater than 50% of SAT locations.

Koala faecal pellet presence as identified by USC (2016) correlated with koala habitat mapped by ERM (2016). The presence of koala faecal pellets were recorded within either ‘remnant vegetation with less frequent detection of koala or signs’ or ‘remnant vegetation with more frequent detection of koala or signs’. The distribution of koala habitat and recorded pellets across the survey area is presented in Figure 3.

3.4.3 Habitat critical to the survival of the species

An assessment of the koala habitat was undertaken in accordance with the koala habitat assessment tool provided by the *EPBC Act Referral Guidelines for the Vulnerable Koala* (DoE, 2014). Due to the linear nature of the project, the length over which the project occurs and the various vegetation communities and environmental features encountered, the habitat assessment tool has been applied to each of the four different koala habitat types identified. This approach has been taken to accurately identify habitat critical to the survival of the koala. The tool identified that the vegetation within the project area mapped by ERM (2016) as either Category 3 'remnant vegetation with less frequent detection of koala or signs' and Category 4 'remnant vegetation with more frequent detection of koala or signs' meets the criteria to be considered 'habitat critical to survival of koala' with a score of 8. Scores greater than 5 are considered to be critical habitat for the species.

The assessment of habitat defined as either 'remnant vegetation with less frequent detection of koala or signs' and 'remnant vegetation with more frequent detection of koala or signs' is summarised as follows:

- High level of koala activity recorded in the vicinity: **score of 2** (evidence of one or more koalas within the last two years)
- High level of suitability of vegetation structure and composition: **score of 2** (has forest or woodland with 2 or more known koala food trees)
- High level of habitat connectivity: **score of 2** (area is part of a contiguous landscape >500 ha)
- Moderate level of existing threats: **score of 1** (evidence of infrequent or irregular koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence)
- Moderate level of recovery value: **score of 1** (uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context)

Total score: 8

Those areas mapped as either 'generally unsuitable' or 'regrowth' score a lower habitat assessment score as follows:

- High level of koala activity recorded in the vicinity: **score of 1** (evidence of one or more koalas within 2 km of the edge of the impact area within the last 5 years)
- High level of suitability of vegetation structure and composition: **score of 0** (does not include forest or woodland)
- High level of habitat connectivity: **score of 0** (neither part of a contiguous landscape <500 ha or >300 ha)
- Moderate level of existing threats: **score of 1** (evidence of infrequent or irregular koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence)
- Moderate level of recovery value: **score of 1** (uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context)

Total score 3

Impact on habitat critical to the survival of the species

The project will impact a total of 138.44 ha of habitat critical to the survival of the koala (i.e. 'remnant vegetation with less frequent detection of koala or signs' or 'remnant vegetation with more frequent detection of koala or signs'). Habitat critical to the survival of the koala impacted as a result of the project is shown in Figure 3. As Figure 3 demonstrates, the loss of habitat critical to the survival of the species will be linear in nature along a 30 km construction length with an approximate width of 200 m.

3.5 Measures to avoid, reduce or mitigate impacts

3.5.1 Avoidance

Complete avoidance of impacts on the koala and its habitat is not possible due to the widely distributed nature of suitable habitat and the required alignment of the project. However, the following avoidance strategies have been employed during the Planning phases of the project:

- The project area within Curra State Forest was moved approximately 250 m to the west during the Strategic Planning Study undertaken in 2008 (ARUP, 2008) to reduce impacts on the resumption of private properties, reducing impacts on approximately 20 ha of remnant vegetation within Curra State Forest (Jacobs, 2016). This reduction on impacts on remnant vegetation within Curra State Forest is likely to have reduced impacts on habitat for the koala.
- Avoidance of habitat for the koala through consideration of habitat in determining the project area for the project including the placement of ancillary activities within existing cleared areas (i.e. outside Curra State Forest), where practicable.

3.5.2 Reduction and mitigation

Where possible, a reduction of impacts on koalas and their habitat has been achieved through refinement of the project area in areas known to support habitat for koalas. The following key mitigation measures have been incorporated to address impacts to the koala:

- Development of contract documents to include the establishment of no-go zones.
- Location of ancillary activities within previously cleared areas, where possible.
- Requirement for staged vegetation clearing deemed suitable by the Contract Administrator. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins.
- Erection of fauna fencing (koala exclusion fencing) along retained bushland and on either side of nominate fauna connectivity structures, including both fauna underpasses and bridges.
- Incorporation of four fauna connectivity structures and 10 bridge structures (eight over water, two over roads). Fauna connectivity structure locations have been selected based on known populations of fauna being present including koala populations, large areas of suitable habitat on either side of the project and the length and skew of the required connectivity structure to encourage fauna to enter, as fauna are known to not use connectivity structures which involve a dark entry point. Each fauna connectivity structure has been sized to accommodate koalas (i.e. 3 m x 3 m for culverts) and will incorporate fauna furniture and refuge poles specific for koalas.
- Incorporation of revegetation under bridges over waterways where disturbance has occurred. Vegetation to be planted under bridges will incorporate shade tolerant species, with height restrictions based on the pre-clearance RE. The native vegetation cover will provide refuge for koalas when moving through riparian vegetation underneath the bridges.
- Incorporation of vegetation clearing limits, pre-clearing surveys, specific vegetation clearing requirements and methodologies within the contract documentation.

These key mitigation measures as well as generic management actions specific for terrestrial fauna, which are indirectly relevant to mitigating impacts to the Koala, have been developed for the project, as shown in Appendix A. These management actions will be documented in the relevant contract documentation required for the project.

3.6 Significance of impact assessment

3.6.1 Significance of impact assessment

Impacts of the project on the koala have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 7.

Table 7 Significant impact assessment for the koala

Criteria	Response
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of an important population	**Unlikely.** The koala referral guidelines do not specify important populations of koalas (DoE, 2014). It is unlikely that the local koala population represents an important population given the low densities at which the species occurs (ERM, 2016; USC, 2016). Furthermore, the population present is unlikely to be a key source population for breeding or dispersal or maintaining genetic diversity due to the limiting nature of the population recorded. The population present is not near the limit of the species range. However, the project will impact 138.44 ha of koala habitat that is considered habitat critical to the survival of the species. The project will also introduce the potential for mortality of koalas through collision with vehicles and has the capacity to create a barrier effect to local koala movement. While many of these impacts can be mitigated through the use of koala exclusion fencing and providing fauna underpasses with koala design features the potential risk of residual impact is still sufficient to suggest the project may have a significant adverse impact on the local koala population rather than an important population of the species.
Reduce the area of occupancy of an important population	**Unlikely.** Koalas are anticipated to be present in low densities within the immediate project area however, an important population is unlikely to be present.
Fragment an existing important population into two or more populations	**Unlikely.** The koala population present is unlikely to constitute an important population as it is unlikely to be a key source population for breeding or dispersal, maintaining genetic diversity and is not near the limit of the species range. However, the project has the potential to introduce a significant barrier which may limit the local movement of the local population of koalas. Existing habitats within the broader regional area are currently fragmented by the existing Bruce Highway (to the east of the project area), the North Coast Rail Network (immediately to the east of the project area) and local road networks. Targeted surveys and investigations to date have not included the collection of data relevant to local koala movement or genetic distribution to confirm the above statement. While koala fencing and fauna connectivity structures designed for koalas have been

Criteria	Response
	incorporated in the design to mitigate adverse impacts (such as increased mortality) on barrier effects, there is a potential to impact the local koala population rather than an important population of the species.
Adversely affect habitat critical to the survival of the species	**Likely.** The project area will result in a loss of 138.44 ha of vegetation that represents habitat critical to the survival of the koala. Habitat across the project area was separated into four habitat types: • **Category 1 - Generally unsuitable** – e.g. waterbodies, cleared land and mature regrowth not containing koala food trees • **Category 2 - Regrowth** – mature regrowth containing recognised koala food tree species • **Category 3 - Remnant vegetation with less frequent detection of koala or signs** – mapped REs where koala pellets were recorded in less than 50% of SAT locations • **Category 4 - Remnant vegetation with more frequent detection of koala or signs** – mapped REs where koala pellets were recorded at greater than 50% of SAT locations Habitat defined as either 'remnant vegetation with less frequent detection of koala or signs' and 'remnant vegetation with more frequent detection of koala or signs' has been assessed as comprising habitat critical to the survival of the species as these habitat types scored a score of 8 using the koala habitat assessment tool. The *EPBC Act referral guidelines for the vulnerable koala* (DoE, 2014) suggest loss of greater than 20 ha of habitat with a habitat score of greater than 8 is considered a significant impact. In accordance with the guidelines the project is likely to adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	**Unlikely.** Construction activities have the potential to disrupt breeding activities if coinciding with the breeding season of the koala; however, the population present is unlikely to constitute an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent the species is likely to decline	**Possible.** The project will result in a loss of 138.44 ha of koala habitat which has been assessed as habitat critical to the survival of the species. Koalas are likely to occur within these habitats at very low densities (0.2 koalas/ha or 3.8% utilisation rate) (ERM, 2016; USC, 2016). It is important to note that approximately 69 ha of this habitat is contained within the Curra State Forest. Curra State Forest is an actively managed State Forest with regular logging and fire management activities which is likely to modify the extent of koala habitat within this location and may discourage koalas from utilising the habitat. Notwithstanding, the loss of koala habitat as a result of the project contributes to a cumulative impact on koala habitat within a region that is predicted to experience increasing urban expansion in coming decades. Within that context, the loss of habitat critical to the survival of the koala is considered significant for the viability of the

Criteria	Response
	local koala population. However it is uncertain whether these impacts will decrease the availability or quality of habitat to the extent the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	**Likely.** Dog attacks represent a significant cause of koala mortality in south-east Queensland (DoE, 2014). Construction activities can attract feral predators to bushland areas by increasing accessibility. However, given the project area has been subject to extensive anthropogenic disturbance associated with vegetation clearing for agriculture, transport infrastructure and residential housing, this risk is considered minimal given the area is already accessible to feral predators. Crossing the road corridor may require koalas to enter areas where dogs occur in higher densities. Fauna connectivity structures designed specifically for koalas include fauna furniture and refuge poles to minimise susceptibility to predation at various locations across the project area; as wild dogs are known to target the entry and exit locations of these structures.
Introduce disease that may cause the species to decline	**Possible.** The project has the potential to increase stress levels within the local koala population. There is circumstantial evidence to suggest the incidence of chlamydia may increase with environmental stresses attributed to habitat fragmentation and overcrowding (Melzer *et al.*, 2000). While impacts associated with the project are unlikely to contribute directly to diseases within the local koala population, it has the potential to contribute to cumulative regional impacts that may increase the incidence of chlamydia infection.
Interfere substantially with the recovery of the species	**Likely**. The project has the potential to interfere with the recovery of the koala by creating a barrier to movement and increasing mortality due to interactions with vehicles or wild dogs. Linear transport corridors have been shown to have significant adverse impacts on koala populations by acting as a barrier to movement and gene flow (Lee *et al.*, 2010). While the Warrego Highway has been shown to act as a significant barrier to koala movement, effectively isolating the Ipswich and Esk koala populations (Lee *et al.*, 2010), the significance of the barrier effect caused by the current project is likely to be less severe given the reduced koala densities occurring locally. Nevertheless, the project has the potential to cause a barrier effect. Incorporating fauna connectivity structures specifically designed for koalas at locations based on recorded habitat or the presence of a koala population will reduce the severity of this impact. The project also has the potential to cause significant ongoing mortality risks to koalas via collision with vehicles during the Operational phase. Roadkill mortality has been shown to have a significant effect on the viability of regional koala populations in southeast Queensland (DERM, 2009). Unlike construction impacts, mortality from vehicle strikes has the potential to present an insidious, long-term impact on the local koala population if left unmitigated. Mitigating barrier effects and mortality is therefore important to limit the

Criteria	Response
	residual impact on the local koala population. A total of 14 fauna connectivity structures (10 bridges and four culverts) have been included in the Detailed Design phase. Fauna exclusion fencing will also be erected on the entrances and exits of these structures to direct fauna usage. Fauna exclusion fencing has also been incorporated in bushland areas where koala habitat and utilisation has been recorded. Regardless of these mitigation measures, impacts on the koala are expected to be potentially significant and sufficient to warrant a controlled action.

As shown in Table 7, the project is likely to have a significant impact on the koala due to the associated impacts on habitat critical to the survival of the species and the possibility of the introduction of invasive species to the species habitat.

3.6.2 Significant residual impact

Although a number of avoidance measures, mitigation measures and management plans have been developed for the project, the works are anticipated to have a significant residual impact on the species due to the loss of 138.44 ha of habitat critical to the survival of the koala.

3.6.3 Offset strategies

The *Commonwealth Conservation Advice on Phascolarctos cinereus (combined population in Queensland, New South Wales and the Australian Capital Territory)* (TSSC, 2012) identifies a number of specific actions for koala conservation under the following broad priority management actions, as well as a number of research priorities including:

Priority management actions

- Habitat loss, disturbance and modification
- Feral animal predation
- Conservation information

Research priorities

- Population monitoring and abundance estimates across the koala's range
- Landscape-scale population models
- Develop understanding of gene flow and landscape connectivity
- Identify and delineate key populations
- Research programs directed at the assessment of the incidence and consequences to populations of disease, and of mechanisms to reduce the impacts of disease
- Research programs directed at the assessment of the incidence and consequences to populations of koala mortality or injury due to dogs and traffic, and of mechanisms to reduce the impacts of these threatening factors
- Determine the ability of inland koala populations to persist after, or recover from, drought and evaluate the likely influence of climate change on these processes

Potential land based offset

As the project is anticipated to have a significant residual impact on habitat critical to the survival of the koala, an appropriate offset will be required to provide for a conservation gain for the species. A direct offset would achieve two priority actions of the listing advice including:

- Habitat loss
- Feral animal predation

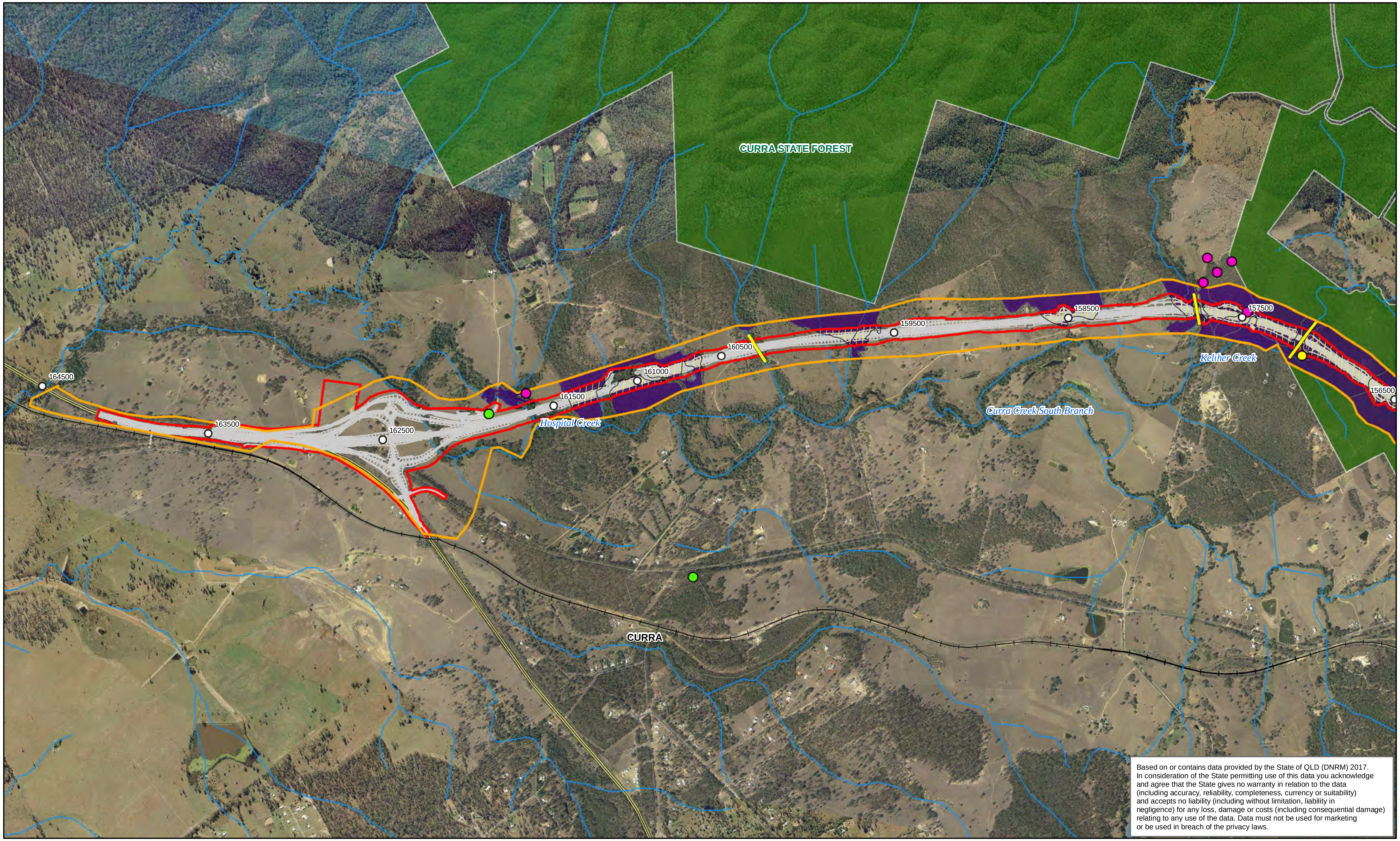
TMR are proposing to provide a land based offset for impacts to habitat critical to the survival of the koala. The size of an offset site will be determined in an Offsets Proposal in accordance with the EPBC Act Offsets Calculator. TMR are developing a draft EPBC Act Offsets Proposal for consideration by the Minister as part of the EPBC Act assessment process. It is anticipated that a final EPBC Act Offsets Proposal will form part of preliminary documentation for the project to be submitted and approved prior to commencement of major civil construction activities.

In preparing the draft EPBC Act Offsets Proposal, habitat condition assessments will be undertaken to confirm the sizing requirements for the required land based offset for the koala and the exact properties to be secured will be selected. TMR is currently undertaking consultation with Gympie Regional Council and the Department of National Parks, Sport and Racing in regards to the locations of potential direct land based offsetting locations to provide habitat connectivity across the region.

TMR are also currently progressing a research based offset for the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum). The outcomes of this research are intended to guide the selection of land based offsets for future projects. As a result, where either preliminary results or final results are available at the time of the development of an EPBC Act Offsets Proposal which will include offset site selection for the current project these results will be used to guide the property selection process.

Potential non-land based Offset

A second direct offset to assist in reducing threats to the koala is direct financial support for the regional feral animal abatement program. Gympie Regional Council's current feral animal abatement program includes setting traps which target wild dogs (Gympie Regional Council, 2014). Preliminary stakeholder engagement undertaken for this project has indicated that Gympie Regional Council are likely to support direct funding to the current wild dog program due to recent success in the program through TMR's previously supplied funding for the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project. This direct offset would achieve a recovery actions identified in the listing advice which feral animal predation as a key threat to the species. The final funding contribution to these programs would be determined based on the outcomes of the EPBC Act Offsets Calculator and will be presented in the final EPBC Act Offsets Proposal for the project.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- Town
- 1 km Chainage
- Railway
- Watercourses
- Fauna Connectivity Structure
- Survey Area
- Protected Areas

Project Area

- Contract 1
- Contract 2

ERM/Jacobs Threatened Fauna Records

- Koala (Record)
- Koala (Scratches/Scat)
- Koala Evidence Present (USC)

- Koala Habitat to be Lost
- Habitat Critical to the Survival of the Koala

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
Revision	0
Date	24 Mar 2017

Koala records and habitat

Figure 3
Sheet 1 of 4

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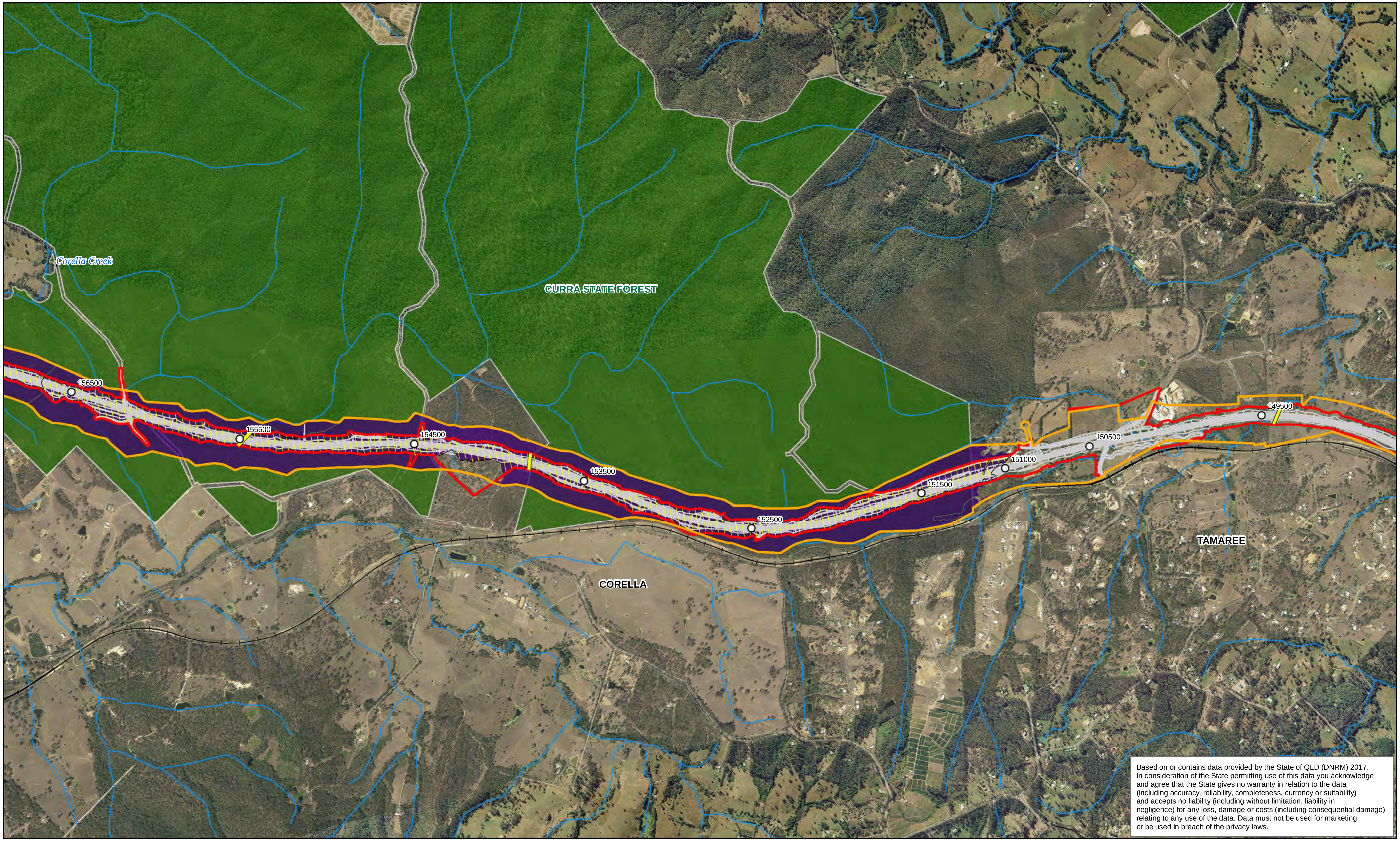
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015), Protected Areas (2014); TMR: Imagery, Survey Area, Chainage (2016), ERM/Jacobs Threatened Fauna Records, Habitat Critical to the Survival of the Koala (2016). GHD: Fauna Connectivity Structures (2016), Project Area (March 2017), Road Design (November 2016). USC: Koala Evidence Present (2016). Created by:schadwick



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Kilometres

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Grid: GDA 1994 MGA Zone 55

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Department of Transport and Main Roads
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Koala records and habitat

Figure 3
Sheet 2 of 4

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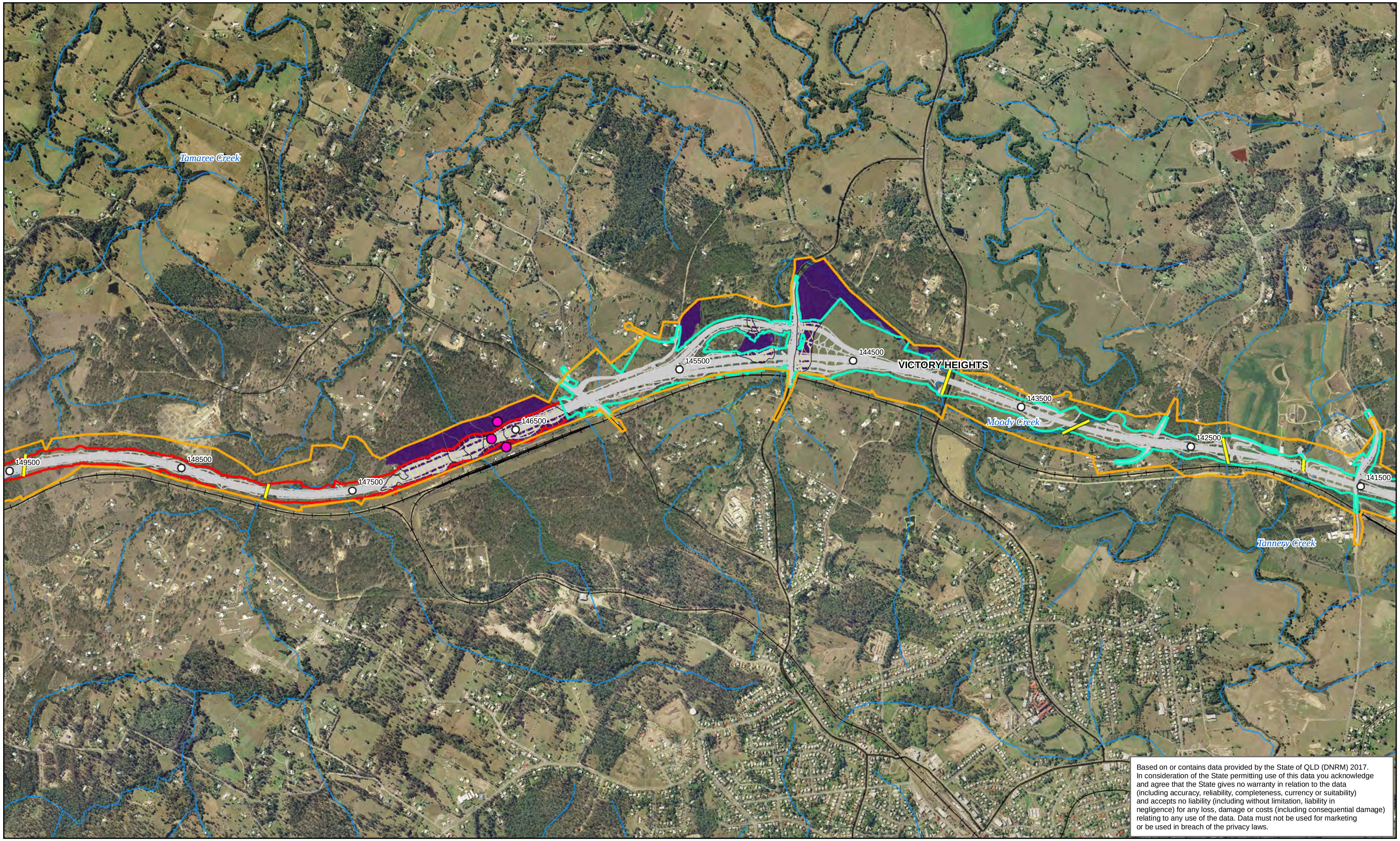

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Kilometres

Map Projection: Universal Transverse Mercator
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Koala records and habitat

Figure 3
Sheet 3 of 4

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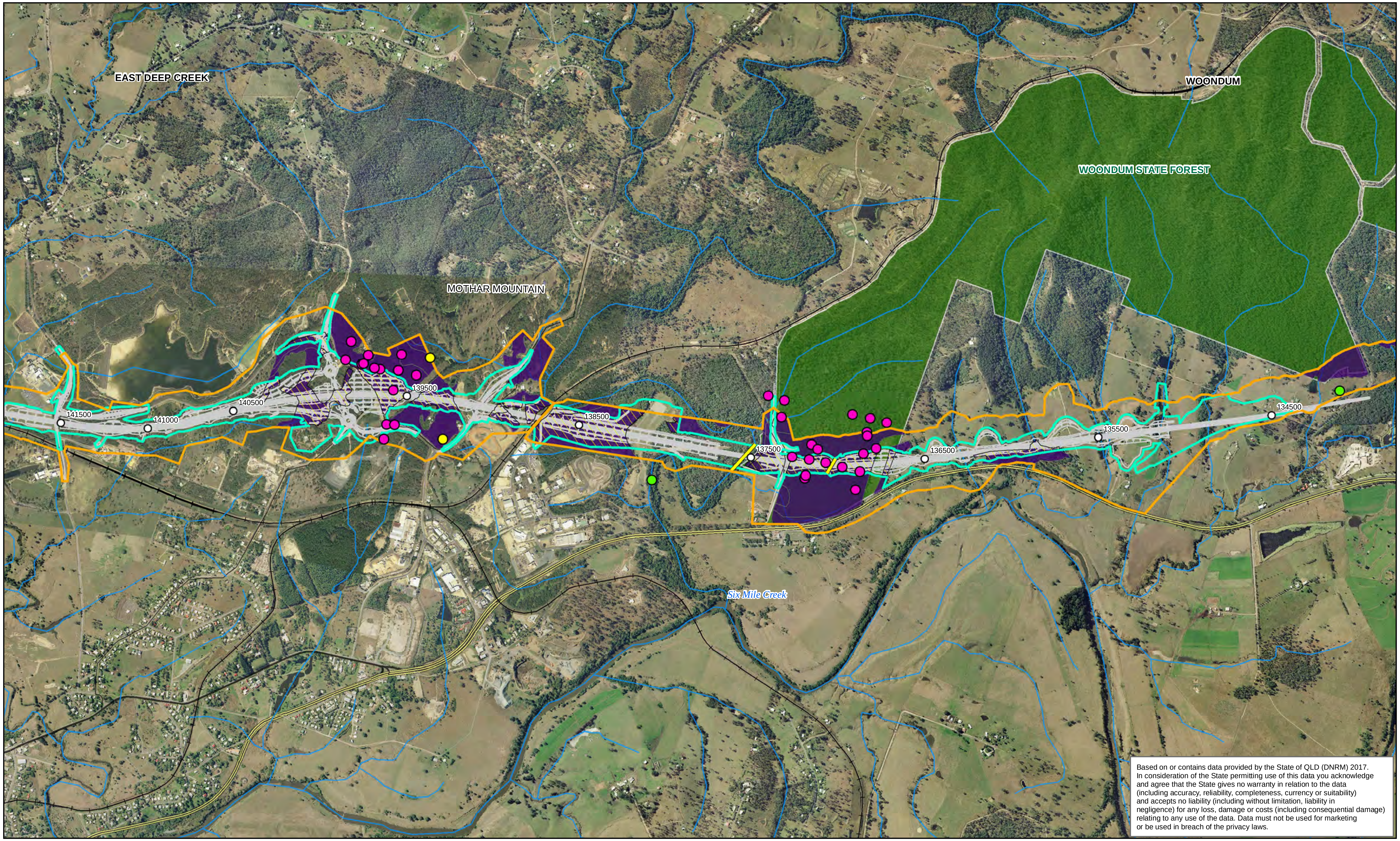

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Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
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LEGEND

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Koala records and habitat

Figure 3
Sheet 4 of 4

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4. Greater glider (*Petauroides volans*)

4.1 Conservation status and documentation

4.1.1 Conservation status

The greater glider (*Petauroides volans*) was listed as ‘vulnerable’ under Criterion 1 of the EPBC Act on 25 May 2016 (decline in numbers). There is no robust data on population estimates for the species across its range. However, decline in numbers, occupancy rates and extent of habitat have been recorded at numerous sites from which a total rate of decline can be inferred (TSSC, 2016).

4.1.2 Threats to the species

Historically this species has experienced significant declines in its area of occupancy through clearing for agriculture (van der Ree *et al.*, 2004). The species has a low capacity for dispersal, limited ability to cross vegetation gaps and has low reproductive viability in small habitat remnants. These factors mean the species is susceptible to decline due to habitat fragmentation. Key threats to greater gliders are typically associated with the following:

- Habitat loss and fragmentation through logging and destruction of senescent hollow-bearing trees.
- Inappropriate fire regimes (i.e. too intense or frequent fires) which reduce the availability of den sites by destroying mature hollow-bearing trees.
- Logging impacts (i.e. prime habitat coincides largely with areas suitable for logging).
- Climate change – modelling predicts a severe range contraction in the northern sub-species due to projected increases in water stress induced by climate change (Kearney *et al.*, 2010).

4.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessment for this species:

- *The Action Plan for Australian Mammals 2012* (Woinarski *et al*., 2014)
- *The Survey Guidelines for Australia’s Threatened Mammals: Guidelines for detecting mammals listed under the EPBC Act* (DSEWPaC, 2011a)
- *Survey Standards: Greater glider Petauroides volans* (DSE, 2011)
- *Terrestrial Vertebrate Survey Guidelines for Queensland* (DSITIA, 2014)

4.1.4 Recommended survey methods

Due to the species’ recent listing, there are no Commonwealth survey guidelines for the greater glider. The Victorian Department of Sustainability and Environment has provided survey guidelines for the species (DSE, 2011). These recommend the following methods:

- Direct observation during spotlighting. Spotlighting should be undertaken on-foot along a series of transects through suitable habitat. To increase detectability, spotlighting should be undertaken on warm nights with little wind, rain or moonlight. A minimum of two nights spotlighting is recommended to detect the species under good conditions. Surveys should be undertaken by experienced observers.
- Additional methods which may be used to detect the species include:

- Detection of greater glider remains in predator scats. These generally do not represent conclusive evidence of local occurrence, as the individuals may have been consumed in another part of the predators' home range.
- Collection of hairs using hair-tubes. This provides evidence of local presence but cannot provide any information on local population densities.

4.2 Targeted survey effort

Due to the species' listing on 25 May 2016, targeted surveys for the greater glider were not included during baseline and targeted surveys undertaken for the project by BAAM (2015) or ERM (2016). Both surveys included general nocturnal spotlighting survey effort; however, neither recorded the presence of greater gliders during opportunistic searches. GHD undertook a targeted greater glider survey in 22 – 26 August 2016 (GHD, 2016c) within suitable habitat across the project area to provide a consistent level of assessment for all EPBC Act listed species with a likelihood of occurrence within the project area.

The survey methodology for the targeted greater glider surveys is detailed in the following sections.

Targeted greater glider surveys

Targeted surveys for the greater glider were undertaken over five days and nights by a team of two ecologists. The surveys comprised the following methodology:

- Habitat assessments to document habitat quality and the presence of possible den sites
- Diurnal targeted searches for faecal pellets using an approach similar to the SAT (Phillips and Callaghan, 2011) methodology. Instead of focussing on a central koala food tree, searches focused on a central hollow-bearing tree.
- Diurnal survey to locate potential den sites in hollow-bearing trees
- Nocturnal spotlighting over four nights, with two ecologists walking a minimum of two 1 km transects per night, searching with 30W spotlights.
- Opportunistic searches for pellets of predators and predator scats including dogs, foxes and powerful owls (these provided additional information only, rather than evidence of local occurrence).

Total survey effort for the greater glider is summarised in Table 8 below.

Table 8 Targeted survey effort for the greater glider

Survey Methods	Survey	Survey Effort Undertaken
Methods recommended in DSE survey guidelines		
Targeted spotlighting Recommended effort is walking a 1 km transect over 100 minutes for a minimum of two nights for areas less than 50 ha	GHD, 2016c	Total of 50 person hours of spotlighting over five nights between 7 pm and 1 am • Five transects located within 200 m of the project area within Curra State Forest • Four transects within the vicinity of historical records in the centre of Curra State Forest (approximately 4 km east of the project area).

Survey Methods	Survey	Survey Effort Undertaken
	BAAM, 2015	General nocturnal spotlighting was undertaken over four nights targeting mature vegetation, creeks and Curra State Forest.
Habitat assessments to document habitat quality and the presence of possible den sites	ERM, 2016 GHD, 2016c	Various locations along the length of the project area within large areas of bushland.
Additional methods		
Targeted faecal pellet surveys	GHD, 2016c	25 SAT surveys were undertaken at representative locations along the length of the project area within Curra State Forest. At each location, two observers searched for faecal pellets beneath 30 trees for a period of 30 minutes (i.e. 2 minutes per tree).
Opportunistic surveys for predator scats	GHD, 2016c	Five days of opportunistic searches

4.3 Records

4.3.1 Desktop and field records

The greater glider has been historically recorded from the region on Wildnet and ALA records (refer to Table 9). The greater glider was directly observed at two locations within the project area during surveys conducted in August 2016 (refer to Figure 4 for the location of the greater glider locations).

Table 9 Greater glider records within the region

Source	Record
Wildnet / Atlas of Living Australia	Thirteen Wildnet records of the species occur within 10 km of the project area Five records were obtained by Queensland Parks and Wildlife in 1997, (four of which were within Curra State Forest) One record was from Gympie National Park. The nearest record was located 2.3 km from the project area.
Targeted field survey (GHD, 2016)	Two greater gliders were observed during spotlighting surveys, one within the project area and the other, in the vicinity of historical records in the interior of Curra State Forest, approximately 5 km north-east of the project area. Only one greater glider faecal pellet was found during targeted pellet searches of Curra State Forest. This was found beneath a greater glider observed during spotlighting in the interior of Curra State Forest, approximately 5 km north-east of the project area.

4.3.2 Importance of population

The *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) defines an important population as a population that is necessary for a species long-term survival and recovery, including those populations identified in recovery plans. Given the species recent listing under the EPBC Act, important populations of the greater glider are yet to be specifically nominated in a species-specific recovery plan.

The project area is within the limits of the species range however, no information on the genetics of this population has been collected and therefore the importance of this population for genetic diversity is unable to be quantified. As a result, it is therefore uncertain whether the population represents an 'important population' of the species.

4.4 Habitat suitability

4.4.1 Species habitat requirements

The greater glider occurs in highest densities in tall, montane, moist eucalypt forests with relatively old trees and abundant hollows (Andrews *et al.*, 1994; Smith *et al*., 1994, 1995; Kavanagh 2000; Eyre 2004; van der Ree *et al*., 2004; Vanderduys *et al*., 2012). Like the koala, the greater glider is a specialist foliovore with a diet mostly comprising eucalypt leaves, and occasionally flowers (Kehl and Borsboom 1984; Kavanagh and Lambert 1990; van der Ree *et al*., 2004). The species displays seasonal variation in food preference and therefore favours forests that contain a diversity of *Eucalyptus* spp. food tree species (Kavanagh, 1984). Due to a combination of low dispersal capability, reluctance to cross vegetation gaps and low persistence in small remnants, the species typically requires forest remnants larger than 160 km^2 to maintain viable populations (Eyre, 2002). The species is therefore expected to be particularly sensitive to habitat fragmentation (Eyre 2006; McCarthy and Lindenmayer 1999; Lindenmayer *et al*., 2000; Taylor and Goldingay 2009).

4.4.2 Habitat within the project area

Suitable foraging habitat and den sites for the greater glider were recorded in both Curra State Forest and Woondum State Forest (refer to Figure 4). Both areas contain a mix of eucalypt species which provide foliage and flowers at different times throughout the year. Although Woondum State Forest contains suitable foraging and denning habitat, the area is relatively small (<50 km^2) and not well connected to other areas of forest habitat. Based on the relatively small area of Woondum State Forest as well as the isolated nature and the absence of historical records of the greater glider, the greater glider is considered unlikely to occur (ERM, 2016). As a result, the species is not expected to occur within the southern extent of the project area.

Curra State Forest is a large and connected network of remnant vegetation (>160 km^2). Greater glider records have been reported from heterogeneous terrain associated with steep gullies and ridges in the central region of Curra State Forest. Moist montane habitat is generally considered favourable habitat for the greater glider. GHD (2016c) noted that a mix of the greater gliders' preferred food tree species was recorded along the project area including *Corymbia citriodora, Eucalyptus propinqua, E. moluccana, E. crebra* and *Lophostemon suaveolens.* Riparian vegetation along waterways within Curra State Forest supported an abundance of mature *L. confertus* and *E. tereticornis* and are likely to represent nutrient-rich foraging habitat for the greater glider. The diversity of tree species observed within the project area indicates the species is likely to have year-round access to flowering vegetation.

While suitable foraging habitat is present, very few mature, hollow-bearing trees were observed within the project area. The abundance and distribution of suitable den sites is therefore relatively limited along the project area. Mature, hollow-bearing trees that represent potential den sites for the greater glider were observed in several locations, generally along waterways. These were located in the southern and northern extents of Curra State Forest within the project area (refer to Figure 4). However, the project area supports 45.63 ha of foraging habitat and 21.83 ha denning habitat for the greater glider which primarily occurs within Curra State Forest.

4.4.3 Habitat critical to the survival of the species

Habitat critical to the survival of the greater glider has not been specified in listing advice for the species (TSSC, 2016). The *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) defines habitat critical to the survival of a species as areas that are necessary:

- For activities such as foraging, breeding, roosting or dispersal
- For the long-term maintenance of the species
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or the recovery of the species.

Targeted surveys have confirmed the presence of greater glider within Curra State Forest (GHD, 2016c) however, these surveys also noted that large areas along the project area within Curra State Forest have been intensively logged and recently burnt due to the designation of this bushland as an actively managed State Forest reducing the extent of breeding and foraging habitat. The removal of mature hollow-bearing trees through past logging activities has meant that suitable denning habitat is restricted to two locations of the project area in the northern and southern extent of Curra State Forest (refer to Figure 4). Foraging habitat for the species is present along the extent of much of Curra State Forest due to the presence of flowering eucalypt genera species. Areas of 45.63 ha of foraging habitat and 21.83 ha denning habitat of the greater glider has been mapped primarily within Curra State Forest.

Based on the degraded nature of the habitats observed and the absence of historical records from that location, habitats within the project area are unlikely to be necessary for the long-term survival of the species or for maintaining genetic diversity and long-term evolutionary development of the greater glider. Reintroduction of the species is unlikely to be undertaken in the project area as the majority of the suitable habitat is present within the actively managed State Forest.

Impact on habitat critical to the survival of the species

In this regard, given that the species has the potential to forage and breed within extensive networks of habitat that occur to the east of the project area within the central and eastern sections of Curra State Forest and throughout large areas of bushland associated with Gympie National Park to the east of the project area, habitats within the project area are unlikely to represent habitat critical to the survival of the species.

4.5 Measures to avoid, reduce or mitigate impacts

4.5.1 Avoidance

Complete avoidance of impacts on the greater glider and its habitat is not possible due to the required alignment of the project. However, the following avoidance strategies have been employed during the Planning phases:

- The project area within Curra State Forest was moved approximately 250 m to the west during the Strategic Planning Study (ARUP, 2008) to reduce impacts on the resumption of private properties, reducing impacts on approximately 20 ha of remnant vegetation within Curra State Forest (Jacobs, 2016). This reduction of impacts on remnant vegetation within Curra State Forest is likely to have reduced impacts on foraging habitat for the greater glider.

- Avoidance of habitat for the greater glider through consideration of habitat in determining the project area for the project including the placement of ancillary activities within existing cleared areas (i.e. outside Curra State Forest), where practicable.
- Avoidance of high value breeding habitat for arboreal MNES such as the greater glider. High value habitat is located further to the east outside the project area.

4.5.2 Reduction and mitigation

Where possible, a reduction of impacts on the greater glider and its habitat has been achieved through refinement of the project area in areas known to support habitat for the greater glider. Further reduction measures have been incorporated through each of the following:

- Development of contract documents to include the establishment of no-go zones.
- Limits of vegetation clearing included in contract documentation and nomination on design plans.
- Location of ancillary activities within previously cleared areas, where possible.
- Requirement for staged vegetation clearing deemed suitable by the Contract Administrator. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins).

The mitigation measures included in Appendix A include overarching environmental mitigation measures specific for terrestrial fauna, which are indirectly relevant to mitigating impacts to the greater glider. These management actions will be documented in the relevant contract documentation required for the project.

4.6 Significance of impact assessment

4.6.1 Significance of impact assessment

Impacts of the project on the greater glider have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 10 below.

Table 10 Significant impact assessment for the greater glider

Criteria	Response
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of an important population	**Unlikely.** Important populations of the greater glider have not been explicitly identified in recovery plans or the like. While the species is susceptible to declines as a result of habitat loss and fragmentation, the areas of Curra State Forest that will be directly impacted occur in less heterogeneous habitat along the western boundary of Curra State Forest. Areas of higher value habitat (i.e. montane, moist eucalypt genera forest) occur in the interior of Curra State Forest, east of the project area. These areas are not impacted by the project and will not be fragmented, as they are connected to more extensive networks

Criteria	Response
	of habitat that occur further to the east (i.e. Gympie National Park). Thus while the project has the potential to cause localised losses of denning and foraging habitat, it is unlikely to cause a significant decline in the local population. Nevertheless, clearance of hollow-bearing trees for the project may have localised impact on the species and therefore the implementation of the mitigation measures nominated in Appendix A will assist in mitigating this impact.
Reduce the area of occupancy of an important population	**Unlikely.** The project will result in localised losses of foraging habitat and the potential loss of den habitat during construction, refer to Figure 4 . However, a number of previous records have been noted within areas of higher value habitat (i.e. montane, moist eucalypt genera forest) occur in the interior of Curra State Forest, east of the project area (GHD, 2016c). Despite the anticipated localised impact of denning and foraging habitat, the magnitude of impact is expected to be relatively localised and insufficient to reduce the area of occupancy of the local population.
Fragment an important population into two or more populations	**Unlikely.** Linear infrastructure has the potential to fragment populations of the greater glider by creating a barrier to movement. However, the area of greater glider habitat to be lost as a result of the project is located along the western boundary of Curra State Forest within sub-optimal low elevation (80 – 120 m) habitats that have already been substantially degraded by past logging activities. In contrast, much of the State Forest, including higher-value montane habitats (i.e. areas up to 260 m elevation) that are typically preferred by the greater glider, remain intact and un-fragmented by the project and will remain connected to bushland habitats in the east (i.e. Gympie National Park). As a result, habitat fragmentation resulting from the project is unlikely to have a significant impact on the local greater glider population.
Adversely affect habitat critical to the survival of the species	**Unlikely.** Vegetation along the project area will be subject to localised loss of foraging habitat and loss of potential denning habitat. The abundance of suitable foraging and denning habitat in the surrounding landscape is such that the project is unlikely to adversely affect habitat value in the long term.
Disrupt the breeding cycle of an important population	**Unlikely.** The project has the potential to cause local loss of potential denning habitat in mature hollow-bearing trees. Clearing of potential denning habitat will be mitigated by incorporating the management measures in Appendix A. Clearing for construction is expected to affect a small number of individuals at most and is unlikely to have an impact at the population level.
Modify, destroy, remove, isolate or decrease the availability or quality of	**Unlikely.** The project will result in the loss of potentially suitable denning and foraging habitat for the greater glider. Localised

Criteria	Response
habitat to the extent the species is likely to decline	losses of potential denning or foraging habitat likely to result from the project are considered unlikely to lead to a decline in the local population due to the extent and higher value habitat available to the east of the project area.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	**Unlikely.** Eucalypt forests that provide habitat for the greater glider are susceptible to Phytophthora root fungus (Woinarski *et al.*, 2014). Hygiene protocols will be required during construction to limit the potential introduction of plant and machinery previously exposed to areas subject to Phytophthora, refer to mitigation measures included in Appendix A. These precautions will limit the potential impact on habitat for the greater glider during construction. The project is therefore considered unlikely to result in invasive species that may be harmful to the greater glider.
Introduce disease that may cause the species to decline	**Unlikely.** Disease is not considered to be a key threat to the greater glider. Given that most potential vectors for disease spread will be controlled through weed hygiene protocols and feral animal control measures, the project is expected to have negligible impact on the species in this regard.
Interfere substantially with the recovery of the species	**Unlikely.** Impacts on foraging habitat and potential denning habitat for the greater glider are expected to be relatively localised. Impacts resulting from the project will be predominantly limited to construction phase and are likely to be of insufficient magnitude to interfere with the long term viability or recovery of the species.

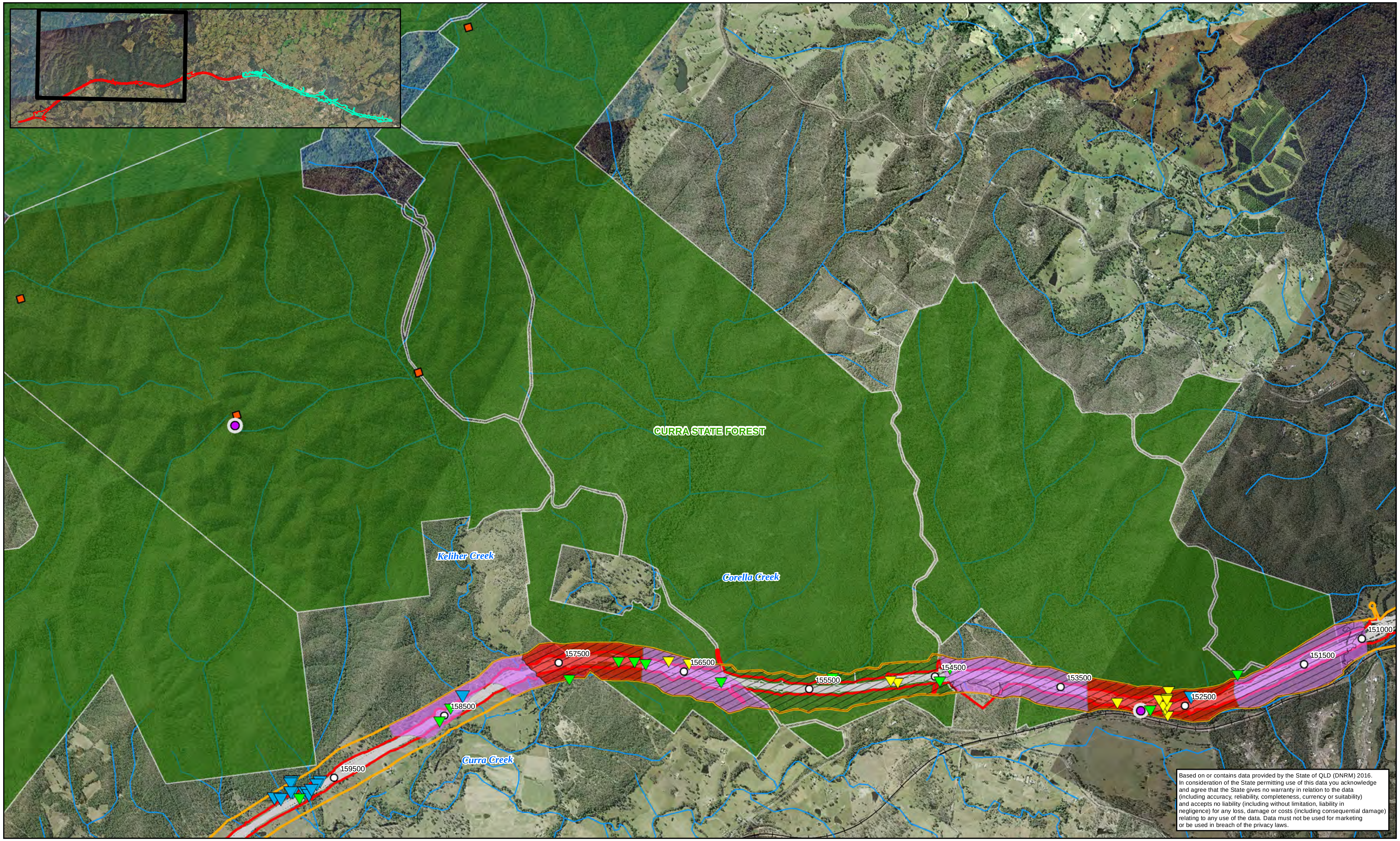
As detailed in Table 10, the project is unlikely to have a significant impact on the greater glider due to the absence of an important population and the absence of habitat critical to the survival of the species.

4.6.2 Significant residual impact

Following the implementation of avoidance, reduction and mitigation measures the project will result in a loss of 45.63 ha of foraging habitat and 21.83 ha of denning habitat of the greater glider primarily within Curra State Forest, refer to Figure 4. Although, the project will result in a loss of habitat this habitat has been assessed as not comprising habitat critical to the survival of the species and therefore the project will not result in a significant residual impact.

4.6.3 Offset strategies

No offset strategies are required for residual impacts to the great glider as the remaining residual impact is not considered to result in a significant impact on the species (refer to Table 10).



1:27,500

0 250 500 1,000 1,500

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

- 1 km Chainage
- Historic Greater Glider Record
- Greater Glider Observation (GHD)

Hollow Bearing Trees

- HBT (ERM)
- HBT (GHD)
- HBT (BAAM)

- Watercourses
- Protected Area

Project Area

- Contract 2
- Survey Area

- Greater Glider Habitat (ERM, 2016)

Greater Glider Habitat (GHD, 2016)

- Suitable Foraging Habitat
- Suitable Denning Habitat

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	24 Mar 2017

Greater Glider Records and Habitat

Figure 4

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3035_MNES_Fig04_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: TMR: BAAM HBT, ERM HBT,ERM, Greater Glider Habitat, Survey Area (2016), Imagery (2014); DNRM: Greater Glider Historic Records (2016), Cadastre, Watercourse, Road Network (2015). GHD: Road Design (November 2016), Project Area (March 2017), Greater Glider Habitat and Observation, HBT, Habitat Lost (2016). Created by: sc

5. Grey-headed flying-fox (*Pteropus poliocephalus*)

5.1 Conservation status and documentation

5.1.1 Conservation status

The grey-headed flying-fox (*Pteropus poliocephalus*) is listed as 'vulnerable' under Criterion 1 of the EPBC Act (decline in numbers). Population counts were undertaken in 1989 and 1998-2001. Although the 1998 – 2001 count was more comprehensive in survey extent (including Queensland), a reduced population count was obtained, indicating the species has experienced a decline in total abundance in the order of 30% (TSSC, 2001). This decline, combined with the loss of habitat from coastal areas of northern New South Wales and southern Queensland that is anticipated to occur in the next decade was the stimulus for the species' listing under the EPBC Act in 2001.

5.1.2 Threats to the species

Historically, this species has experienced significant loss of foraging and roosting habitat through vegetation clearing for agriculture (Birt, 2000). This has significantly reduced the abundance and diversity of flowering and fruiting tree species, particularly those with a high nectar output (Birt, 2000). Current key threats to the species include:

- Loss of habitat due to urban expansion. This affects the species through:
  - Loss of winter foraging resources such as *Melaleuca quinquenervia* (broad-leaved paper bark), *Corymbia maculata* (spotted gum), *Eucalyptus robusta* (swamp mahogany) and *Eucalyptus tereticornis* (Queensland blue gum) in coastal areas of northern New South Wales and southern Queensland that are being targeted for development.
  - Loss of potential roosting habitat, and increased reliance on habitats within the urban fringe
  - Increased reliance on alternative food sources (i.e. commercial fruit crops)
  - Reduced energetic efficiency due to increased distances between foraging sites.
- Direct mortality of individuals via illegal shooting of flying foxes that are feeding on commercial fruit crops. The magnitude of this impact is uncertain but has been estimated at 100,000 individuals annually (Vardon and Tidemann 1995).
- Competition with the black flying-fox (*Pteropus alecto*).
- Mortality due to electrocution on powerlines, accumulation of biotoxins and pathogens such as the Australian Bat Lyssavirus, Bat Paramyxovirus and Menangle Pig virus.

5.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessment for this species:

- The *Action Plan for Australian Mammals 2012* (Woinarski *et al.*, 2014)
- The *Survey Guidelines for Australia's Threatened Bats: Guidelines for detecting bats listed under the EPBC Act* (DEWHA, 2010b)

- *Referral Guideline for Management Actions in Grey-headed and Spectacled Flying-fox Camps* (DoE, 2015)
- *Draft National Recovery Plan for the Grey-headed Flying-fox (Pteropus poliocephalus)* (DEE, 2017)
- *Terrestrial Vertebrate Survey Guidelines for Queensland* (DSITIA, 2014).

5.1.4 Recommended survey methods

Recommended survey methods were taken from those detailed for the grey-headed flying-fox within the *Survey Guidelines for Australia's Threatened Bats: Guidelines for detecting bats listed under the EPBC Act* (DEWHA, 2010b). These recommend the following methods:

- A desktop review of known flying-fox roost camps within the project area and surrounding region
- Daytime surveys of vegetation within the project area to establish the presence of significant stands of foraging species
- Daytime searches for roosting camps along linear transects spaced 100 m apart
- Nocturnal spotlighting surveys, whilst walking transects spaced 100 m apart to locate flying or feeding individuals.

5.2 Targeted survey effort

Targeted surveys for the grey-headed flying-fox were undertaken by BAAM (2015) and ERM (2016).

BAAM (2015) targeted grey-headed flying-fox surveys

BAAM undertook targeted surveys for the grey-headed flying-fox as part of nocturnal spotlighting. This was undertaken over four nights at targeted creeks and at Curra State Forest at four trapping sites.

ERM (2016) targeted grey-headed flying-fox surveys

During SAT surveys for koala, ERM undertook targeted surveys for significant food trees of the grey-headed flying-fox. This information was used to calculate the relative dominance of significant food tree species in each RE community. Locations with high densities of food trees were recorded in areas of remnant vegetation and orchards.

Total survey effort for the grey-headed flying-fox is summarised in Table 11 below.

Table 11 Targeted survey effort for the grey-headed flying-fox

Survey Methods	Survey	Survey Effort Undertaken
Methods recommended in *Survey Guidelines for Australia's Threatened Bats: Guidelines for detecting bats listed under the EPBC Act*		
Targeted spotlighting Recommended effort is 5 hrs / 50 ha	BAAM, 2015	General nocturnal spotlighting was undertaken for the REF over four nights, targeting creeks, Curra State Forest and trapping sites. Total of approximately 24 hrs spotlighting.
Daytime searches for roost camps Recommended effort is 5 hrs / 50 ha	BAAM, 2015	Five days of surveys across the project area

Daytime surveys of vegetation for significant food trees	ERM, 2016	Surveyed 1230 trees at 42 SAT survey sites

5.3 Records

5.3.1 Desktop and field results

The grey-headed flying fox has been historically recorded from the region according to Wildnet and Atlas of Living Australia records and recently recorded during targeted surveys by BAAM (2015) and ERM (2016), refer to Table 12 and Figure 5.

Table 12 Grey-headed flying-fox records within the region

Source	Record
Wildnet/Atlas of Living Australia	Thirty-nine records of the species are listed in both Wildnet and ALA databases within 10 km of the project area: 38 records at Gympie township, Widgee Crossing, 5 km west of the project area One record at Hill Street camp, 1.7 km west of the project area.
2012-2015 Flying Fox Monitoring program (DEE, 2016a)	Known camps for the grey-headed flying-fox occur within the region at Goomboorian, Gympie township, Kandanga and Cooran areas (DEE, 2016a). The Gympie township camp is located approximately 6 km west of the project area.
Targeted field survey (BAAM, 2015)	No flying-fox roost camps were detected within the project area during the BAAM (2015) surveys. An individual grey-headed flying-fox was recorded 500 m to the east of project area within Curra State Forest during BAAM (2015) surveys.
Targeted field survey (ERM, 2016)	Flying-foxes were recorded within the project area by ERM (2016), however, the species identity was unconfirmed. Given the species forages up to 25 km and the project area contains suitable foraging habitat for the species, the grey-headed flying-fox was considered likely to forage within the project area by ERM (2016).

5.3.2 Importance of population

Important populations of the grey-headed flying-fox have not been specifically nominated in the *Referral Guideline for Management Actions in Grey-headed and Spectacled Flying-fox Camps* (DoE, 2015). However, due to constant genetic interchange and movement of individuals between camps throughout the species' entire range, there are no genetically isolated populations. The species is therefore considered to be a single interbreeding population (Webb and Tidemann 1995). Given that the project area is within the limits of the grey-headed flying-foxes range and there is no evidence that the local population located to the west of the project area is important for genetic diversity, the local population is not expected to represent an important population.

5.4 Habitat suitability

5.4.1 Species habitat requirements

The grey-headed flying-fox feeds on nectar and pollen from flowers of canopy trees and fleshy fruits from rainforest trees and vines (Tidemann, 1999; Hall and Richards, 2000). As with all Australian flying-foxes, *Eucalyptus* forest (including *Eucalyptus* and *Corymbia* species) are the most important contributors of nectar and pollen within the diet of the grey-headed flying-fox (Eby and Law, 2008). The species forages widely to overcome seasonal and longer-term temporal changes in food resource value and availability. The species roosts near water within stands of rainforest, *Melaleuca*, mangroves and riparian vegetation (van der Ree *at al*., 2005).

5.4.2 Habitat within the project area

Suitable foraging habitat occurs throughout the project area and contains a diverse variety of *Eucalyptus* and *Corymbia* food tree species that provide nectar and pollen resources throughout the year. An area of 251.50 ha of suitable foraging habitat was mapped in Figure 5a – 5f of the *Terrestrial Fauna Survey Report Bruce Highway (Cooroy to Curra) Project Section D* (ERM, 2016) and shown in Figure 5 of this document. The largest areas of potential foraging habitat occur in Curra State Forest and Woondum State Forest. However, the grey-headed flying-fox is likely to forage in smaller remnants of vegetation including non-remnant patches that occur along the length of the project area. No known roosting camps are present within the project area despite numerous terrestrial fauna surveys having been undertaken.

5.4.3 Habitat critical to the survival of the species

Habitat critical to the survival of the grey-headed flying-fox has not been specified in listing advice for the species. The *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) defines habitat critical to the survival of a species as areas that are necessary:

- For activities such as foraging, breeding, roosting or dispersal
- For the long-term maintenance of the species
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or the recovery of the species

The *Draft Recovery Plan for the Grey-headed flying-fox Pteropus poliocephalus* (DEE, 2017) states that habitat and associated seasonal resources which are critical to the survival of the species are yet to be mapped. However, the loss of winter forage is considered a primary threat to the species with the loss of spring forage unlikely to adequately provide resources for the species (DEE, 2017).

The project will impact upon vegetation communities which contain *Eucalyptus tereticornis*, *E. crebra*, *E. fibrosa*, *E. pilularis*, *E. robusta*, *E. siderophloia*, *Banksia integrifolia*, *Castanospermum australe*, *Corymbia citriodora citriodora*, *Grevillea robusta* and *Melaleuca quinquenervia*. Vegetation communities containing the aforementioned species are listed on the recovery plan as important winter and spring habitats (DEE, 2017). However, the recovery plan does not attribute an area value to what constitutes habitat critical to the survival of the species.

The project will result in the loss of 251.50 ha of suitable foraging habitat which is likely to contain the previously mentioned species. However, it is important to note the relative abundance of suitable foraging habitat which contains both winter and spring forage within the broader region and particularly to the east of Curra State Forest. The habitat within the project area is unlikely to be defined as dispersal habitat given the species' high mobility. Habitat within project area is also unlikely to be necessary for the long-term maintenance of the species and to maintain genetic diversity and long-term evolutionary development of the species given the species' high mobility and lack of high numbers of previous records within the project area. Reintroduction of the species is unlikely to be undertaken in the project area as the majority of the suitable habitat is present within the actively managed State Forests.

Impact on habitat critical to the survival of the species

In this regard, given that the species forages widely throughout the region and suitable foraging habitat is widely available in the broader region, habitats within the project area are unlikely to represent habitat critical to the survival of the species.

5.5 Measures to avoid, reduce or mitigate impacts

5.5.1 Avoidance

Complete avoidance of impacts on foraging habitat for the grey-headed flying-fox is not possible due to the required alignment of the project. However, the following avoidance strategies have been employed during the Planning phases:

- The project area within Curra State Forest was moved approximately 250 m to the west during the Strategic Planning Study (ARUP, 2008) to reduce impacts on the resumption of private properties, reducing impacts on approximately 20 ha of remnant vegetation within Curra State Forest (Jacobs, 2016). This reduction on impacts on remnant vegetation within Curra State Forest is likely to have reduced impacts on foraging habitat for the grey-headed flying-fox.

5.5.2 Reduction and mitigation

Where possible, a reduction of impacts on foraging habitat for the grey-headed flying-fox has been achieved through refinement of the project area in areas known to support foraging habitat for the grey-headed flying-fox. Further reduction measures have been incorporated through each of the following:

- Development of contract documents to include the establishment of no-go zones.
- Limits of vegetation clearing included in contract documentation and nomination on design plans.
- Location of ancillary activities within previously cleared areas, where possible.
- Requirement for staged vegetation clearing deemed suitable by the Contract Administrator. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins).

The mitigation measures in Appendix A include overarching environmental mitigation measures for terrestrial fauna species, which are indirectly relevant to mitigating impacts to the grey-headed flying-fox. These management actions will be documented in the relevant contract documentation required for the project.

5.6 Significance of impact assessment

5.6.1 Significance of impact assessment

Impacts of the project on the grey-headed flying-fox have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 13.

Table 13 Significant impact assessment for the grey-headed flying-fox

Criteria	Response
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of an important population	**Unlikely.** A single roosting camp is located approximately 6 km to the west of the project area within riparian vegetation of the Mary River (DEE, 2016a). There are no separate or distinct populations of the grey-headed flying-fox due to the constant genetic exchange and movement between camps throughout the species' entire geographic range (DEE, 2016a). This indicates that there is one single interbreeding population. The grey-headed flying-fox is known to occur north to Bundaberg and a breeding population has been recorded as far north as Mackay (DEE, 2017). Due to the above, the population present within the broader Gympie region is unlikely to constitute an important population as it is unlikely to be a key source population for breeding or dispersal, unlikely to be necessary for maintaining genetic diversity and is not near the limit of the species range.
Reduce the area of occupancy of an important population	**Unlikely.** As detailed above, the population within the broader Gympie region is unlikely to represent an important population. The project will result in localised losses of foraging habitat within an actively managed State forest within which one unidentified flying-fox individual was recorded during targeted surveys and will not impact on known roosting camps. Given the wide distribution and broad availability of suitable foraging habitat within the surrounding region, the project is unlikely to affect the area of occupancy of the species.
Fragment an existing important population into two or more populations	**Unlikely.** As previously stated, the population within the broader Gympie region is unlikely to represent an important population. Furthermore, the grey-headed flying fox is highly mobile and has the capacity to fly over infrastructure within suburbia and other large built up areas. Given the high level of movement of individuals between camps across the species entire range the species is considered a single interbreeding population (DEE, 2016a). While the project will cause localised fragmentation of habitat, this will not create a barrier to the movement for the grey-headed flying-fox.
Adversely affect habitat critical to the survival of the species	**Unlikely.** The *Draft Recovery Plan for the Grey-headed flying-fox Pteropus poliocephalus* (DEE, 2017) states that habitat and associated seasonal resources which are critical to the survival of the species are yet to be mapped. However, the loss of winter forage is considered a primary threat to the species with the loss of spring forage unlikely to adequately provide resources for the species (DEE, 2017). The project will impact upon vegetation communities which contain *Eucalyptus tereticornis*, *E. crebra*, *E. fibrosa*, *E. pilularis*, *E.*

Criteria	Response
	robusta, *E. siderophloia*, *Banksia integrifolia*, *Castanospermum australe*, *Corymbia citriodora citriodora*, *Grevillea robusta* and *Melaleuca quinquenervia*. Vegetation communities containing the aforementioned species are listed on the recovery plan as important winter and spring habitats (DEE, 2017). However, the recovery plan does not attribute an area value to what constitutes habitat critical to the survival of the species. The project will result in the loss of 251.50 ha of suitable foraging habitat which is likely to contain the previously mentioned flora species. However, it is important to note the relative abundance of suitable foraging habitat which contains both winter and spring forage within the broader region and particularly to the east of the project within Curra State Forest. Due to the extent of resources available within the broader region, the impact of the loss of foraging habitat from the project on the grey-headed flying fox population is unlikely to significantly impact the species.
Disrupt the breeding cycle of an important population	**Unlikely.** A single roosting camp is located approximately 6 km to the west of the project area within riparian vegetation of the Mary River (DEE, 2016a). This population is unlikely to represent an important population. Grey-headed flying-foxes are also known to undertake their breeding activities, such as birth, lactation and conception at roost sites (DEE, 2017). As no known roost sites are located within the project area the project will not disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent the species is likely to decline	**Unlikely.** Although, the project will result in the destruction of 251.50 ha of suitable foraging habitat, this loss is unlikely to result in the species to decline given that impacts on foraging habitat will be relatively localised and there is a substantial amount of suitable foraging habitat within the region.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	**Unlikely.** The grey-headed flying fox is generally not susceptible to predation by feral predators or competition or exclusion by introduced species. As a result, the project is unlikely to have an adverse impact on the grey-headed flying fox due to invasive species.
Introduce disease that may cause the species to decline	**Unlikely.** The grey-headed flying fox is potentially susceptible to pathogens including the Australian Bat Lyssavirus, Bat Paramyxovirus and Menangle Pig virus (Hoar *et al.*, 1998). However, the project is unlikely to have any impact on vectors that could exacerbate the spread of these diseases. Standard hygiene protocols will be used during construction and are considered likely to reduce disease risks to the grey-headed flying fox to negligible levels.
Interfere substantially with the recovery of the species	**Unlikely.** Recovery actions for the grey-headed flying-fox are detailed in the *Draft Recovery Plan for the Grey-headed flying-fox Pteropus poliocephalus* (DEE, 2017). Recovery objectives include:

Criteria	Response
	• Identify, protect and enhance native foraging habitat critical to the survival of the grey-headed flying-fox. • Identify, protect and enhance roosting habitat of grey-headed flying-fox camps. • Determine population trends in grey-headed flying-foxes so as to monitor the species' national distribution and conservation status. • Build community capacity to coexist with flying-foxes and minimise the impacts on urban settlements from existing camps without resorting to dispersal. • Increase public awareness and understanding of grey-headed flying-foxes and the recovery program, and involve the community in the recovery program where appropriate. • Improve the management of grey-headed flying-fox camps in sensitive areas. • Significantly reduce levels of deliberate grey-headed flying-fox habitat destruction associated with commercial horticulture. • Support research activities that will improve the conservation status and management of grey-headed flying-foxes. • Assess and reduce the impact on grey-headed flying-foxes of electrocution on power lines, and entanglement in netting and on barbed-wire. The project will not interfere with any of these recovery actions and, as such, the project is not expected to interfere with the recovery of the species.

As detailed in Table 13, the project is unlikely to have a significant impact on the grey-headed flying-fox due to the absence of an important population. Although the project has the potential to impact upon winter and spring foraging habitat, this habitat is unlikely to constitute habitat critical to the survival of the species due to the wide spread availability of such habitat within the broader region.

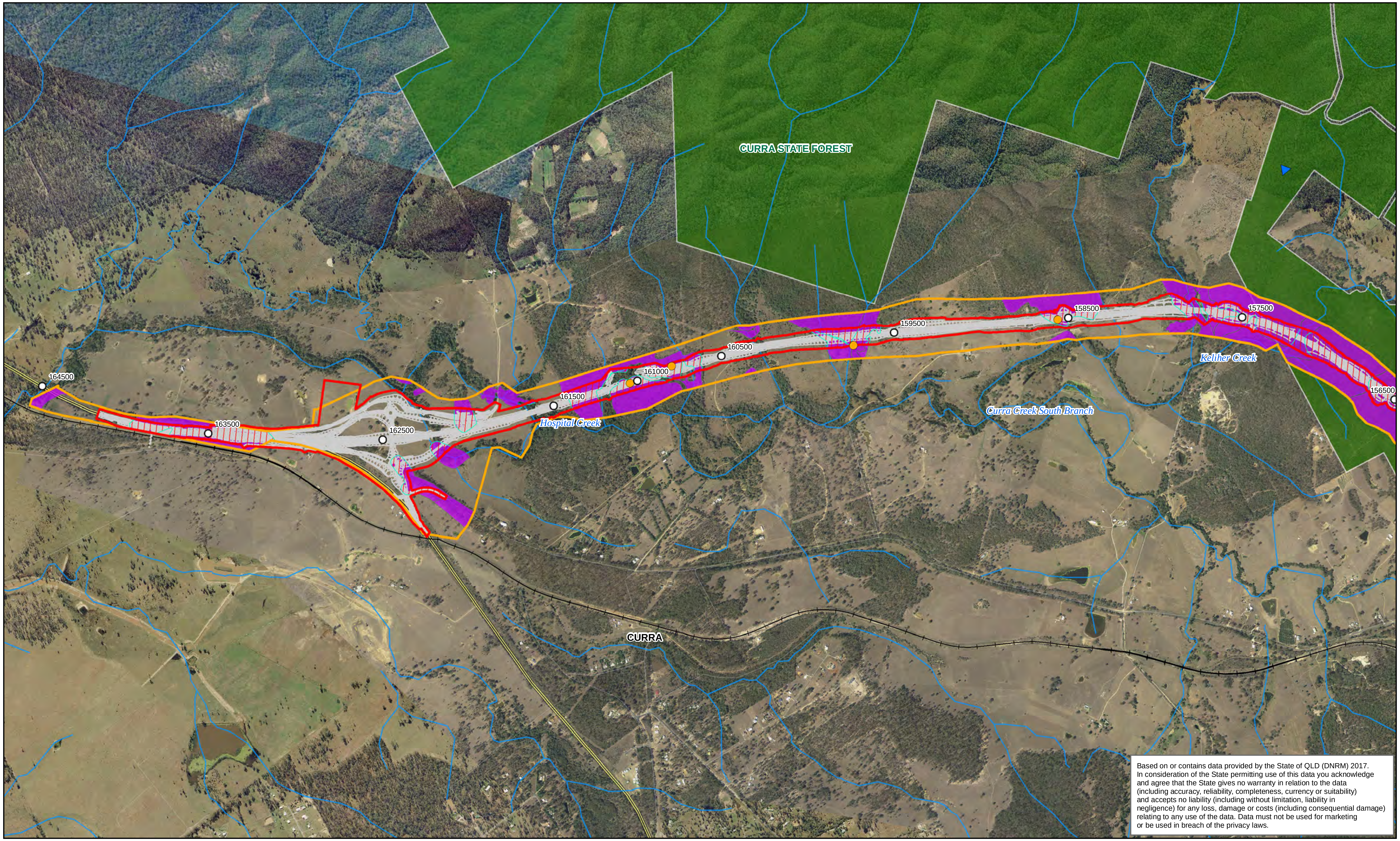
It is noted the construction works associated with the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project were assessed as resulting in a significant impact on the grey-headed flying-fox due to the potential for habitat fragmentation to occur as a result of the project. The current project (Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project) will result in the loss of forage habitat for the species however, as previously mentioned the project is situated on the western extent of Curra State Forest and will therefore not result in habitat fragmentation for the species. Furthermore, due to the availability of foraging resources within the broader region, the impact of the loss of foraging habitat from the project on the grey-headed flying fox population is unlikely to significantly impact the species.

5.6.2 Significant residual impact

Following the implementation of avoidance, reduction and mitigation measures the project will result in a loss of 251.50 ha of suitable foraging habitat for the grey-headed flying-fox, refer to Figure 5. Although, the project will result in a loss of habitat, this habitat has been assessed as not comprising habitat critical to the survival of the species and therefore the project will not result in a significant residual impact to the species.

5.6.3 Offset strategies

No offset strategies are required for impacts to the grey-headed flying-fox as the remaining residual impact is not considered to result in a significant impact on the species (refer to Table 13).



Paper Size A3

0 0.125 0.25 0.5 0.75 1

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- Town
- 1 km Chainage
- Railway
- Highway
- Street/Local Road
- Protected Areas

Project Area

- Contract 1
- Contract 2
- Survey Area
- Habitat Lost

Grey-headed Flying-fox

- Grey-Headed Flying Fox (Fleshy Fruit Present)
- Grey-headed Flying Fox (Record) (BAAM, 2015)
- GHFF Foraging Habitat (ERM, 2016)

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
Revision	0
Date	24 Mar 2017

Grey-headed flying-fox records and habitat

Figure 5
Sheet 1 of 4

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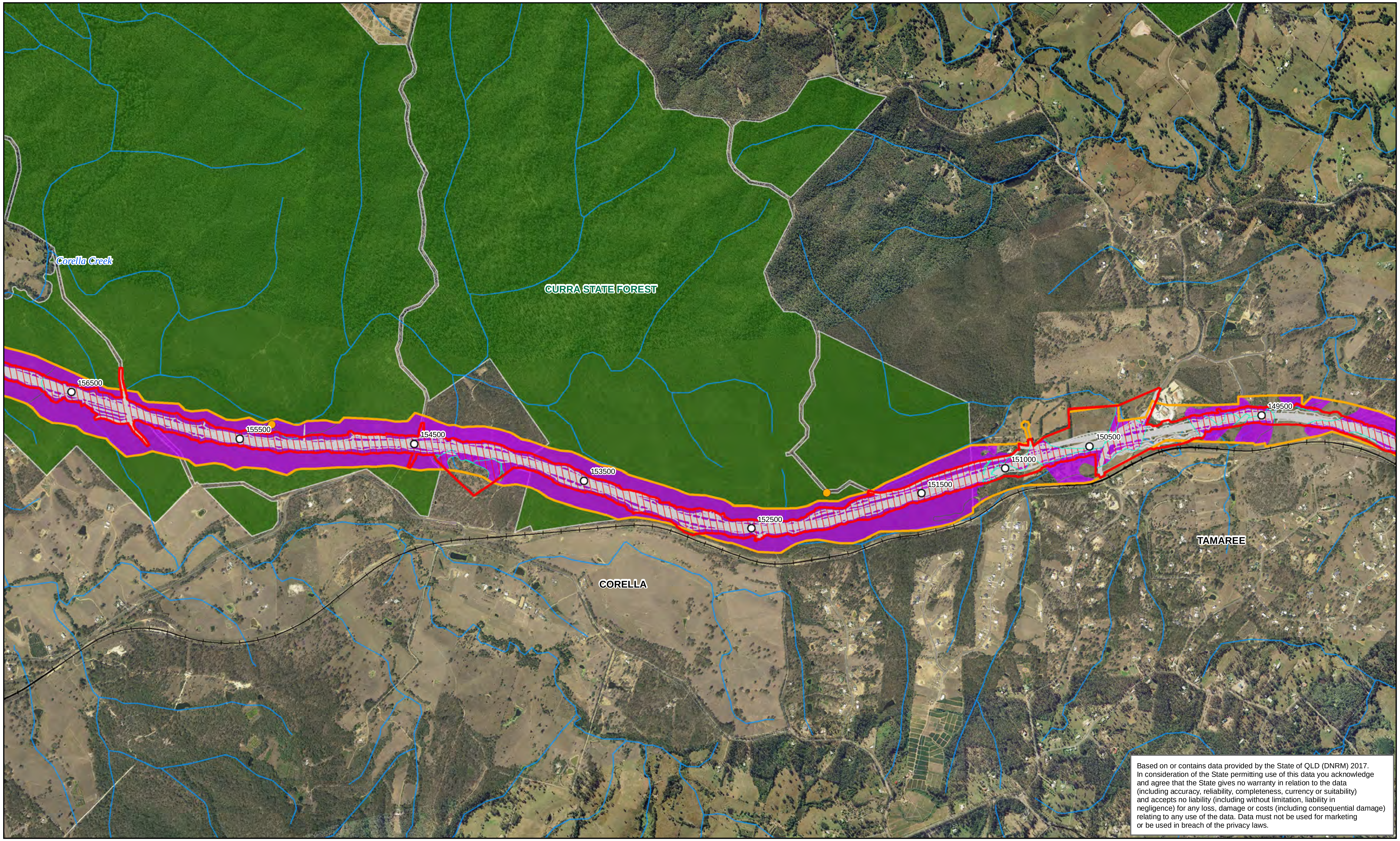
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015), Protected Areas (2014); TMR: Imagery, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, Grey-headed Flying-fox foraging habitat (2016). GHD: Project Area (March 2017), Road Design (November 2016), Habitat Lost (2016). Created by:schadwick



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- Town
- 1 km Chainage
- Railway
- Local Connector Road
- Street/Local Road
- Protected Areas

Project Area

- Contract 1
- Contract 2
- Survey Area
- Habitat Lost

Grey-headed Flying-fox

- Grey-Headed Flying Fox (Fleshy Fruit Present)
- GHFF Foraging Habitat (ERM, 2016)

Department of Transport and Main Roads
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Grey-headed flying-fox records and habitat

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Figure 5
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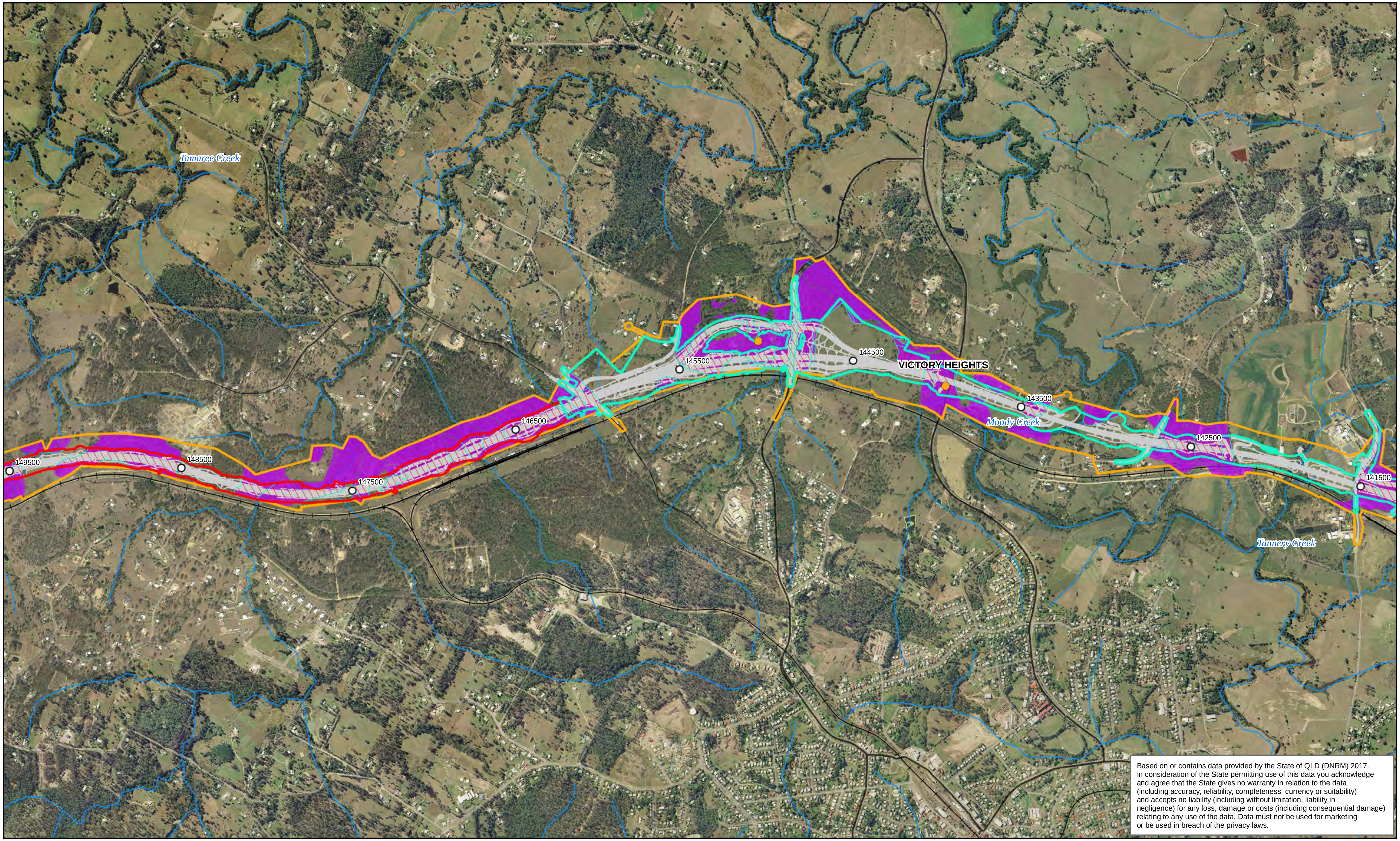

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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LEGEND

- Town
- 1 km Chainage
- Railway
- Secondary Road
- Local Connector Road
- Street/Local Road
- Protected Areas

Project Area

- Contract 1
- Contract 2
- Survey Area

- Habitat Lost

Grey-headed Flying-fox

- Grey-Headed Flying Fox (Fleshy Fruit Present)
- GHFF Foraging Habitat (ERM, 2016)

Department of Transport and Main Roads

Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
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Grey-headed flying-fox records and habitat

Figure 5
Sheet 3 of 4

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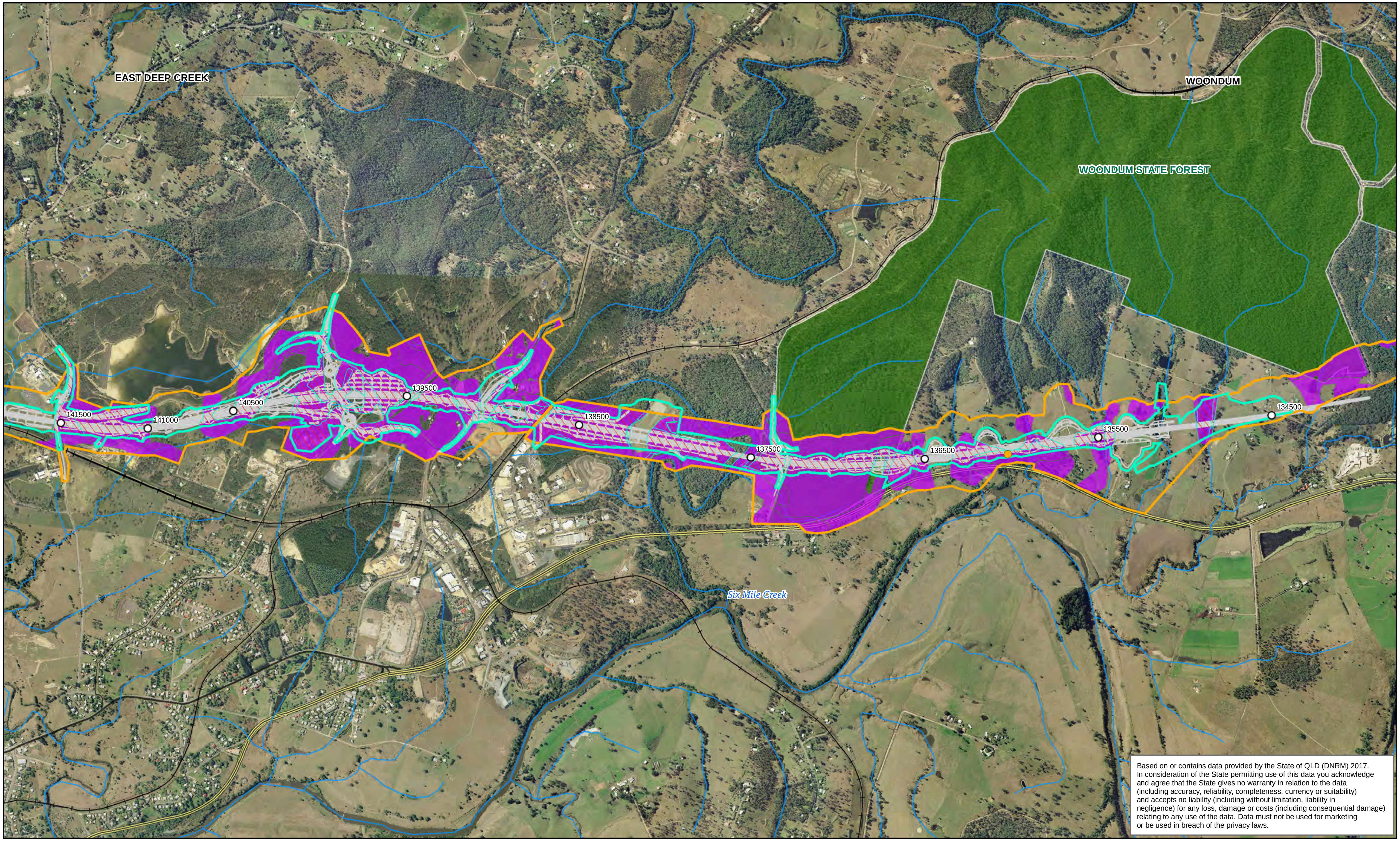
Data source: DNRM: Rail (2014), Roads (2016), Towns (2015), Protected Areas (2014); TMR: Imagery, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, Grey-headed Flying-fox foraging habitat (2016). GHD: Project Area (March 2017), Road Design (November 2016), Habitat Lost (2016). Created by:schadwick



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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LEGEND

Town	Secondary Road	**Project Area**	Habitat Lost
1 km Chainage	Local Connector Road	Contract 1	**Grey-headed Flying-fox**
Railway	Street/Local Road	Contract 2	Grey-Headed Flying Fox (Fleshy Fruit Present)
Highway	Protected Areas	Survey Area	GHFF Foraging Habitat (ERM, 2016)

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
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Data source: DNRM: Rail (2014), Roads (2016), Towns (2015), Protected Areas (2014); TMR: Imagery, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, Grey-headed Flying-fox foraging habitat (2016). GHD: Project Area (March 2017), Road Design (November 2016), Habitat Lost (2016). Created by:schadwick

6. Migratory species

6.1 Conservation status and documentation

6.1.1 Conservation status

Ten migratory and/or marine bird species listed under the EPBC Act have been confirmed present or are considered likely to occur within the project area. These can be divided into the following three broad functional groups:

- **Rainforest and wet eucalypt species**
  - spectacled monarch (*Symposiarchus trivirgatus*)
  - rufous fantail (*Rhipidura ruficauda*)
  - black-faced monarch (*Monarcha melanopsis*)
- **Habitat generalists/aerial species**
  - rainbow bee-eater (*Merops ornatus*)
  - white-throated needletail *Hirundapus caudacutus*)
  - fork-tailed swift (*Ardea modesta*)
- **Wetland dependent species**
  - common sandpiper (*Actitis hypoleucos*)
  - Latham's snipe (*Gallinago hardwickii*)
  - cattle egret (*Ardea ibis*)
  - eastern great egret (*Apus pacificus*)

Given the ecological similarities among the species within each group, the assessment of significance of impact has been undertaken on a functional group basis.

6.1.2 Threats to the species

Threats faced by migratory/marine species typically vary between functional groups. The threats faced by each group are detailed below.

Rainforest and wet eucalypt dependent migrant bird species

Key threats facing these species are associated with loss and fragmentation of core breeding habitat within rainforest and wet sclerophyll forest resulting from urbanisation and the loss of habitat corridors along migration routes (Huggett, 2000). The species are also susceptible to occasional collision with houses (Taplin, 1991). Predation by feral predators, particularly feral cats is also considered a threat to some rainforest and wet eucalypt dependent migrant bird species.

Habitat generalist/aerial migratory birds

The introduced cane toad (*Rhinella marina*) is considered to be a key threat to the rainbow bee-eater, usurping its nesting burrows and feeding on eggs and nestlings (Boland, 2004). Historically, the rainbow bee-eater was also threatened by shooting, as it was considered a noxious pest in the 1930's and hunted for its feathers. The impacts of predation on the rainbow bee-eater by other feral predators such as dogs, cats and foxes is uncertain. Aerial species such as the fork-tailed swift and white-throated needletail have few threatening processes within Australia. Both species experience some mortality through collision with powerlines, windows, lighthouses and other man-made structures. However, the rate of mortality is not considered to be sufficiently high to represent a threat to the species (DEE, 2016b).

Wetland dependent and shorebird migratory bird species

The greatest threat facing wetland-dependent and wader bird species is loss and degradation of foraging and breeding habitat through reclamation of wetlands and mudflats for coastal development and alteration of overland flows. Other key threats include wetland pollution and harvesting of shellfish (DEE, 2016b). Historically, migratory wetland bird species have been subjected to high losses due to hunting (DEE, 2016b).

6.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessment for this species:

- *Draft Referral Guidelines for 14 birds listed as migratory species under the EPBC Act (DoE, 2015b)*
- *EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebirds (DoE, 2015c)*
- *Terrestrial Vertebrate Survey Guidelines for Queensland* (DSITIA, 2014).

6.1.4 Recommended survey methods

Recommended survey methods were taken from those detailed within the *Draft Referral Guidelines for 14 birds listed as migratory species under the EPBC Act* (DoE, 2015b) and the Species Profile and Threats Database (DEE, 2016b).

Rainforest and wet eucalypt dependent migrant bird species

Recommended survey methods for the black-faced monarch, spectacled monarch and rufous fantail include standardised 20-minute visual and aural area surveys undertaken within a 2 ha area. These should target areas of suitable habitat and coincide with northward and southward migrations during spring and autumn (DoE, 2015b)

Habitat generalist/aerial migratory birds

There are no standard survey techniques for swifts. However, visual surveys can be undertaken from an elevated position by an experienced observer (DoE, 2015b). If white-throated needletails are known to occur, targeted visual surveys should be undertaken in the late evening, watching potential roost sites in very tall trees along ridgetops (DoE, 2015b). The rainbow bee-eater is a readily identified bird that can be easily identified during standardised 20-minute visual and aural area surveys undertaken within a 2 ha area or by incidental visual or aural records.

Wetland dependent and shorebird migratory bird species

Surveys for wetland birds such as egrets and waders can be undertaken using a combination of habitat assessments to identify and target potential breeding and foraging habitat, standardised area surveys conducted on foot and searches of potential nests (DoE, 2016b).

6.2 Targeted survey effort

Targeted surveys for migratory/marine bird species listed under the EPBC Act were undertaken by BAAM (2015) and ERM (2016).

BAAM (2015) targeted migratory bird surveys

BAAM undertook standardised visual and aural area surveys for terrestrial birds (including migratory/marine birds listed under the EPBC Act) at 39 locations throughout the project area. These were timed, 20-minute surveys of a 2 ha search area, in accordance with the Birds Australia Atlas methodology.

ERM (2016) targeted migratory bird surveys

ERM undertook habitat assessments for migratory bird species at 45 sites across the project area. Incidental observations of migratory bird species were noted during all survey effort undertaken by ERM for the project.

6.3 Records

6.3.1 Database searches

Eleven migratory and/or marine bird species have been historically recorded from within 10 km of the project area according to BirdData and Atlas of Living Australia records. Historical records for migratory bird species are summarised in Table 14.

Table 14 Local historical records of EPBC Act listed migratory birds

Species	Number of records	Source	Dates
Rainforest and wet eucalypt dependent species			
Spectacled monarch	8	ALA	1993 - 2015
	21	BirdData	1997 - 2007
Rufous fantail	22	ALA	1993 - 2015
	21	BirdData	1999 - 2007
Black-faced monarch	12	ALA	1993 - 2015
	6	BirdData	1999 - 2007
Habitat generalists and aerial bird species			
Rainbow bee-eater	110	ALA	1976 - 2014
	91	BirdData	1998 - 2014
Fork-tailed swift	1	ALA	Date not specified
White-throated needletail	24		1906 - 2014
Wetland dependent and shorebird species			
Common sandpiper	1	ALA	2007
Latham's snipe	4	ALA	1905 - 2003
	1	BirdData	2008
Cattle egret	156	ALA	1986 - 2015
	158	BirdData	1998 - 2014

Species	Number of records	Source	Dates
Eastern great egret	42	ALA	1977 - 2010
	40	BirdData	1999 - 2014
Australian reed-warbler	18	ALA	1977 - 2000

6.3.2 Field survey results

Five migratory bird species were recorded within the project area during the BAAM (2015) and ERM (2016) field surveys. Details of species recorded during field surveys are summarised in Table 15 below.

Table 15 EPBC Act listed migratory birds recorded in field surveys

Species	Location	Survey
Rainforest and wet eucalypt dependent species		
Spectacled monarch	One individual recorded within vine forest in Woondum State Forest	ERM, 2016
Rufous fantail	One individual recorded within vine forest in Woondum State Forest	ERM, 2016
	Species recorded from unspecified location	BAAM, 2015
Habitat generalists and aerial bird species		
Fork-tailed swift	Less than 10 individuals were observed flying overhead from the north of Curra State Forest	ERM, 2016
Rainbow bee-eater	Recorded from three locations in Curra State Forest, Woondum State Forest and in Victory Heights near the Gympie Connection Road	ERM, 2016
	Species recorded from unspecified location	BAAM, 2015
Wetland dependent and shorebird species		
Cattle egret	Species recorded from unspecified location	BAAM, 2015

6.3.1 Ecologically significant proportion of the population

A key element of the significance of impact assessment for migratory bird species relies on determining whether the number of birds affected represents ‘an ecologically significant proportion’ of the population. The *Draft Referral Guidelines for 14 birds listed as migratory species under the EPBC Act* (DoE, 2015b) defines an ecologically significant proportion of a migratory bird population to be 1% of the international population and 0.1% of the national population. Estimates of the number of birds required to represent a significant proportion of the internationally important and nationally important population are detailed in Table 16. Species denoted with an asterisk (*) represent those for which a population estimate is not provided in the *Draft Referral Guidelines for 14 birds listed as migratory species under the EPBC Act* (DoE, 2015b). For these species, population estimates were obtained from the Species Profile and Threats Database (DEE, 2016b), where (#) represents 1% of the total global population estimate and (^) represents 0.1% of the total East Asian-Australasian flyway population estimate. There are no estimates of important population sizes for Marine bird species (i.e. cattle egret, eastern great egret and Australian reed-warbler).

Table 16 Size of internationally and nationally significant migratory bird populations

Species	Estimate of number of birds required to be considered Internationally important population	Estimate of number of birds required to be considered Nationally important population
Rainforest and wet eucalypt dependent species		
Spectacled monarch	6,500	650
Black-faced monarch	4,600	460
Rufous fantail	48,000	4,800
Habitat generalists and aerial bird species		
Fork-tailed swift	1,000	100
White-throated needletail	100	10
Rainbow bee-eater*	100,000	10,000
Wetland dependent and shorebird species		
Cattle egret*	N/A	N/A
Eastern great egret*	N/A	N/A
Latham's snipe*	18	18
Australian reed warbler*	N/A	N/A
Common sandpiper	245,500 – 403,000#	250 – 1,000^

For each species listed above, the number of birds likely to occur within the project area would not represent a significant proportion of the international or national total population. This assessment is based on the small numbers of individuals that were observed during field surveys and the relatively small, localised areas of suitable habitat present within the project area for each species.

6.4 Habitat suitability

6.4.1 Species habitat requirements

The habitat requirements of EPBC Act listed migratory bird species are detailed for each functional group of species below.

Rainforest and wet eucalypt dependent migrant bird species

These species are distributed along the east coast of Australia and are typically restricted to areas of rainforest and wet sclerophyll forest. During migration these species can be found within drier Eucalypt forests (DEE, 2016b).

Habitat generalist/aerial migratory birds

The rainbow bee-eater, fork-tailed swift and white-throated needletail have generalist habitat requirements, occurring over a broad range of habitat types including cleared agricultural landscapes (DEE, 2016b). The fork-tailed swift and white-throated needletail are predominantly aerial species and rarely alight within Australia (DEE, 2016b).

Wetland dependent and shorebird migratory bird species

These species are widely distributed throughout Australia, typically breeding and foraging in wetland habitats. Specific habitat requirements are detailed for each species below:

- Latham's snipe occurs in permanent and ephemeral open freshwater wetlands with low, dense vegetation
- Cattle egret occurs in shallow, open water wetlands and forages in poorly drained grasslands often near cattle and other livestock
- Eastern great egret occurs in a wide range of wetland habitats including saline and freshwater, permanent and ephemeral, inland and coastal including the margins of rivers and lakes, marshes and swamps, creeks and drainage channels, sewage treatment plants, open pasture.
- Australian reed-warbler occurs in dense reeds and fringing vegetation adjacent to waterbodies.
- Common sandpiper is a coastal shorebird found predominantly on muddy margins and rocky shores and only rarely on mudflats. The species forages widely in coastal wetlands associated with estuaries and deltas but also further upstream along the muddy banks of lakes, pools, billabongs, claypans and other wetlands (DEE, 2016b).

6.4.2 Habitat within the project area

Suitable habitat for migratory/marine bird species occurs within the project area. Habitats observed within the project area are described for each functional group below.

Rainforest and wet eucalypt dependent migrant bird species

Suitable habitat for these species occurs in dense vine thicket and wet sclerophyll forest within Woondum State Forest, in riparian zones along Six Mile Creek and in wet eucalypt forest associated with Land Zone 3. These areas represent potential breeding and nesting habitat for these species. Other large remnants of drier woodland and forest may also hold value as corridors for dispersal.

Habitat generalist/aerial migratory birds

These species utilise a broad range of habitats. As such they have the potential to occur in most habitats throughout the project area including the canopy and areas above vine thickets, wet sclerophyll, open woodland and cleared agricultural land.

Wetland dependent and shorebird migratory bird species

Suitable habitat for wetland dependent migratory bird species occurs throughout the project area, associated with localised watercourses, dams and areas of pastoral land. A drainage line between Keefton Road and Six Mile Creek is fringed by dense reed vegetation which may provide habitat for the Australian reed-warbler.

6.4.3 Important habitat for migratory species

A key element of the significance of impact assessment for migratory bird species relies on determining whether a given action will impact 'important habitat' for a migratory species. Important habitat for a migratory bird species includes:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or
- Habitat that is of critical importance to the species at particular life-cycle stages, and/or
- Habitat utilised by a migratory species which is at the limit of the species range, and/or
- Habitat within an area where the species is declining

An assessment of habitat importance is presented in the following sections for each of the broad functional groups of EPBC Act listed migratory bird species that occur or are likely to occur within the project area.

Rainforest and wet eucalypt dependent migrant bird species

Important habitat for these species is defined as moist, dense habitats, predominantly including rainforest and wet sclerophyll, riparian forest, vine thickets and occasionally dense vegetation including mangroves, drier sclerophyll forest and woodlands.

While areas of vine thicket and wet sclerophyll forest within the project area are consistent with this description, the habitat remnants present are generally small and fragmented in nature as they occur predominantly within the alluvial plain of waterways. For this reason, they are unlikely to represent important habitat as they are unlikely to support an ecologically significant proportion of the population.

Habitat generalist/aerial migratory birds

Important habitats for the white-throated needletail and fork-tailed swift are described within the *Draft Referral Guidelines for 14 birds listed as migratory under the EPBC Act* (DoE, 2015b). These species are exclusively aerial, habitat generalists, occurring over a broad range of habitats including open plains and forested areas. While the white-throated needletail appears to be dependent on native vegetation, typically occurring over large tracts of forest and woodland (DoE, 2015b), the habitat requirement is broad. Similarly, the rainbow bee-eater utilises a broad range of habitats including grazed pastoral land, woodland, forest, beaches, urban areas, parkland, mangroves and grasslands (DEE, 2016b). Critical habitats for this species are likely to be associated with nesting habitat which is typically associated with clay banks and sandy substrates along the banks of rivers, creeks, dams, roadside cuttings and quarries (Higgins, 1999). Given the diverse range of habitats utilised by these species, and their relative abundance within the surrounding region, habitats within the project area are unlikely to represent 'important habitat' for these species.

Wetland dependent and migratory shorebird species

In general terms, important habitat for these species is considered to be habitat that is likely to support a significant proportion of the International and/or National population.

Internationally important habitat is considered to be habitat that supports:

- 1% of the individuals in a global population of waterbird species or sub-species, or
- A total abundance of at least 20,000 birds.

Nationally important habitat is considered to be habitat that supports:

- 0.1% of the flyway population of a single species

- A total abundance of at least 2,000 migratory shorebirds, or
- Presence of at least 15 migratory shorebird species.

Due to its cryptic nature, Latham's snipe is considered separately. Important habitat for Latham's snipe is considered to be areas that have previously been identified as important habitat for the species, or areas that support at least 18 individuals. For all wetland and migratory shorebird species known or likely to occur within the project area, suitable habitats are limited to localised dams, waterbodies and watercourses which occur intermittently along the length of the project area. These resources provide an insufficient abundance and diversity of foraging or nesting resources to support the abundance and/or diversity of species required to qualify as 'important habitat' for each of the wetland dependant and migratory shorebird species.

Impact on habitat critical to the survival of the species

In this regard, given that the migratory bird species are anticipated to inhabit a broad range of habitats throughout the region and suitable habitat is widely available in the broader region, habitats within the project area are unlikely to represent habitat critical to the survival of these migratory species.

6.5 Measures to avoid, reduce or mitigate impacts

Complete avoidance of impacts on migratory bird species (where present) is not possible due to the required alignment of the project. However, general environmental avoidance strategies have been incorporated within the Business Case and Detailed Design phases of the project to reduce the environmental impact on sensitive environments.

A number of overarching environmental mitigation measures which have been previously described in this document are indirectly relevant to mitigating impacts to migratory species. These mitigation measures will be incorporated into the relevant contract documentation required for the project.

6.6 Significance of impact assessment

The *Draft Referral Guidelines for 14 birds listed as migratory species under the EPBC Act* states that an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

6.6.1 Significance of impact assessment

Impacts of the project on migratory birds listed under the EPBC Act have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 17.

Table 17 Significance of impact on migratory birds

Criteria	Response
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
Substantially modify (including by fragmentation, altered fire regimes, altering nutrient cycles, or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	**Unlikely.** The migratory species known or considered likely to occur within the project area are all widely distributed and regionally common in south-east Queensland, occurring in a broad range of woodland, agricultural and suburban habitats. These species do not breed specifically in a localised area of important habitat (such as a wetland) that supports a substantial proportion of the local population and is therefore susceptible to significantly elevated risks due to localised impact. The project will cause localised losses of woodland vegetation and grassland that provides nesting and foraging resources for these species. However, given the wide availability of suitable habitat within the surrounding landscape, the project is unlikely to have a significant adverse impact on important habitat for the species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Unlikely**. No important habitat as defined in the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) occurs within the project area for the migratory species known or considered likely to occur. The relevant species do not rely on a communal breeding site that supports a significant proportion of the local population and all species are regionally common (i.e. not near the limit of the species range). Some ground-dwelling migratory species are susceptible to predation by cats and foxes. While construction activities can increase predation pressures by increasing accessibility to feral animals, the project area is in close proximity to agricultural activities, residential housing developments and other transport related infrastructure and is likely to support high densities of feral predators. The project is therefore unlikely to exacerbate the impact of feral predators.
Seriously disrupt the lifecycle (breeding, feeding, migration and resting behaviour) of an ecologically significant proportion of the population of a migratory species	**Unlikely**. The migratory species known or considered likely to occur within the project area are not dependent on a localised breeding or foraging resource. The species nest and forage over a broad area of woodland and agricultural habitat. While the project will have localised impacts on nesting and foraging habitat for the species listed above, the impacts will be localised and restricted in extent and will not adversely impact a significant proportion of the population.

6.6.1 Significant residual impact

Migratory species are anticipated to inhabit a broad range of habitats across the project area. Due to the variety and diversity of habitats a quantified residual impact for migratory species is not presented. The project will result in the clearing of vegetation within the project area however this impact is not anticipated to result in a significant residual impact on migratory bird species.

6.6.2 Offset strategies

No offset strategies are required for impacts to migratory bird species as the remaining residual impact is not considered to result in a significant impact (refer to Table 17).

7. Mary River cod (*Maccullochella mariensis*)

7.1 Conservation status and documentation

7.1.1 Conservation status

The Mary River cod (*Maccullochella mariensis*) was listed as 'endangered' under the EPBC Act on 20 July 2000. Historically, Mary River cod were distributed throughout the Mary, Brisbane-Stanley, Albert-Logan and Coomera River systems (Wagner and Jackson, 1993). Now, this species is restricted to the Mary River catchment and estimates place the species in less than 30 % of its original range (Simpson and Jackson, 1996).

7.1.2 Threats to the species

The key threatening processes to the Mary River cod are identified in the *Mary River Cod Research and Recovery Plan Action Plan – 1996-2001* (Simpson and Jackson, 1996) and include:

- Excessive siltation and in filling of pools as a result of land clearing and grazing
- Reduction in abundance of instream woody debris as a result of riparian vegetation clearing
- Restriction of movement
- Competition with non-indigenous fish species
- Overfishing during the late 1800's and early 1900's
- Water quality degradation and pollution
- Impoundments causing restriction of movement, degradation of water quality, loss of instream woody debris
- Susceptibility to disease, loss of genetic variability and inbreeding as a result of small isolated populations

7.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessments for this species:

- *The Mary River Cod Research and Recovery Plan Action Plan – 1996-2001* (Simpson and Jackson, 1996)
- *The Survey Guidelines for Australia's Threatened Fish: Guidelines for detecting fish listed as threatened under the EPBC Act* (DSEWPaC, 2011c).

7.1.4 Recommended survey methods

The species prefers large and deep (0.8 to 3.0 m) shaded pools with abundant, slow flowing water and relatively undisturbed tributaries (DSEWPaC, 2011c). The Mary River cod is also known to occur in waters with submerged logs and woody debris (DSEWPaC, 2011c). Due to these habitat preferences the *Survey Guidelines for Australia's Threatened Fish: Guidelines for detecting fish listed as threatened under the EPBC Act* recommends that surveys target these habitat types. *The Survey Guidelines for Australia's Threatened Fish: Guidelines for detecting fish listed as threatened under the EPBC Act* (DSEWPaC, 2011c) recommends the following:

- Daytime snorkelling for direct observations in areas of low turbidity
- Fyke nets
- Backpack electrofishing during daylight hours in areas of low turbidity
- Angling using barbless hooks
- Set lining and gill netting

7.2 Targeted survey effort

Targeted surveys for the Mary River cod were undertaken by FRC Environmental in March 2015 (Jacobs, 2016) and GHD in March 2016 (GHD, 2016a).

FRC Environmental (2015) targeted surveys

FRC Environmental undertook the following survey techniques in regards to the Mary River cod:

- Desktop and field aquatic habitat assessments across the project area to assess the quality of habitat within a representation of waterway reaches intersected by the project.
- Aquatic ecosystem condition and water quality upstream and downstream of the project area at 11 sites within waterways listed in Table 18.
- Targeted fish species surveys including the Mary River cod, through the use of fyke nets and box traps within 8 waterways intersecting the project area.

GHD (2016a) targeted surveys

GHD undertook the following survey techniques in regards to the Mary River cod:

- Broad aquatic habitat assessments upstream and downstream of the project area within 13 waterways intersecting the project, as listed in Table 18.
- Detailed aquatic habitat assessments at sites upstream and downstream of the project area within the three major waterways (Six Mile Creek, Deep Creek and Curra Creek) where threatened species were likely to occur. Detailed habitat assessments involved upstream and downstream 500 m long reach transects.
- Targeted aquatic fauna surveys within the three major waterways (Six Mile Creek, Deep Creek and Curra Creek) were undertaken to establish the likelihood of occurrence for targeted threatened species, such as the Mary River cod. These surveys included general fish community surveys via electrofishing to describe the diversity of the fish community as well as targeted surveys using eletrofishing, fyke netting, bait trapping, dusk surveys and opportunistic sightings.

Targeted survey effort for the Mary River cod is summarised in Table 18.

Table 18 Summary of survey effort for the Mary River cod

Survey methods	Survey	Survey effort undertaken
Methods recommended in EPBC Act survey guidelines		
Aquatic habitat assessment (AUSRIVAS)	GHD, 2016a	Undertaken at sites upstream and downstream of the project area at Six Mile Creek, Tannery Creek, Deep Creek, Moody Creek (north), Banks Creek, Tamaree Creek, Corella Creek, Keliher Creek, Unnamed Creek #2 (Lot 889 on CP864404), Unnamed Creek (Lot 1717 on M37818), Curra Creek, Curra Creek overflow and Curra Creek (north).

Survey methods	Survey	Survey effort undertaken
	FRC Environmental 2015	Undertaken at sites upstream and downstream of Six Mile Creek, Deep Creek, Moody Creek, Banks Creek, Tamaree Creek, Upper Curra Creek, Keliher Creek, Curra Creek overflow and Curra Creek.
Detailed aquatic habitat assessments	GHD, 2016a	Undertaken within sites upstream and downstream of the project area within Six Mile Creek, Deep Creek and Curra Creek.
Fish community surveys via electrofishing	GHD, 2016a	Undertaken at Tannery Creek, Corella Creek, Unnamed Creek #1 (Lot 889 on CP864404) and Unnamed Creek #2 (Lot 889 on CP864404).
Targeted aquatic fauna surveys using fyke nets and box traps	FRC Environmental 2015	Undertaken at sites upstream and downstream of the project area within Six Mile Creek, Deep Creek, Moody Creek, Banks Creek, Tamaree Creek, Curra Creek, Keliher Creek and Curra Creek overflow.
Dusk surveys	FRC Environmental 2015	Deep Creek and Curra Creek.
Targeted aquatic fauna surveys using electrofishing, fyke netting, bait trapping, dusk surveys and opportunistic sightings	GHD, 2016a	Undertaken within sites upstream and downstream of the project area within Six Mile Creek, Deep Creek and Curra Creek.

7.3 Records

7.3.1 Desktop and field results

The Mary River cod has been historically recorded from the region on Wildnet and ALA records (refer to Table 19). This species was also recorded during baseline surveys completed during the Options Analysis and Business Case phase of the project by FRC Environmental (FRC Environmental in Jacobs, 2016) and during targeted field surveys during the Detailed Design phase of the project by GHD (GHD, 2016a).

Table 19 Mary River cod records within the region

Source	Record
Wildnet / Atlas of Living Australia	Four Wildnet/ALA records the species occur within Six Mile Creek upstream of the project area between 1984 and 1992. 18 previous records of this species are known within the upper catchment of the Mary River, approximately 10 – 20 km south of the project area. No other records are known to occur on the Wildnet database within waterways intersected by the project.

Source	Record
Targeted field surveys FRC Environmental in Jacobs, 2016	Recorded at crossing location within Six Mile Creek during surveys.
Targeted field surveys GHD, 2016a	Recorded within Six Mile Creek downstream of the project area. Habitat confirmed within Six Mile Creek. Potentially suitable habitat for the Mary River cod recorded in Deep Creek and Curra Creek.

7.3.2 Importance of population

The *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) defines an important population as a population that is necessary for a species long-term survival and recovery, including those populations identified in recovery plans. *The Mary River Cod Research and Recovery Plan* (Simpson and Jackson, 1996) identified the population of Mary River cod within Six Mile Creek as one of three populations of the species. As Six Mile Creek supports one of only three populations of the species, this population is considered to be an important population for maintaining genetic diversity and for the long-term maintenance of the species (GHD, 2016a).

7.4 Habitat suitability

7.4.1 Species habitat requirements

Mary River cod occur in a variety of habitat types within the Mary River catchment, from high gradient, rocky, upland streams, to large, slow-flowing pools in lowland areas. Deep slow moving pools with abundant instream timber and heavy shading by overhanging vegetation are the preferred habitat. Areas of open water are usually avoided (Simpson and Jackson, 1996).

The Mary River cod is largely territorial and occupies a particular home range between 70 metres and 1 km in length for up to several years (Simpson and Mapleston, 2002). Large scale movement in excess of 30 km either upstream or downstream can occur during high flow events (Simpson and Jackson, 1996).

There are three areas within the Mary River system where the Mary River cod are relatively abundant. These are Tinana-Coondoo Creek upstream from Tinana Barrage, Six Mile Creek downstream from Lake Macdonald, and upper Obi Obi Creek. These natural sub-populations are isolated from one another by impoundments and the main Mary River channel (Simpson and Jackson, 1996).

7.4.2 Habitat within the project area

The Mary River cod was confirmed present within Six Mile Creek during the 2015 surveys and 2016 electrofishing surveys (FRC Environmental in Jacobs, 2016; GHD, 2016a). The section of the Six Mile Creek reach within the project area is considered suitable habitat for the Mary River cod. The deep permanent pool habitat within Six Mile Creek provides suitable habitat conditions for this species with key habitat features such as instream woody debris, undercut banks, overhanging riparian vegetation and shading present in a relatively high abundance. Less than 50 % (i.e. 20 km) of this reach contains deep permanent pool habitat suitable for this species (Simpson, 1994).

The Mary River cod has not been previously recorded within Deep Creek or Curra Creek; however, an anecdotal record of the species exists from the confluence of Curra Creek and the

Mary River (recorded in 1989, Simpson and Jackson, 1996). Reaches of Deep Creek and Curra Creek that contain deep pools, high abundance of large woody debris, presence of overhanging vegetation and shaded habitat provide potentially suitable habitat conditions for the Mary River cod within the project area (GHD, 2016a). The likelihood of occurrence of the Mary River cod within these waterways, is reduced by the distance and connectivity of these creeks from the three main populations of the species. The Mary River cod has the potential to occur in Deep Creek and Curra Creek at low densities (GHD, 2016a).

Spawning of the Mary River cod is thought to occur in association with large woody debris, particularly hollow logs. Potentially suitable breeding habitat for this species therefore occurs throughout Six Mile Creek, Deep Creek and Curra Creek, where large woody debris is present.

7.4.3 Habitat critical to the survival of the species

Habitat critical to the survival of the Mary River cod has not been specified in listing advice for the species. The *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) defines habitat critical to the survival of a species as areas that are necessary:

- For activities such as foraging, breeding, roosting or dispersal
- For the long-term maintenance of the species
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or the recovery of the species

Impact on habitat critical to the survival of the species

In accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013), Six Mile Creek is considered habitat critical to the survival of the Mary River cod as the creek is necessary for critical activities such as foraging and breeding.

7.5 Measures to avoid, reduce or mitigate impacts

7.5.1 Avoidance

Avoidance of direct impacts on the Mary River cod has been achieved through the incorporation of bridge structures rather than culverts at each major waterway crossing (including Six Mile Creek, Deep Creek and Curra Creek). The incorporation of bridges over these waterways will assist in avoiding direct impacts on breeding/spawning habitat for the Mary River cod while also avoiding a direct loss of potential habitat for aquatic MNES by spanning the low flow channel of each waterway.

7.5.2 Reduction and mitigation

The following specific management actions have been developed to mitigate potential impacts to the Mary River cod:

- A review of design and construction methodologies employed for the Six Mile Creek bridge structure to avoid impacts to the waterway. The review of the design and construction methodologies for bridge construction included:
  - Altering the bridge spans from 33 metre span (Business Case phase) to a main span of 46.4 in length made continuous using 38 m long super T-girders (Detailed Design phase) to reduce impacts to the waterway and associated riparian vegetation.
  - Individual span widths have been rationalised during the Detailed Design phase due to environmental concerns associated with Six Mile Creek.

- Raising the deck level by 770 mm during the Detailed Design phase to take account of critical 1% AEP design storm event and climate change.
- Increase in spacing between northbound and southbound bridge structures to 1360 mm to allow for increase in natural light.
- Consideration of specific construction methodologies such as pile structure, timing of construction program, use of a launching truss, use of scaffolding, use of steel casings.
- Bridge superstructure will be installed using either a launching truss or false work platform or existing banks or embankments rather than the installation from the bed and banks of the waterway.

- Nomination of specific construction methodologies for the bridge construction in the contract documentation.
- Nomination on timing requirements for the construction of bridge structures over Six Mile Creek, Deep Creek and Curra Creek.
- Nomination of timing requirements for instream stream works and bank stability works at Six Mile Creek.
- Nomination of specific treatments for bank stability works on either bank of Six Mile Creek.
- Requirement for no temporary waterway crossings to be constructed over Six Mile Creek.
- Construction noise and vibration impacts on the Mary River cod are able to be avoided through the use of bored piles on all bridge structures rather than driven piles. Bored piles with a screw in casing significantly reduce the amount of noise and vibration within the waterway when compared to driven piles.
- Inclusion of bioretension basins adjacent to Six Mile Creek, Deep Creek and Curra Creek to filter out pollutants prior to entry into these waterways during Operational phases of the project.
- Development of contract documents to include the establishment of no-go zones.
- Limits of vegetation clearing included in contract documentation and nomination on design plans.
- Location of ancillary activities within previously cleared areas, where possible.
- Requirement for staged vegetation clearing deemed suitable by the Contract Administrator. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins).
- Requirement for the awarded Construction Contractor to design, install and maintain all erosion and sediment controls in accordance with MRTS52 – Erosion and Sediment Control. This specification was developed in 2016 to provide principles, design standards and quality requirements to be achieved on TMR projects. MRTS52 – Erosion and Sediment Control includes a number of hold points and approvals by the Contract Administrator, which prevents the construction progressing until the environmental checks and requirements have been completed to a performance criteria acceptable to TMR. The specification also includes specific design requirements for all erosion and sediment controls to be installed on the project. Specifically, sediment basins to be installed adjacent to sensitive areas (i.e. Six Mile Creek, Deep Creek and Curra Creek) are required to be designed for a 85th percentile, 5 day rainfall event.

- Requirement for upstream and downstream water quality conditions to be monitored through visual and *in situ* recordings during the construction contract.
- Inclusion of water quality performance criteria in the contract documentation to be achieved prior to release from onsite sediment basins.

These key mitigation measures as well as generic management actions specific for aquatic fauna, which are indirectly relevant to mitigating impacts to the Mary River cod and its habitat, have been developed for the project, as shown in Appendix B. These management actions will be documented in the relevant contract documentation required for the project.

7.6 Significance of impact assessment

7.6.1 Significance of impact assessment

Impacts of the project on the Mary River cod have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 20.

Table 20 Significant impact assessment for the Mary River cod

Criteria	Response
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of a population	**Unlikely.** The size of the Mary River cod population within and upstream of the project area is not predicted to be permanently impacted by the project. The bridges proposed at Six Mile Creek, Curra Creek and Deep Creek will span the waterway and no loss of instream aquatic habitat will occur. Bridge piers will be located outside the low flow channel and no inhibition of fish movement is expected to occur. Habitat degradation and disturbance as a result of traffic noise, vibration disturbance, rubbish and run-off are expected to occur with the immediate vicinity of the bridges during construction and operation. These potential impacts may decrease the value of the habitat for the Mary River cod. However, as this species is known to occur at the existing highway bridge crossing, disturbance and degradation impacts to the Mary River cod from bridge operation are not expected to be significant. Without appropriate management, project construction activities have the potential to decrease the size of the Mary River cod population through direct and indirect impacts to individuals within an important sub-population that is critical to the survival of the species. Direct injury and/or mortality to individuals within the project area may occur as a result of bank vegetation clearing, works within the creek channel or impacts to water quality. Indirect impacts reducing habitat suitability and the availability of resources for the species also have the potential to occur as a result of water quality degradation (particularly sedimentation), clearance of riparian vegetation and noise, vibration and light disturbance.

Criteria	Response
	Applying best practice management strategies, the potential risk for direct and indirect impacts to the Mary River cod are expected to be reduced to minor disruption of individuals and minor degradation of habitat within and downstream of the project area. All erosion and sediment controls designed for the project are required to comply with the design requirements of MRTS52 – Erosion and Sediment Control. This includes the requirement for sediment basins to be designed for an 85th percentile, 5 day rainfall event, rainfall events within this design requirement will be controlled by the Construction Contractor. Individual cod may be temporarily displaced into suitable habitat adjacent to the project area with their return expected following completion of construction activities. As such, no significant impact to the long-term size of the Mary River cod population is expected to occur.
Reduce the area of occupancy of the species	**Unlikely.** The Mary River cod primarily occurs within three areas within the Mary River catchment: Tinana-Coondoo Creek upstream from Tinana Barrage, Six Mile Creek downstream from Lake Macdonald, and upper Obi Obi Creek (Simpson and Jackson, 1996). The project area is within the known range of the Mary River cod within Six Mile Creek and the species is known to occur within this area. The area of occupancy of the Mary River cod is predicted not to be permanently impacted by the project. Flow and fish movement will not be restricted by the proposed bridges and disturbance from bridge operation is expected to be comparable to existing bridges along this waterway. As discussed for the criteria above, without appropriate management, construction phase activities have the potential to reduce the suitability of habitat for the Mary River cod within and adjacent to the project area. The potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation and clearing of riparian vegetation are the key risks for long-term potential impacts to Mary River cod habitat within and upstream of the project area. Potential impacts to the Mary River cod as a result of water quality degradation may include smothering of foraging resources, filling pool habitat, alteration in habitat characteristics and subsequent impacts to fish physiology and behaviour. Clearing of riparian vegetation will reduce shading to the waterway and prevention of the development of important instream structure and mircohabitat in the aquatic environment. Strict management actions will be implemented during all phases of the project to manage potential impacts. By applying best practise management measures, the potential impacts to aquatic habitat suitability for the Mary River cod are expected to be minor. As such, the project is not expected to significantly impact the area of occupancy of the species.

Criteria	Response
Fragment an existing population into two or more populations	**Unlikely.** The proposed bridges over Six Mile Creek, Deep Creek and Curra Creek have been designed to span the low flow section of each waterway and the support piers will be located to avoid disruption of flows during low flow conditions or generation of turbulence during high flow conditions. Upstream and downstream movement of the Mary River cod is not expected to be inhibited and as such, no fragmentation of the population is expected to occur. Maintaining aquatic fauna passage has been a key design feature of the project construction methodology. Water flows will be maintained within the existing channels to avoid altering flows and degrading habitat. While construction activities may restrict fish from moving through the area due to disturbance (i.e. noise and vibration), these impacts will be temporary and will cease at the completion of construction. Overall, construction and operation of the project is not expected to significantly inhibit upstream and downstream movement of the Mary River cod and fragmentation of the population is not predicted to occur result from the proposed action.
Adversely affect habitat critical to the survival of the species	**Unlikely.** In accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE 2013), Six Mile Creek is considered habitat critical to the survival of the Mary River cod as the waterway is necessary for critical activities such as foraging and breeding. Supporting one of only three populations of the species, Six Mile Creek is also critical for maintaining genetic diversity and for the long-term maintenance of the species. No adverse impacts to habitat critical to the survival of the Mary River cod are expected to occur as a result of the bridge operation. As discussed above, without appropriate management, construction phase activities have the potential to adversely affect habitat critical to the survival of the species by reducing the suitability of habitat within and adjacent to the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation and riparian vegetation clearing are the key risks that may trigger long-term potential impacts to the Mary River cod. All erosion and sediment controls designed for the project are required to comply with the design requirements of MRTS52 – Erosion and Sediment Control. This includes the requirement for sediment basins to be designed for an 85th percentile, 5 day rainfall event, rainfall events within this design requirement will be controlled by the Construction Contractor. Those storm events outside the design event are unable to be completely controlled by the Construction Contractor due to the intense nature of such storm events. It is likely that sediment laden runoff will exit the project area untreated during these

Criteria	Response
	storm events. It is important to note that these events are naturally occurring events and an additional amount of sediment laden runoff will occur from the upstream catchment which includes agricultural land uses, rural residential uses and large areas of bushland. Additional mitigation measures have been implemented during all phases of the project to manage potential impacts during construction, refer to Appendix B. Monitoring of water quality conditions will also occur to identify the potential for water quality degradation and allow for adaptive management, refer to Appendix B. Applying best practice management measures, the potential impacts to aquatic habitat suitability for the Mary River cod are expected to be manageable and temporary during the construction phase. As such, the project is not expected to significantly impact habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	**Unlikely.** Operation of the new bridges over Six Mile Creek, Deep Creek and Curra Creek are not expected to disrupt the breeding cycle of the Mary River cod. Fish movement will not be restricted by the project and the level of disturbance from bridge operation is not expected to deter individuals from inhabiting these waterways. Clearing of riparian vegetation within the project area may prevent the generation of breeding habitat (i.e. instream woody debris) within the immediate area. Retaining large woody debris from vegetation clearing for addition post-construction will minimise this potential impact. Disruption to the breeding cycle of the species has potential to occur during construction phase activities as a result of habitat degradation and disturbance. The Mary River cod spawns in spring when water temperature reaches above 20°C (Simpson and Jackson, 1996). Where possible, the project will minimise construction phase activities within Six Mile Creek, Deep Creek and Curra Creek during this period; however, this requirement will be balanced with the need to undertake construction during the dry season when rainfall and flows within the catchment are reduced to manage impact risk to water quality. Additional best practice management measures will be implemented to minimise the disturbance and degradation of aquatic habitat during project construction. Applying the prescribed management measures in Appendix B, any potential disruption to the breeding cycle of Mary River cod is expected to be minor and temporary. As such, the project is not expected to significantly disrupt the breeding cycle of the species such that species decline would occur.
Modify, destroy, remove, isolate or decrease the availability or quality of	**Unlikely.** Operation of new bridges over Six Mile Creek, Curra Creek and Deep Creek will have minimal impact on Mary River cod habitat within the project area as the new bridges will span

Criteria	Response
habitat to the extent the species is likely to decline	the waterways and piers will be located to avoid the low flow channels. The bed and banks of the major waterways within the project area will be restored to their original profile, where possible and stability of the banks following construction to minimise long-term impacts on these waterways. Minor waterway bank habitat loss will be experienced under the immediate project area of the bridge piers and land junction. Areas to be lost has been minimised through bridge design solutions. Habitat degradation and disturbance as a result of traffic noise, vibration disturbance, rubbish and run-off are expected to be comparable to existing bridges at which the species is known to occur. As such, no significant impacts to the availability and quality of Mary River cod habitat are expected during bridge operation. As previously discussed, without appropriate management, construction phase activities have the potential to decease the availability and quality of Mary River cod habitat within and adjacent to the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation and riparian vegetation clearing are the key risks for long-term potential impacts to Mary River cod habitat within and downstream of the project area. As previously stated all erosion and sediment controls designed for the project are required to comply with the design requirements of MRTS52 – Erosion and Sediment Control. This includes the requirement for sediment basins to be designed for an 85th percentile, 5 day rainfall event, rainfall events within this design requirement will be controlled by the Construction Contractor. Those storm events outside the design event are unable to be controlled by the Construction Contractor due to the intense nature of such storm events. It is likely that sediment laden runoff will exit the project area untreated during these storm events. It is important to note that these events are naturally occurring events and an additional amount of sediment laden runoff will occur from the upstream catchment which includes agricultural land uses, rural residential uses and large areas of bushland. Strict management actions have been implemented during all phases of the project to manage these potential impacts to downstream habitats, refer to Appendix B. Monitoring of upstream and downstream water quality conditions will also occur to identify the potential for water quality degradation and allow for adaptive management. Applying the prescribed mitigation measures, the potential impacts to aquatic habitat suitability for the Mary River cod are expected to be minor and temporary. As such, the project is not expected to significantly modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that

Criteria	Response
	the Mary River cod is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species habitat	**Unlikely.** Introduced fish species (translocated and exotic) are present within the Mary River catchment and habitat degradation as a result of project construction activities may facilitate the proliferation of these species within Mary River cod habitat. The potential impacts to the Mary River cod from introduced species are relatively unknown; however, it is likely that a reduction of habitat value for the Mary River cod may occur in addition to increased predation of eggs/juveniles and increased competition for resources. Degradation of the creek banks from introduced weed and pest species also has the potential to degrade Mary River cod habitat as a result of an alteration of bank characteristics, increase in sediment mobilisation and subsequent decrease in water quality. Implementation of weed management measures included in Appendix B coupled with erosion and sediment management controls will reduce the likelihood of this impact. As such, the project is not expected to result in invasive species that are harmful to the Mary River cod becoming established in cod habitat.
Introduce disease that may cause the species to decline	**Unlikely.** The project is unlikely to result in the introduction of disease into the environment given that no biotic materials will be introduced to project area and that construction equipment will be free of weeds and soils which could transfer diseases. Project construction activities do however have the potential to result in the degradation of water quality. This could lead to degradation of cod habitat and food resources affecting fish health with a subsequent increase in disease prevalence. Best practice management procedures for the control of erosion and sedimentation and waste and hazardous materials will be implemented to minimise risks such that decline in Mary River cod as a result of disease introduction is not expected.
Interfere with the recovery of the species	**Unlikely.** Recovery actions for the Mary River cod are detailed in the Mary River Cod Research and Recovery Plan (Simpson and Jackson, 1996). Recovery actions include: • Establishing a program of community involvement/education to develop public support for the conservation of Mary River cod • Developing and implementing regulatory and administrative actions to protect Mary River cod and their habitats • Developing and implementing management procedures for the captive breeding and restocking of Mary River cod into suitable habitats • Undertaking research to increase knowledge of the biology and requirements of Mary River cod, and to improve

Criteria	Response
	techniques for their captive-breeding • Developing and implementing programs to rehabilitate riparian and instream habitats in the Mary River system, and other south-eastern Queensland streams targeted for restocking with cod. • Developing and implementing a long-term monitoring program for assessment of the status of Mary River cod. The project will not interfere with any of these recovery actions and, as such, the project is not expected to interfere with the recovery of the species.

As identified in Table 20, the project is not anticipated to have a significant impact on the Mary River cod.

7.6.2 Significant residual impact

Due to the numerous design and construction mitigation measures which have been applied to either avoid, reduce or mitigate impacts on the Mary River cod from the project, a significant residual impact on this species will not occur.

7.6.3 Offset strategies

No offset strategies are required for impacts to the Mary River cod as the project is not considered to result in a significant impact on the species or its habitat (refer to Table 20).

8. Mary River turtle (*Elusor macrurus*)

8.1 Conservation status and documentation

8.1.1 Conservation status

The Mary River turtle (*Elusor macrurus*) is listed as 'endangered' under the EPBC Act. The species was originally listed as 'endangered' under Schedule 1 of the previous *Endangered Species Protection Act 1992*. The Mary River turtle is endemic to the Mary River where it primarily occurs within the mainstream channel of the Mary River and major tributaries including Tinnana Creek, Yabba Creek and Obi Obi Creek (Limpus, 2008)

8.1.2 Threats to the species

Illegal poaching during the 1960's and 1970's and high nest predation by feral dogs, foxes and goannas, has result in a 90 % reduction in Mary River turtle nesting in the last 50 years (Flakus and Connell, 2008). The long term, pervasive and intense egg loss from predation and cattle trampling of nests has been identified as a critical threat to the species (Limpus, 2008). Other key threatening processes identified in the Species Profile and Threats Database (DEE, 2016b) include:

- Removal of riparian vegetation preventing recruitment of important instream structure and microhabitat into the aquatic environment.
- Degradation of water quality as a result of extensive land clearing, heavy grazing and sandmining.
- Decreasing habitat suitability as a result of increased siltation and filling of deep pool habitats.
- Degradation in nesting habitat suitability as a result of sand mining and proliferation of weed species.
- Loss and degradation of habitat, restriction of movement and injury and mortality from instream furniture (i.e. dams and weirs).

8.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessment for this species:

- *The Survey Guidelines for Australia's Threatened Reptiles: Guidelines for detecting reptiles listed as threatened under the EPBC Act* (DSEWPaC, 2011b).
- *Freshwater turtles in the Mary River: Review of biological data for turtles in the Mary River, with emphasis on Elusor macrurus and Elseya albagula*. Brisbane: Queensland Government (Limpus, 2008).

8.1.4 Recommended survey methods

The Mary River turtle generally inhabits well-oxygenated pools associated with riffle zones. Habitat pools vary in depth from 1 - 6 m and generally have a sand or gravel bottom, steep sides and an abundance of submerged shelter in the form of fallen logs, boulders, undercut banks and aquatic vegetation (Flakus, 2002). Due to these habitat preferences the *Survey Guidelines for Australia's Threatened Reptiles: Guidelines for detecting reptiles listed as threatened under the EPBC Act* recommends survey target these habitat types. The assessment guidelines, as listed above, recommend the following:

- Habitat assessments
- Daytime snorkelling for direct observations in areas of low turbidity
- Trapping – cathedral traps and/or fkye traps
- Seine netting, dip netting and muddling

8.2 Targeted survey effort

Targeted surveys were undertaken for the Mary River turtle were undertaken by FRC Environmental in March 2015 (Jacobs, 2016) and GHD in March 2016 (GHD, 2016a).

FRC Environmental (2015) targeted surveys

FRC Environmental undertook the following survey techniques in regards to the Mary River turtle:

- Desktop and field aquatic habitat assessments across the project area to assess the quality of habitat within a representation of waterway reaches intersected by the project.
- Aquatic ecosystem condition and water quality surveys upstream and downstream of the project area at 11 sites within waterways listed in Table 21.
- Targeted surveys for turtle species including the Mary River turtle through the use of custom made turtle traps and fyke nets within nine waterways intersecting the project area.
- Dusk surveys at Deep Creek and Curra Creek.

GHD (2016a) targeted surveys

GHD undertook the following survey techniques in regards to the Mary River turtle:

- Broad aquatic habitat assessments upstream and downstream of the project area within 13 waterways intersecting the project, as listed in Table 21.
- Detailed aquatic habitat assessments upstream and downstream of the project area within the three major waterways (Six Mile Creek, Deep Creek and Curra Creek) where threatened species were likely to occur. Detailed habitat assessments involved upstream and downstream 500 m long reach transects.
- Aquatic fauna surveys including targeted turtle surveys using turtle cathedral traps, fkye nets and late afternoon dusk watches within the three major waterways (Six Mile Creek, Deep Creek and Curra Creek) to establish the likelihood of occurrence for threatened species, such as the Mary River turtle.
- Targeted snorkelling surveys for the Mary River turtle were attempted at four waterways during the 2016 surveys (Unnamed Creek #2 Lot 889 on CP864404, Unnamed Creek Lot 1717 on M37818, Deep Creek and Curra Creek). Due to high turbidity levels and a visibility less than 30 cm, this survey technique could not be completed at these locations.

Targeted survey effort for the Mary River turtle is summarised in Table 21.

Table 21 Summary of survey effort for the Mary River turtle

Survey methods	Survey	Survey effort undertaken
Methods recommended in EPBC Act survey guidelines		
Aquatic habitat assessment (AUSRIVAS)	GHD, 2016a	Undertaken at sites upstream and downstream of the project area at Six Mile Creek, Tannery Creek, Deep Creek, Moody Creek (north), Banks Creek, Tamaree Creek, Corella Creek, Keliher Creek, Unnamed Creek #2 (Lot 889 on CP864404), Unnamed Creek (Lot 1717 on M37818), Curra Creek, Curra Creek overflow and Curra Creek (north).
	FRC Environmental 2015	Undertaken at sites upstream and downstream of Six Mile Creek, Deep Creek, Moody Creek, Banks Creek, Tamaree Creek, Upper Curra Creek, Keliher Creek, Curra Creek overflow and Curra Creek.
Detailed aquatic habitat assessments	GHD, 2016a	Undertaken at sites upstream and downstream of the project area within Six Mile Creek, Deep Creek and Curra Creek.
Targeted aquatic fauna surveys using turtle traps and fkye nets	FRC Environmental 2015	Undertaken at sites upstream and downstream of the project area within Six Mile Creek, Deep Creek, Moody Creek, Banks Creek, Tamaree Creek, Curra Creek, Keliher Creek and Curra Creek.
Dusk surveys	FRC Environmental 2015	Deep Creek and Curra Creek
Targeted aquatic fauna surveys using turtle cathedral traps, fyke nets, dusk pool watches and opportunistic sightings	GHD, 2016a	Undertaken within sites upstream and downstream of the project area within Six Mile Creek, Deep Creek and Curra Creek.

8.3 Records

8.3.1 Desktop and field results

The Mary River turtle has been historically recorded from the region according to Wildnet and ALA records, refer to Table 22. This species has not been previously recorded for ecological surveys undertaken for the project (FRC Environmental in Jacobs, 2016; GHD, 2016a).

Table 22 Mary River turtle records within the region

Source	Record
Wildnet / Atlas of Living Australia	There are no previous records of the species from waterways within the project area. The closest records of the Mary River turtle within the lower Mary River catchment are from the Mary River at the junction with Curra Creek, downstream of the project area. The species has also been recorded from three locations within the Mary River west of Gympie and the project area. The Mary River turtle has been recorded at eight locations within the upper Mary River catchment, the closest of which to the project area is at Traveston.
Targeted field surveys FRC Environmental in Jacobs, 2016	Not recorded. Potentially suitable habitat recorded where the project area intersects Six Mile Creek, Deep Creek and Curra Creek.
Targeted field surveys GHD, 2016a	Not recorded. Potentially suitable foraging habitat within Six Mile Creek, Deep Creek and Curra Creek.

8.3.2 Importance of population

Important populations of Mary River turtle have not been specified in listing advice for the species. The absence of previous records for the Mary River turtle from waterways within the project area and low suitability of turtle nesting habitat, suggests that this region of the Mary River catchment does not support a significant proportion of the Mary River turtle population and does not represent an important population of the species.

8.4 Habitat suitability

8.4.1 Species habitat requirements

The Mary River turtle generally inhabits well-oxygenated pools associated with riffle zones. Habitat pools vary in depth from one to six metres and generally have a sand or gravel bottom, steep sides and an abundance of submerged shelter in the form of fallen logs, boulders, undercut banks and aquatic vegetation (Limpus, 2008). Very little information is known about the habitat requirements of hatchling turtles; however, rocky outcrops are thought to be of importance (Flakus, 2002).

Nesting of the Mary River turtle is primarily restricted to alluvial sand/loam banks that occur in depositional areas. These banks generally form at the river's edge and extend back into the immediate riparian zone; however, islands are also known to occur in places. There is insufficient evidence available on species specific nesting requirements to accurately describe optimal nesting bank conditions; however, banks are generally large, steep and sparsely vegetated. Eggs are laid between two metres and 50 m away from the waters' edge and are an average of 2.3 m above water level (Limpus, 2008, Flakus, 2002; Flakus and Connell, 2008). Nesting occurs from October to December and females are thought to return to the same nesting banks each year. The majority of aggregated nesting occurs at traditional nesting banks immediately upstream from Tiaro. Limited turtle nesting has been observed outside this area (Limpus, 2008).

8.4.2 Habitat within the project area

The Mary River turtle has not been previously recorded in any of the waterways within the project area and the species was not observed during field surveys.

GHD (2016a) noted that majority of the waterways within the project area other than the three major waterways are ephemeral and do not contain suitable habitat for the Mary River turtle. The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek do however, provide potentially suitable habitat conditions for the Mary River turtle. Key habitat features, such as instream woody debris, undercut banks, and overhanging riparian vegetation, are present in a relatively high abundance within these areas (GHD, 2016a). The pool-riffle-glide sequences within Six Mile Creek represent ideal habitat conditions for the Mary River turtle and, due to the proximity of the project area to the main channel of the Mary River, the Mary River turtle is considered likely to occur within this reach. Reduced connectivity and degradation from land use practises are likely to affect the distribution of the Mary River turtle within Deep Creek and Curra Creek. Habitat conditions within these waterways is considered sub-optimal with potential habitation by the Mary River turtle most likely during periods of increased water flows within the main channel of the Mary River. Overall, the Mary River turtle has the potential to occur within Deep Creek and Curra Creek within the project area (GHD, 2016a).

Nesting of the Mary River turtle is restricted to steep, sparsely vegetated sandy banks with aggregated nesting occurring primarily at a small number of traditional banks within the lower catchment near Tiaro (Limpus, 2008). No aggregated nesting has been recorded within any of the waterways within the project area (GHD, 2016a). Although some sandy banks are present within Six Mile Creek, Deep Creek and Curra Creek, the suitability of these banks for turtle nesting is generally limited by the density of riparian bank vegetation and degradation by cattle. As a result, nesting of the Mary River turtle within the project area is considered unlikely to occur (GHD, 2016a).

8.4.3 Habitat critical to the survival of the species

Habitat critical to the survival of the Mary River turtle has not been specified in listing advice for the species. The *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) defines habitat critical to the survival of a species as areas that are necessary:

- For activities such as foraging, breeding, roosting or dispersal
- For the long-term maintenance of the species
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or the recovery of the species

Impact on habitat critical to the survival of the species

The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek provide potentially suitable habitat conditions for the Mary River turtle, however, the species has not been previously recorded and nesting is considered unlikely to occur due to limited density of riparian bank vegetation and degradation by cattle. As such, aquatic habitats within the project area are unlikely to represent habitat critical to the survival of the species.

8.5 Measures to avoid, reduce or mitigate impacts

8.5.1 Avoidance

Avoidance of direct impacts on the Mary River turtle has been achieved through the incorporation of bridge structures rather than culverts at each major waterway crossing (including Six Mile Creek, Deep Creek and Curra Creek). The incorporation of bridges over these waterways will assist in avoiding direct impacts on breeding/nesting habitat for the Mary River turtle while also avoiding a direct loss of potential habitat for aquatic MNES by spanning the low flow channel of each waterway.

8.5.2 Reduction and mitigation

The reduction and mitigation measures for the Mary River cod (refer Section 7.5.2) will assist in the reducing and mitigating impacts to the Mary River turtle. Other species management actions specific for aquatic fauna, which are indirectly relevant to mitigating impacts to the Mary River turtle and its habitat, have been developed for the project, as shown in Appendix B. These management actions will be documented in the relevant contract documentation required for the project.

8.6 Significance of impact assessment

8.6.1 Significance of impact assessment

Impacts of the project on the Mary River turtle have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 23.

Table 23 Significant impact assessment for the Mary River turtle

Criteria	Response
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of a population	**Unlikely.** The size of the Mary River turtle population within and downstream of the project area is not predicted to be permanently impacted by the project. The bridges proposed at Six Mile Creek, Curra Creek and Deep Creek will span the waterway and no permanent loss of instream aquatic habitat will occur. Bridge piers will be located outside the low flow channel and no inhibition of turtle movement within each waterway is expected to occur. Habitat degradation and disturbance during the construction and operational phase may occur as a result of traffic noise, vibration disturbance, rubbish and run-off are expected to occur with the immediate vicinity of the bridges. These potential impacts may decrease the value of the habitat for the Mary River turtle within the immediate area. Impacts are however, expected to be minor and affect a small number of individuals within the immediate area, rather than an entire population. Without appropriate management, project construction activities have the potential to result in direct and indirect impacts to the Mary River turtle within and adjacent to the project area. These

Criteria	Response
	potential impacts include injury and/or mortality to individuals and decreased habitat suitability as a result of water quality degradation, particularly sedimentation, and noise, vibration and light disturbance. Applying the mitigation measures in Appendix B, the potential risk for direct and indirect impacts to the Mary River turtle are expected to be reduced to minor disruption of individuals and temporary degradation of habitat within the project area. All erosion and sediment controls designed for the project are required to comply with the design requirements of MRTS52 – Erosion and Sediment Control. This includes the requirement for sediment basins to be designed for an 85th percentile, 5 day rainfall event, rainfall events within this design requirement will be controlled by the Construction Contractor. Individual turtles may be temporarily displaced into suitable habitat adjacent to the project area with their return expected following completion of construction activities. The majority of the Mary River turtle population has been previously recorded within the main Mary River channel. The absence of previous records for the species from waterways within the project area suggest that this region of the Mary River catchment does not support a significant proportion of the Mary River turtle population. As such, no significant impact to the long-term size of the Mary River turtle population is expected to occur as a result of the project.
Reduce the area of occupancy of the species	**Unlikely.** The Mary River turtle primarily occurs in the mainstream of the Mary River and major tributaries, including Tinnana Creek, Yabba Creek and Obi Obi Creek (Limpus, 2008). Almost all aggregated nesting of the species also occur within the lower Mary River channel near Tiaro (Limpus, 2008). The project area is located outside the main distribution of the Mary River turtle, however, suitable habitat in which the species has potential to occur exists within Six Mile Creek, Curra Creek and Deep Creek. The area of occupancy of the Mary River turtle is not predicted to be permanently impacted by project. Flow and turtle movement will not be restricted by the new bridges and habitat disturbance from the bridge operation is expected to cause a minor localised impact. As discussed for the criteria above, without appropriate management, construction phase activities have the potential to reduce the suitability of habitat for the Mary River turtle within and downstream of the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation is the key risk for long-term potential impacts to Mary River turtle habitat within and downstream of the project area. Potential impacts as a result of

Criteria	Response
	water quality degradation may include smothering of foraging resources, filling pool habitat, alteration in habitat characteristics and impacts to turtle physiology and behaviour. As a bimodally respiring species, the Mary River turtle is particularly susceptible to changes in water quality with reduced oxygen levels and increased water temperature known to decrease a turtle's ability to respire aquatically (Clark, 2008). Decreased reliance on aquatic respiration decreases the amount of time a turtle can spend underwater and increases surfacing frequency. These changes in diving behaviour have the potential to result in reduced time available for foraging, increased energy expenditure during surfacing and increased predation levels (Clark, 2008). Strict management actions have been incorporated during all phases of the project to manage potential impacts, including the inclusion of project specific water quality performance objectives for all waters released from the construction site. Applying the mitigation measures included in Appendix B, the potential impacts to aquatic habitat suitability for the Mary River turtle are expected to be manageable. As such, the project is not expected to significantly impact the area of occupancy of the species.
Fragment an existing population into two or more populations	**Unlikely.** The new bridges over Six Mile Creek, Deep Creek and Curra Creek have been designed to completely span each waterway and the support piers will be located to avoid disruption of flows during low flow conditions or generation of turbulence during high flow conditions. Records of the species from upstream and downstream of the project have not been recorded however, where present movement of the Mary River turtle occurs, it is not expected to be inhibited and as such, no fragmentation of the population is expected to occur. Maintaining aquatic fauna passage within these three waterways has been a key design feature of project design methodology. Water flows will be maintained during construction to avoid altering flows and degrading habitat. While construction activities may restrict turtles from moving through the area due to disturbance (i.e. noise and vibration), these impacts will be temporary and will cease at the completion of construction. Overall, construction and operation of the project is not expected to significantly inhibit upstream and downstream movement of the Mary River turtles and fragmentation of the population is not predicted to occur result from the project.
Adversely affect habitat critical to the survival of the species	**Unlikely.** The waterways within the project area have been assessed as not comprising habitat critical to the survival of the Mary River turtle. The majority of species records are from within the main channel of the Mary River (i.e. downstream of the project) and almost all aggregated nesting of the species recorded in the lower catchment of the Mary River, near Tiaro (approximately 40 km further downstream of the project).

Criteria	Response
	No adverse impacts to habitat critical to the survival of the Mary River turtle are expected to occur as a result of the project. As discussed above, without appropriate mitigation measures construction phase activities have the potential to adversely affect habitat suitable for species within and adjacent to the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation is the key risk for long-term potential impacts to Mary River turtle habitat within and downstream of the project area. Strict management actions will be implemented during all phases of the project to manage this potential impact including the requirement for compliance with MRTS52 – Erosion and Sediment Control. Monitoring of water quality conditions will also occur to identify the potential for water quality degradation and allow for adaptive management. Applying the mitigation measures in Appendix B, the potential impacts to aquatic habitat suitability for the Mary River turtle are expected to be manageable and temporary. As such, the project is not expected to significantly impact habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	**Unlikely.** The Mary River turtle is thought to undertake aggregated nesting at traditional nesting sites. Almost all aggregated nesting in the species has been recorded within the main channel of the Mary River near Tiaro approximately 40 km downstream of the project (Limpus, 2008). Low-density nesting has also been identified in the upper Mary River in the reaches between Traveston Crossing and Kenilworth (Limpus, 2008) approximately 13 km upstream and further from the project. Aggregated nesting of the species have not been recorded from any of the waterways within the project area. Although some sandy banks are present within Six Mile Creek, Deep Creek and Curra Creek, the suitability of these banks for turtle nesting is generally limited by the density of riparian bank vegetation and degradation by feral animals such as cattle. As a result, nesting of the Mary River turtle within the project area is considered unlikely to occur and, therefore, the project is not predicted to significantly disrupt the breeding cycle of the species such that species decline would occur.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent the species is likely to decline	**Unlikely.** Operation of the new bridge over Six Mile Creek, Deep Creek and Curra Creek will have minimal impact on potential Mary River turtle habitat within the project area as the new bridges will span each waterway and piers will be located to avoid the low flow channel. The waterway bed and banks within the project area will be restored to their original profile and stability following construction to minimise long-term impacts. Habitat degradation and disturbance as a result of traffic noise, vibration disturbance, rubbish and run-off are expected within the immediate area of the bridges, however,

Criteria	Response
	impacts to the Mary River turtle population are considered minor. As such, no significant impacts to the availability and quality of Mary River turtle habitat are expected during bridge operation. As discussed for the assessment above, without appropriate management, construction phase activities have the potential to decease the availability and quality of Mary River turtle habitat within and downstream of the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation is the key risk for long-term potential impacts to Mary River turtle habitat within and downstream of the project area. Mitigation measures have been incorporated during all phases of the project to manage this potential impact, refer to Appendix B. Monitoring of receiving water quality conditions and water quality of water to be released is required under contract documentation to identify the potential for water quality degradation and allow for adaptive management. Applying the mitigation measures in Appendix B, the potential impacts to aquatic habitat suitability for the Mary River turtle are expected to be minor and temporary. As such, the project is not expected to significantly modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Mary River turtle is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species habitat	**Unlikely.** Degradation of potential Mary River turtle nesting habitat from cattle trampling and excessive weed growth is widespread in the Mary River catchment reducing the suitability of habitat for turtle nesting in many areas. Where nesting does occur, predation by native and introduced fauna is extremely high, with close to 100 per cent of clutches predated each season (Limpus *et al.*, 2011; Limpus, 2008). The high mortality of eggs has led to little to no recruitment of hatchlings into the population over the last decade. This lack of recruitment into the population has been identified as the key threatening process to the species (DEE, 2016b). Without appropriate management, construction phase activities have the potential to increase the presence of introduced weed and pest species that can degrade turtle nesting habitat suitability and predate upon turtle nests. As discussed above, the suitability of habitat within the project area for turtle nesting is limited and nesting of the Mary River turtle is therefore considered unlikely to occur. Implementation of best practice weed and pest management techniques as identified in Appendix B coupled with the erosion and sediment management controls identified will reduce the likelihood of potential impacts to turtle nesting habitats located upstream or downstream of the project area.

Criteria	Response
	The management actions proposed for the control of weed and pest species are considered sufficient such that no significant impact to the Mary River turtle and/or the species' habitat is likely to occur.
Introduce disease that may cause the species to decline	**Unlikely.** The project is unlikely to result in the introduction of disease into the environment given that no biotic materials will be introduced to site and that construction equipment will be free of weeds and soils which could transfer diseases. Project construction activities do however, have the potential to result in the degradation of water quality. This could lead to degradation of turtle habitat and food resources affecting turtle health with a subsequent increase in disease prevalence (Limpus et al., 2011). As a biomodally respiring species, the Mary River turtle is likely to be more susceptible to the impacts of poor water quality and water borne disease than primarily air-breathing species. Best practice management procedures for the control of erosion and sedimentation and waste and hazardous materials will be implemented during construction to minimise risks such that decline in Mary River turtles as a result of disease introduction is not expected (refer to Appendix B).
Interfere with the recovery of the species	**Unlikely.** There is no approved recovery plan for the Mary River turtle; however, the DEE species profile and threats database (DEE, 2016b) includes management strategies for the recovery and maintenance of the species. These include the following management actions: • Identifying and protecting critical habitat, and involving sand mining leases in habitat protection • Identifying nesting sites and the range of the species throughout the Mary River catchment • Determining its population dynamics, demography (maturity, growth, survival and reproductive cycle), and nesting success • Undertaking predator control in nesting areas • Undertaking a public awareness program • Developing an incubation program to protect eggs from predators and illegal collectors • Commencing a headstart program to increase hatchling survival and allow recruitment into the population, including moving clutches to safe incubation sites, creating new sandbanks for nesting, re-planting macrophytes after flood scouring, and introducing snags to pools • Constructing devices to move turtles upstream of impoundments • Undertaking research into the effect of translocation of the species.

Criteria	Response
	The proposed action will not interfere with any of these recovery actions. As such, the project is not expected to interfere with the recovery of the species.

As identified in Table 23, the project is not anticipated to have a significant impact on the Mary River turtle.

8.6.2 Significant residual impact

Due to the numerous design and construction mitigation measures which have been applied to either avoid, reduce or mitigate impacts to aquatic species from the project, a significant residual impact on the Mary River turtle will not occur.

8.6.3 Offset strategies

No offset strategies are required for impacts to the Mary River turtle as the project is not considered to result in a significant impact on the species or its habitat (refer to Table 23).

9. White-throated snapping turtle (*Elseya albagula*)

9.1 Conservation status and documentation

9.1.1 Conservation status

The white-throated snapping turtle (*Elseya albagula*) was listed as 'critically endangered' under the EPBC Act on 20 October 2014. The species was listed under Criterion 1 A3 of the EPBC Act (population size reduction). The white-throated snapping turtle is endemic to the Fitzroy, Burnett and Mary River catchments. Within the Mary River catchment, the white-throated snapping turtle occurs from the Mary River Barrage near Tiaro (approximately 40 km downstream of the project) up to Kenilworth in the upper catchment (approximately 50 km upstream of the project). Individuals have been recorded in main tributaries with permanent water including Tinana Creek, Wide Bay Creek, Obi Obi Creek and Yabba Creek (Limpus, 2008). These waterways are not located within the project area.

9.1.2 Threats to the species

The key threatening process to the white-throated snapping turtle is the lack of recruitment into the population (TSSC, 2014). Predation of nests by foxes, goannas, feral cats, and water rats is extremely high, with close to 100 per cent of clutches predated each season (Limpus *et al*., 2011; Hamann *et al*., 2007). The high mortality of eggs has led to little to no recruitment of hatchlings into the population over the last decade. The population of white-throated snapping turtle in the Mary River is now primarily comprised of adult individuals with only 0.9 per cent of adults recruited into the breeding population each year (Hamann *et al*., 2007). The protection of turtle nests and the artificial incubation of eggs have been key recovery actions for the species (TSSC, 2014).

Other threatening processes include:

- Stocking of top end predator fish into impoundments and recreational fishing
- Dense aquatic weeds restricting access to nesting areas
- Extended drought resulting in poor water quality
- Loss and degradation of habitat, restriction of movement and injury and mortality from instream infrastructure (e.g. dams and weirs) (TSSC, 2014).

9.1.3 Assessment guidelines

The following assessment guidelines were used to inform targeted surveys and impact assessment for this species:

- *The Survey Guidelines for Australia's Threatened Reptiles: Guidelines for detecting reptiles listed as threatened under the EPBC Act* (DSEWPaC, 2011b).
- Management plan for the conservation of *Elseya* sp. (Burnett River) in the Burnett River Catchment, Queensland Environmental Protection Agency (Hamann *et al*., 2007).
- Freshwater turtles in the Mary River: Review of biological data for turtles in the Mary River, with emphasis on *Elusor macrurus* and *Elseya albagula*. Brisbane: Queensland Government (Limpus, 2008).

9.1.4 Recommended survey methods

The white-throated snapping turtle primarily inhabits permanent flowing reaches of streams with a sand/gravel substrate and an abundance of refugia (i.e. rock crevices, submerged logs, macrophytes beds) (Hamann *et al.,* 2007; Limpus, 2008). The white-throated snapping turtle is not thought to occur within farm dams, ephemeral swamplands or brackish waters but does occur in impounded pools at lower densities (Limpus *et al*., 2011; Hamann *et al*., 2007)). During the day, the white-throated snapping turtle is generally found in deep pools (>6 m) either up- or downstream from a riffle zone, whereas at night the turtle moves into the shallow riffle zones (Gordos *et al*., 2007; Hamann *et al*., 2007). Due to these habitat preferences the *Survey Guidelines for Australia's Threatened Reptiles: Guidelines for detecting reptiles listed as threatened under the EPBC Act* recommends survey target these habitat types. The assessment guidelines, as listed above, recommend the following:

- Habitat assessments
- Daytime snorkelling for direct observations in areas of low turbidity
- Trapping – cathedral traps and fkye traps
- Other methods include: seine netting, dip netting and muddling.

9.2 Targeted survey effort

Targeted surveys were undertaken for the white-throated snapping turtle by FRC Environmental in March 2015 (Jacobs, 2016) and GHD in March 2016 (GHD, 2016a).

FRC Environmental (2015) targeted surveys

FRC Environmental undertook the following survey techniques in regards to the white-throated snapping turtle:

- Desktop and field aquatic habitat assessments across the project area to assess the quality of habitat within a representation of waterway reaches intersected by the project.
- Aquatic ecosystem condition and water quality upstream and downstream of the project area at 11 sites within waterways listed in Table 24.
- Targeted surveys for turtle species including the white-throated snapping turtle through the use of custom made turtle traps and fyke nets within 9 waterways intersecting the project area.
- Dusk surveys at Deep Creek and Curra Creek.

GHD (2016a) targeted surveys

GHD undertook the following survey techniques in regards to the white-throated snapping turtle:

- Broad aquatic habitat assessments upstream and downstream of the project area within 13 waterways intersecting the project, as listed in Table 24.
- Detailed aquatic habitat assessments at sites upstream and downstream of the project area within the three major waterways (Six Mile Creek, Deep Creek and Curra Creek) where threatened species were likely to occur. Detailed habitat assessments involved upstream and downstream 500 m long reach transects.
- Aquatic fauna surveys including targeted turtle surveys using turtle cathedral traps, fkye nets and late afternoon dusk watches within the three major waterways (Six Mile Creek, Deep Creek and Curra Creek) to establish the likelihood of occurrence for threatened species, such as the white-throated snapping turtle.

- Targeted snorkelling surveys for the white-throated snapping turtle were attempted at four waterways during the 2016 surveys (Unnamed Creek #2 Lot 889 on CP864404, Unnamed Creek Lot 1717 on M37818, Deep Creek and Curra Creek. Due to high turbidity levels and a visibility less than 30 cm, this survey technique could not be completed at these locations.

Targeted survey effort for the white-throated snapping turtle is summarised in Table 24.

Table 24 Summary of survey effort for the white-throated snapping-turtle

Survey methods	Survey	Survey effort undertaken
Methods recommended in survey guidelines		
Aquatic habitat assessment (AUSRIVAS)	GHD, 2016a	Undertaken at sites upstream and downstream of the project area at Six Mile Creek, Tannery Creek, Deep Creek, Moody Creek (north), Banks Creek, Tamaree Creek, Corella Creek, Keliher Creek, Unnamed Creek #2 (Lot 889 on CP864404), Unnamed Creek (Lot 1717 on M37818), Curra Creek, Curra Creek overflow and Curra Creek (north).
	FRC Environmental 2015	Undertaken at sites upstream and downstream of Six Mile Creek, Deep Creek, Moody Creek, Banks Creek, Tamaree Creek, Upper Curra Creek, Keliher Creek, Curra Creek overflow and Curra Creek.
Detailed aquatic habitat assessments	GHD, 2016a	Undertaken at upstream and downstream sites of the project area within Six Mile Creek, Deep Creek and Curra Creek.
Targeted aquatic fauna surveys using turtle traps and fkye nets	FRC Environmental 2015	Undertaken at upstream and downstream sites of the project area within Six Mile Creek, Deep Creek, Moody Creek, Banks Creek, Tamaree Creek, Curra Creek, Keliher Creek and Curra Creek overflow.
Dusk surveys	FRC Environmental 2015	Undertaken at upstream and downstream sites of the project area within Deep creek and Curra Creek
Targeted aquatic fauna surveys using turtle cathedral trapping, fyke netting, dusk pool watches and opportunistic sightings	GHD, 2016a	Undertaken at upstream and downstream sites of the project area within Six Mile Creek, Deep Creek and Curra Creek.

9.3 Records

9.3.1 Desktop and field results

The white-throated snapping turtle has been historically recorded within the region according to Wildnet and ALA records, refer to Table 25. This species was also confirmed present within Curra Creek during the GHD 2016 surveys (GHD, 2016a).

Table 25 White-throated snapping turtle records within the region

Source	Record
Wildnet / Atlas of Living Australia	There are no previous records of the species from waterways which intersect the project area. The closest records of the species within the lower Mary River catchment are from the Mary River at the junction with Curra Creek (approximately 12 km downstream of the project area). The white-throated snapping turtle has been recorded at eight locations within the upper Mary River catchment, the closest of which to the project area is at Imbil (>40 km south).
Targeted field surveys FRC Environmental in Jacobs, 2016	Not recorded. Potentially suitable habitat recorded where the project area intersects Six Mile Creek, Deep Creek and Curra Creek.
Targeted field surveys GHD, 2016a	Recorded within Curra Creek. Potentially suitable foraging habitat within Six Mile Creek, Deep Creek and Curra Creek.

9.3.2 Importance of population

Important populations of white-throated snapping turtle have not been specified in listing advice for the species. It is noted in the conservation listing advice for the species that populations are known to occur within the main channels of the Mary, Fitzroy and Burnett Rivers with occurrences occurring also within smaller drainages within these regions.

It is noted that due to the species recent species listing under the EPBC Act there is a knowledge gap in relation to widespread population studies within sub-catchments of the known distribution of the species. However, the low abundance of previous records for the white-throated snapping turtle from waterways within the project area (i.e. Six Mile Creek, Deep Creek and Curra Creek) and low suitability of turtle nesting habitat, suggests that this region of the Mary River catchment does not support a significant proportion of the white-throated snapping turtle population. Therefore, the population present is unlikely to represent an important population of the species.

Due to the presence of known nesting sites occurring at the confluence of the Mary River and Curra Creek (approximately 12 km downstream of the project) it is likely that an important population occurs within the main channel of the Mary River.

9.4 Habitat suitability

9.4.1 Species habitat requirements

The white-throated snapping turtle primarily inhabits permanent flowing reaches of streams with a sand/gravel substrate and an abundance of refugia (i.e. rock crevices, submerged logs, macrophytes beds) (Hamann *et al.,* 2007; Limpus, 2008). The white-throated snapping turtle is not thought to occur within farm dams, ephemeral swamplands or brackish waters, but does occur in impounded pools at lower densities (Hamann *et al*., 2007; Limpus, 2008). During the day, the white-throated snapping turtle is generally found in deep pools (>6 m) either upstream or downstream from a riffle zone, whereas at night the turtle moves into the shallow riffle zones (Gordos *et al*., 2007; Hamann *et al*., 2007).

The white-throated snapping turtle is thought to aggregate nesting at traditional nesting sites. Nesting aggregations have been recorded near Tiaro, the junction with Munna Creek, Gunalda, upstream from Traveston and along Obi Obi Creek (Limpus, 2008). Nesting usually occurs on alluvial sand/loam banks that are deposited by floodwaters. Nesting can however, occur in a variety of substrates ranging from sand to dark clay and grassed loam slopes. Nests are generally laid on the front face and top of steep slopes, are an average of 16.6 m from the water's edge (Limpus *et al*., 2011). The white-throated snapping turtle nests from autumn through to early spring (peak activity between May and July) with hatching generally occurring in early summer (December- January) after an embryonic diapause over the winter months (Hamann *et al*., 2007). Once they reach sexual maturity (15 – 20 years) female turtles are thought to breed annually (Hamann *et al*., 2007).

9.4.2 Habitat within the project area

The white-throated snapping turtle was opportunistically observed surfacing within Curra Creek during field surveys (GHD, 2016a). This species primarily inhabits permanent flowing pools within the main channel of the Mary River and major tributaries. The white-throated snapping turtle had not been previously recorded from any of the waterways within the project area. The majority of the minor waterways within the project area are ephemeral and do not contain suitable habitat for this species (GHD, 2016a). The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek do however, provide potentially suitable habitat conditions for the white-throated snapping turtle. Key habitat features, such as instream woody debris, undercut banks, and overhanging riparian vegetation, are present in a relatively high abundance within these areas (GHD, 2016a). The pool-riffle-glide sequences within Six Mile Creek represent ideal habitat conditions for the white-throated snapping turtle and due to the proximity of the project area to the main channel of the Mary River, the white-throated snapping turtle is considered likely to occur within this reach (GHD, 2016a). One female white-throated snapping turtle was confirmed present within Curra Creek during field surveys (GHD, 2016a). Habitat conditions within Curra Creek are considered sub-optimal for the white-throated snapping turtle, due to reduced connectivity and habitat degradation, and as such, the species is predicted to occur at lower densities than expected within pool-riffle-run sequences (e.g. within the main Mary River channel and Six Mile Creek). Similar habitat conditions occur within Deep Creek, and as such, the white-throated snapping has the potential to occur at low densities within this reach also (GHD, 2016a).

Similar to the Mary River turtle, aggregated nesting of the white-throated snapping turtle primarily occurs at a small number of traditional sandy banks. Nesting requirements for this species are however, more variable than those for the Mary River turtle, with nests recorded in a variety of substrates ranging from sand to dark clay and grassed loam slopes (Limpus, 2008; Limpus *et al*., 2011). No white-throated snapping turtle nesting sites have been recorded within any of the waterways within the project area. Alluvial sandy/loam banks are present within Six Mile Creek, Deep Creek and Curra Creek and the suitability of these banks for turtle nesting is generally limited by the high density of riparian bank vegetation and degradation by cattle (GHD, 2016a). Where bank vegetation and degradation is reduced within Six Mile Creek, Deep Creek and Curra Creek, nesting of the white-throated snapping turtle has the potential to occur; however, this habitat is likely to be low value and support only isolated nesting (GHD, 2016a).

9.4.3 Habitat critical to the survival of the species

Habitat critical to the survival of the white-throated snapping turtle has not been specified in listing advice for the species. The *Matters of National Environmental Significance Significant*

Impact Guidelines 1.1 (DoE, 2013) defines habitat critical to the survival of a species as areas that are necessary:

- For activities such as foraging, breeding, roosting or dispersal
- For the long-term maintenance of the species
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or the recovery of the species

Impact on habitat critical to the survival of the species

The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek provide potentially suitable habitat conditions for the white-throated snapping turtle, however, only one individual has been previously recorded (GHD, 2016a) from within these waterways both historically and during targeted surveys undertaken for the project. The low abundance of species recorded from the project area and the low suitability of turtle nesting habitat within these waterways, suggests aquatic habitats within the project area are unlikely to represent habitat critical to the survival of the species.

9.5 Measures to avoid, reduce or mitigate impacts

9.5.1 Avoidance

Avoidance of direct impacts on the white-throated snapping turtle has been achieved through the incorporation of bridge structures rather than culverts at each major waterway crossing (including Six Mile Creek, Deep Creek and Curra Creek), while also avoiding a direct loss of potential habitat for aquatic MNES by spanning the low flow channel of each waterway.

9.5.2 Reduction and mitigation

The reduction and mitigation measures for the Mary River cod (refer Section 7.5.2) will assist in the reducing and mitigating impacts to the white-throated snapping turtle. Other species management actions specific for aquatic fauna, which are indirectly relevant to mitigating impacts to the white-throated snapping turtle and its habitat, have been developed for the project, as shown in Appendix B .

9.6 Significance of impact assessment

9.6.1 Significance of impact assessment

Impacts of the project on the white-throated snapping turtle have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 26.

Table 26 Significant impact assessment for the white-throated snapping turtle

Criteria	Response
An action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of a population	**Unlikely.** The size of the white-throated snapping turtle population within and downstream of the project area is not predicted to be permanently impacted by the project. The bridges proposed at Six Mile Creek, Curra Creek and Deep

Criteria	Response
	Creek will span the waterway and no permanent loss of instream aquatic habitat. Bridge piers will be located outside the low flow channel and no inhibition of turtle movement is expected to occur during construction or operation. Habitat degradation and disturbance as a result of traffic noise, vibration disturbance, rubbish and run-off are expected to occur with the immediate vicinity of the bridges during construction and operation. These potential impacts may decrease the value of the habitat for the white-throated snapping turtle within the immediate area. Impacts are, however, expected to be temporary and managed through the contract. Although these temporary disturbances may affect a small number of individuals within the immediate area, a long term decrease in the size of a downstream population is unlikely to occur. Without appropriate mitigation measures, project construction activities have the potential to result in direct and indirect impacts to the white-throated snapping turtle within and adjacent to the project area. These potential impacts include injury and/or mortality to individuals and decreased habitat suitability as a result of water quality degradation, particularly sedimentation, noise, vibration and light disturbance. Applying the prescribed mitigation measures in Appendix B the potential risk for direct and indirect impacts to the white-throated snapping turtle are expected to be reduced to minor disruption of individuals and minor degradation of habitat within the immediate area of the project area. Individual turtles may be temporarily displaced into suitable habitat adjacent to the project area with their return expected following completion of construction activities. All erosion and sediment controls designed for the project are required to comply with the design requirements of MRTS52 – Erosion and Sediment Control. This includes the requirement for sediment basins to be designed for an 85th percentile, 5 day rainfall event, rainfall events within this design requirement will be controlled by the Construction Contractor. Additional mitigation measures have been implemented during all phases of the project to manage these potential impacts, refer to Appendix B. Monitoring of water quality conditions will also occur upstream and downstream of the project to identify potential for water quality degradation and allow for adaptive management, refer to Appendix B. The majority of the white-throated snapping turtle population has been previously recorded within the main Mary River channel. The very low abundance of records for the species from waterways within the project area (one individual confirmed present within Curra Creek during the ecological surveys undertaken for the project (GHD, 2016a)) suggests that this region of the Mary River catchment does not support a significant proportion of the white-throated snapping turtle population. As such, no significant impact to the long-term size

Criteria	Response
	of the white-throated snapping turtle population is expected to occur as a result of the project.
Reduce the area of occupancy of the species	**Unlikely.** The white-throated snapping turtle occurs within the Mary River from the Mary River barrage, near Tiaro, to Kenilworth in the upper catchment. The species also inhabits main tributaries with permanent water including Tinana Creek, Wide Bay Creek, Obi Obi Creek and Yabba Creek (Limpus, 2008; TSSC, 2014). One individual white-throated snapping turtle was observed within Curra Creek during targeted ecological surveys undertaken for the project (GHD, 2016a). No other records of the species exist from waterways which intersect the project area. The area of occupancy of the white-throated snapping turtle is not predicted to be permanently impacted by project. Flow and turtle movement will not be restricted by the construction of the new bridges over Six Mile Creek, Deep Creek and Curra Creek and habitat disturbance from bridge operation is expected to cause a minor localised impact. As discussed for the criteria above, without appropriate management, construction phase activities have the potential to reduce the suitability of habitat for the white-throated snapping turtle within and adjacent to the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation is the key risk for long-term potential impacts to white-throated snapping habitat within and downstream of the project area. Potential impacts as a result of water quality degradation may include smothering of foraging resources, filling pool habitat, alteration in habitat characteristics and impacts to turtle physiology and behaviour. As a bimodally respiring species, the white-throated snapping turtle is particularly susceptible to changes in water quality with reduced oxygen levels and increased water temperature known to decrease a turtle's ability to respire aquatically (Clark, 2008). Decreased reliance on aquatic respiration decreases the amount of time a turtle can spend underwater and increases surfacing frequency. These changes in diving behaviour have the potential to result in reduced time available for foraging, increased energy expenditure during surfacing and increased predation levels (Clark, 2008). Strict management actions have been implemented during all phases of the project to manage potential impacts to water quality degradation, refer to Appendix B. Applying the prescribed mitigation measures the potential impacts to aquatic habitat suitability for the white-throated snapping turtle are expected to be managed during the design storm event. As such, the project is not expected to reduce the area of occupancy of the species.

Criteria	Response
Fragment an existing population into two or more populations	**Unlikely.** The new bridges over Six Mile Creek, Deep Creek and Curra Creek have been designed to span each waterway and the support piers have been located to avoid disruption of flows during low flow conditions or generation of turbulence during high flow conditions. Upstream and downstream movement of the white-throated snapping turtle is not expected to be inhibited and as such, no fragmentation of a population is expected to occur. Maintaining aquatic fauna passage within the aforementioned waterways has been a key design feature of project design methodology. Water flows during construction activities will be maintained within the existing channel of each waterway to avoid altering flows and degrading habitat. While construction activities may restrict turtles from moving through the project area due to disturbance (i.e. noise and vibration) these impacts will be temporary and will cease at the completion of construction of the structure over each waterway. Overall, construction and operation of the project is not expected to significantly inhibit upstream and downstream movement of the white-throated snapping turtles and fragmentation of the population is not predicted to occur as a result of the project.
Adversely affect habitat critical to the survival of the species	**Unlikely.** The waterways within the project area were not assessed as comprising habitat critical to the survival of the white-throated snapping turtle. The majority of species records are from within the main channel of the Mary River and large tributaries and almost all aggregated nesting of the species recorded in the lower catchment, near Tiaro (approximately 40 km downstream of the project). No adverse impacts to habitat critical to the survival of white-throated snapping turtle are expected to occur as a result of the project. As discussed above, without appropriate mitigation measures construction phase activities have the potential to adversely affect habitat suitable for species downstream of the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation is the key risk for long-term potential impacts to white-throated snapping turtle habitat downstream of the project area. Although, the regional catchment of the Mary River is an agricultural catchment which generates an increased amount of sediment runoff during rain events, strict mitigation measures have been implemented during all phases of the project to manage potential impacts to habitat quality, refer to Appendix B. Monitoring of receiving water quality conditions and water quality of water to be released is required under the contract documentation to manage impacts to water quality and allow for adaptive management. Applying the mitigation measures prescribed in Appendix B the potential impacts to aquatic habitat suitability for the white-

Criteria	Response
	throated snapping turtle are expected to be minor and temporary. As such, the project is not expected to significantly impact habitat critical to the survival of the species.
Disrupt the breeding cycle of a population	**Unlikely.** White-throated snapping turtle is thought to aggregate nesting at traditional nesting sites. Within the Mary River catchment, nesting aggregations have been recorded near Tiaro, the junction with Munna Creek (approximately 40 km downstream of the project), Gunalda, upstream from Traveston and along Obi Obi Creek (Limpus, 2008). Nesting (aggregated or isolated) of the species has not been recorded from any of the waterways within the project area. Although some sandy banks are present within Six Mile Creek, Deep Creek and Curra Creek, the suitability of these banks for turtle nesting is generally limited by the density of riparian bank vegetation and degradation by cattle. Where bank vegetation and degradation is reduced within Six Mile Creek, Deep Creek and Curra Creek, nesting of the white-throated snapping turtle has the potential to occur; however, this habitat is likely to be low value and support only isolated nesting. As a result, the project is not predicted to significantly disrupt the breeding cycle of the species such that species decline would occur.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent the species is likely to decline	**Unlikely.** Operation of the new bridges will have minimal impact on white-throated snapping habitat within the project area as the new bridges will span each waterway with piers located to avoid the low flow channel. The waterway banks within the project area bed and banks will be restored to their original profile and stability following construction to minimise the potential for long-term impacts. Habitat degradation and disturbance as a result of traffic noise, vibration disturbance, rubbish and run-off are expected within the immediate area of the bridges, however, impacts to the white-throated snapping turtle population are considered minor and temporary. As such, no significant impacts to the availability and quality of white-throated snapping turtle habitat are expected during bridge operation. As discussed for the assessment above, without appropriate mitigation measures, construction phase activities have the potential to decease the availability and quality of white-throated snapping turtle habitat within and downstream to the project area. Potential impacts to habitat suitability are temporary and will cease at the completion of construction. Water quality degradation is the key risk for long-term potential impacts to white-throated snapping turtle habitat within and downstream of the project area. Mitigation measures have been implemented during all phases of the project to manage this potential impact, refer to Appendix B. Monitoring of receiving water quality conditions and water quality of water to be released is required

Criteria	Response
	under contract documentation to identify the potential for water quality degradation and allow for adaptive management. Applying the mitigation measures as described in Appendix B, the potential impacts to aquatic habitat suitable for the white-throated snapping turtle are expected to be minor and temporary. As such, the project is not expected to significantly modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species habitat	**Unlikely.** Degradation of potential white-throated snapping turtle nesting habitat from cattle trampling and excessive weed growth is widespread in the Mary River catchment reducing the suitability of habitat for turtle nesting in many areas. Where nesting does occur within the broader catchment, predation by native and introduced fauna is extremely high, with close to 100 per cent of clutches predated each season (Limpus *et al.*, 2011; Limpus, 2008). The high mortality of eggs has led to little to no recruitment of hatchlings into the population over the last decade. This lack of recruitment into the population is identified as the key threatening process to the species (TSSC, 2014). Without appropriate management, construction phase activities have the potential to increase the presence of introduced weed and pest species that can degrade turtle nesting habitat suitability and predate upon turtle nests. As discussed above, the suitability of habitat within the project area for white-throated snapping turtle nesting is low value and support isolated nesting only. Implementation of best practice weed and pest management techniques coupled with erosion and sediment management controls (refer to Appendix B) will reduce the likelihood of potential impacts to turtle nesting habitats located upstream or downstream of the project area. The mitigation measures proposed for the control of weed and pest species are considered sufficient such that no significant impact to the white-throated snapping turtle and/or the species' habitat is likely to occur.
Introduce disease that may cause the species to decline	**Unlikely.** The project is unlikely to result in the introduction of disease into the environment given that no biotic materials will be introduced to the project area and that construction equipment will be free of weeds and soils which could transfer diseases. However the project construction activities do have the potential to result in the degradation of water quality. This could lead to degradation of turtle habitat and food resources affecting turtle health with a subsequent increase in disease prevalence (Limpus *et al.*, 2011). As a biomodally respiring species, the white-throated snapping turtle is likely to be more susceptible to the impacts of poor water quality and water borne disease than primarily air-breathing species. Best practice

Criteria	Response
	management procedures for the control of erosion and sedimentation and waste and hazardous materials have been implemented to minimise risks such that decline in white-throated snapping turtles as a result of disease introduction is not expected.
Interfere with the recovery of the species	**Unlikely.** There is no approved recovery plan for the white-throated snapping turtle; however, the DEE Conservation Advice (TSSC, 2014) and management plan for the species within the Burnett River catchment (Hamann *et al.*, 2007)) includes management strategies for the recovery and maintenance of the species: • Improving recruitment of hatchlings into the population via protection of nests and hatchery programs • Maintaining functional turtle nesting banks throughout the catchment, including restriction of cattle access to river banks and predator control • Maintaining stream flow and high quality in-river habitat between impoundments • Managing water levels so as to avoid inundation of nesting banks during the incubation period • Maintaining continuity of population throughout the catchment • Reducing the incidence of death and physical injury to turtles at existing and future impoundment structures • Managing recreational fishing and boating activities in impoundments to be compatible with the maintenance of sustainable turtle populations and reduce unnecessary injury to turtles • Improving water quality within the lower Fitzroy catchment • Increasing the area of river and adjacent riverine habitat managed for conservation purposes • Increasing stake-holder, including Indigenous traditional owners, participation in conservation and management processes • Monitoring the response of turtle populations in each catchment to the management strategies and evaluate their effectiveness of these strategies and modify them accordingly. The project will not interfere with any of these recovery actions. As such, the project is not expected to interfere with the recovery of the species.

As shown in Table 26, the project is anticipated not to have a significant impact on the white-throated snapping turtle.

9.6.2 Significant residual impact

Due to the numerous design and construction mitigation measures which have been applied to either avoid, reduce or mitigate impacts on the white-throated snapping turtle from the project, a significant residual impact on this species will not occur.

9.6.3 Offset strategies

No offset strategies are required for impacts to the white-throated snapping turtle as the project is not considered to result in a significant impact on the species or its habitat (refer to Table 26).

10. *Macrozamia pauli-guilielmi* (pineapple zamia)

10.1 Conservation status and documentation

10.1.1 Conservation status

Macrozamia pauli-guilielmi (pineapple zamia) is listed as 'endangered' under the EPBC Act.

10.1.2 Threats to the species

Threats to *M. pauli-guilielmi* have been documented in the Queensland Herbarium's *National Multi-species Recovery Plan for the cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi and Macrozamia platyrhachis* (Queensland Herbarium, 2007) as including the following:

- Loss of habitat
- Removal of plants
- Inappropriate fire regime
- Loss of genetic variation
- Loss of associations with other species (including pollinators and fungus)
- Climate change

10.1.3 Assessment guidelines

A *National Multi-species Recovery Plan for the cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi and Macrozamia platyrhachis* (Queensland Herbarium, 2007) has been developed which aims to:

- Prevent further loss of individuals, populations, pollinator species and habitat critical to the species' survival.
- Recover existing populations to normal reproductive capacity to ensure viability in the long-term, prevent extinction, maintain genetic viability, and improve conservation status.

10.1.4 Recommended survey methodology

The Commonwealth government has not developed species-specific survey guidelines for *M. pauli-guilielmi*. A combination of survey methods from DEC (2004) and EHP (2014) threatened species survey guidelines was implemented during the flora surveys. The most effective method of searching a wide area for threatened flora species that are naturally rare is through the implementation of a random meander survey technique through potentially suitable habitat, rather than undertaking transect or plot-based surveys (DEC, 2004). This technique allows for substantially greater coverage than a plot-based survey and is less time consuming. As the name suggests, the random meander technique involves traversing areas of suitable habitat in no set pattern, but roughly back and forth, whilst searching for particular plant species, usually threatened species.

An analysis of the optimal survey timing for *M. pauli-guilielmi* identified that flora surveys are able to detect the species throughout the year as it is a long lived perennial species.

10.2 Survey effort

Targeted surveys for the *M. pauli-guilielmi* were undertaken by BAAM (2016) in March 2015, May 2015 and February 2016. GHD (2016b) also undertook targeted surveys in July 2016. Targeted surveys for the species included a random meander survey technique through potentially suitable habitat in accordance with relevant guidelines (DEC, 2004; EHP, 2014). As this species is a perennial species with leaves present throughout the year, surveys at all times of the year are appropriate for detecting the species. Targeted survey effort for *M. pauli-guilielmi* is summarised in Table 27.

Table 27 Summary of survey effort for *Macrozamia pauli-guilielmi*

Survey methods	Survey	Survey effort undertaken
Random meander survey technique through potentially suitable habitat	BAAM, 2016	Total of 144 person hours over three events: • 6-7 March 2015 (2 ecologists x 16 hrs) • 5-7 May 2015 (2 ecologists x 24 hrs) • 22-25 February 2016 (2 ecologists x 32 hrs)
	GHD, 2016	Total of 160 person hours over one event • 25-29 July 2016 (4 ecologists x 40 hrs)

10.3 Records

10.3.1 Desktop and field results

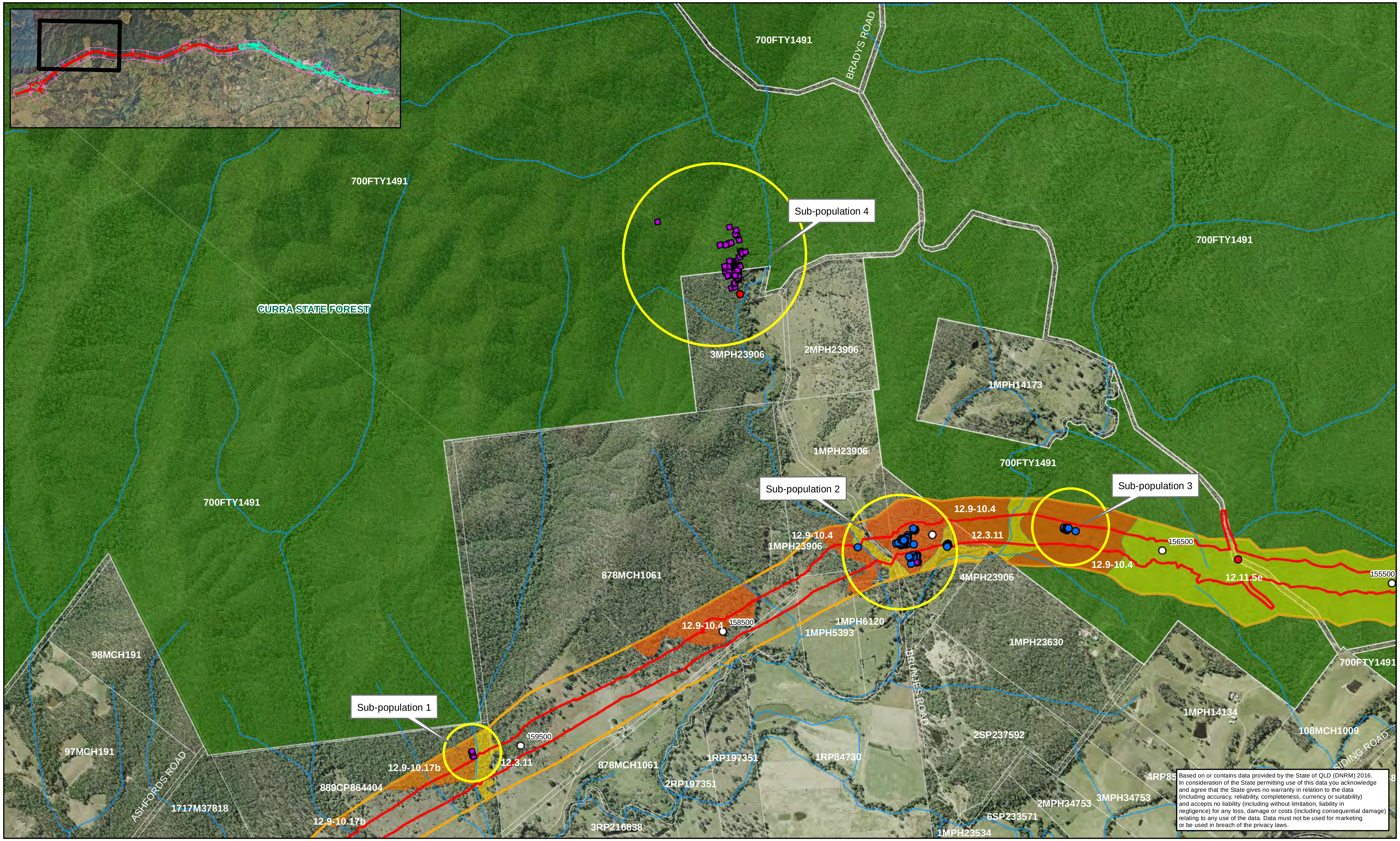
M. pauli-guilielmi has been historically recorded from the region according to ALA records, refer to Table 28. This species was also confirmed present during field surveys undertaken for the project (Jacobs, 2016).

The locations of *M. pauli-guilielmi* are shown on Figure 6 while details of the sub-population sizes and supporting habitats are summarised in Table 3.4 of BAAM's 2016 *Detailed Terrestrial Flora Surveys* report (2016). A sub-population (referred to as 'sub-population 4') was confirmed at the site of a historical specimen record (collected from 1997 and 2011) located 1.3 km east of the study area (refer to Figure 6).

Table 28 *Macrozamia pauli-guilielmi* records within the region

Source	Record
Atlas of Living Australia	Four specimens of *M. pauli-guilielmi* have been previously recorded within the vicinity of the project area. These are recorded from two locations within Curra State Forest: October 1997 (D. Halford). Curra State Forest (S.F.700), Keliher Logging Area, 14 km NNW of Gympie. Eucalypt open forest with shrubby understorey, hilly terrain, simple slope, southerly aspect, stony dark brown light clay. Female plant, frond 70 cm long erect, dark green. Occasional. October 1997 (D. Halford). Curra State Forest (S.F.700), Keliher Logging Area, 14 km NNW of Gympie. Eucalypt open forest with shrubby understorey, hilly terrain, simple slope, southerly aspect, stony dark brown light clay. Frond

Source	Record
	80 cm long, erect male. Occasional. April 2011 (P.I. Forster). Curra State Forest (S.F.700), Keliher Logging Area; 14 km NNW of Gympie. Open forest of Corymbia intermedia, C. citriodora, Eucalyptus acmenoides, E. propinqua, Lophostemon confertus, dense shrubby understorey, south facing ridge; gravelly clay soil from metasediments. Small cycad, subterranean caudex; leaves 2-6, 70-80 cm long, leaflets dark green with whitish-yellow petiolules; male cones green (aseasonal). Very common at locality. October 1997 (D Halford). Curra State Forest (S.F.700), Tamaree Logging Area, 12 km NNW of Gympie. Eucalypt open forest, hilly terrain, crest, stony dark reddish brown loam. Frond 70 cm high, female plant. Only one male and one female plant seen.
Targeted field surveys Jacobs 2016	A total of 48 adults and 167 seedlings were confirmed present within the project area with an extent of occurrence of 7.85 ha The *M. pauli-guilielmi* are present as three sub-populations within or in close proximity to the project area and form part of a larger meta-population.
Targeted field surveys GHD, 2016	No additional individuals were found.



1:15,000 @A3

0 100 200 400 600 800

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

LEGEND

- 1 km Chainage
- Macrozamia (BAAM 2015)
- Macrozamia ALA Record
- Macrozamia (BAAM 2016)
- Street/Local Road
- Watercourses
- Cadastre
- Survey Area

Project Area

- Contract 2

Field Verified RE (BAAM 2015)

- 12.11.5e
- 12.3.11
- 12.9-10.17b
- 12.9-10.4
- Protected Areas

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	27 Mar 2017

Macrozamia pauli-guilielmi records

Figure 6

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3037_MNES_Fig06_A3_Macrozamia_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: TMR: BAAM Flora Survey data, Chainage, Project Footprint (2016), Field Verified RE, Imagery (2015); DNRM: Cadastre (2015), Protected Areas (2015), Waterways (2010). GHD: Project Area (March 2017). Created by: sc

10.3.2 Importance of population

Important populations are those considered to be viable in the long-term (Queensland Herbarium, 2007). While very small populations may not be viable in the long-term, they may represent significant genetic variation across the range of the species. Therefore, all populations should be considered to be worth preserving or, where appropriate, translocating into suitable habitat (Queensland Herbarium, 2007).

Only four of the populations identified in the *National Multi-species Recovery Plan for the cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi and Macrozamia platyrhachis* (Queensland Herbarium, 2007) are currently considered to be viable in the long-term, none of which occur within the study area. Most of the remaining populations of *M. pauli-guilielmi* show evidence of insect pollination and seedling recruitment, an indication of viability at least in the short term.

10.4 Habitat suitability

10.4.1 Species habitat requirements

M. pauli-guilielmi is endemic to south-east Queensland where it is only found in the Wide Bay district between the Isis River in the north, and Wolvi in the south, from the coast and Fraser Island inland to Mt Woocoo and the Gympie district (Queensland Herbarium, 2007; ALA, 2016). *M. pauli-guilielmi* grows in lowland (5 to 230 m altitude) open forest or woodland dominated by banksias or eucalypts (wallum), or in shrub land or heath land, generally on sandy and loamy soils, including stabilised sand dunes. It does not have a preferred aspect. Like other Macrozamia species, *M. pauli-guilielmi* grows in clusters or groves that derive ecological benefit from existing as high-density, spatially discrete populations (Hall and Walter 2013).

10.4.2 Habitat within the project area

The three sub-populations were all found growing in soft, sandy soils derived from sandstone in the following REs:

- RE 12.3.11 – *Eucalyptus tereticornis* +/- *Eucalyptus siderophloia*, *Corymbia intermedia* open forest on alluvial plains usually near coast.
- RE 12.9-10.4 – *Eucalyptus racemosa* subsp*. racemosa* woodland on sedimentary rocks.
- RE 12.9-10.17b – *Corymbia citriodora* subsp*. variegata* mixed open forest to woodland on sedimentary rocks.

Sub-population 4 was found growing in RE 12.11.5e, which is described as a *Corymbia citriodora* subsp*. variegata* open forest on metamorphics +/- interbedded volcanics, usually including *Eucalyptus siderophloia, E. propinqua* and *E. acmenoides.*

The presence of seedlings in all sub-populations suggests that all sub-populations have reproduced successfully in the recent past. Many female plants in sub-populations 2 to 4 had green developing cones at the time of the early 2016 flora surveys whereas many male plants had old, open cones. The presence of cones and multiple seedlings indicate healthy, successfully reproducing sub-populations and suitable habitat.

The *M. pauli-guilielmi* sub-populations are highly localised and discrete, despite adjacent areas of suitable habitat in adjoining areas. This pattern of occurrence is typical of the species (Queensland Herbarium, 2007), and is thought to be a consequence of very limited dispersal opportunities following the extinction of megafauna (which previously dispersed the seeds) from the area tens of thousands of years ago (Snow and Walter, 2007; Hall and Walter, 2013).

10.4.3 Habitat critical to the survival of the species

National Multi-species Recovery Plan for the cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi and Macrozamia platyrhachis (Queensland Herbarium, 2007) identified that habitat where the remaining viable populations occur is considered to be habitat critical to the survival of the species (Queensland Herbarium, 2007). Although there is uncertainty as to what constitutes a viable population for cycads, populations with indicators of attrition and natural recruitment that display a progression of size classes (e.g. with fewer, older individuals and many juveniles) can be considered to be adequately replacing itself. For dioecious species, 500 individuals is often cited as the minimum number of individuals within a viable population (Gilpin and Soulé, 1986, cited in Queensland Herbarium, 2007).

The current sub-populations all exhibit attrition and natural recruitment; however, the current known number of individuals within the identified four sub-populations is 190 adults and 194 seedlings (with the seedlings in sub-populations not quantified but noted as ‘abundant’). Although the number of individuals is less than the benchmark of 500, the lack of individuals may be attributed to a lack of survey effort in the surrounding area. With due regard for the precautionary approach, and for the purposes of this assessment, the sub-populations are being considered as a viable population.

For this project, this includes RE 12.3.11, RE 12.9-10.4 and RE 12.9-10.17b where soft, sandy soils derived from sandstone are present. However, as the species has limited dispersal potential, habitat critical to the survival of the species is restricted to where individuals of the species are located.

10.5 Measures to avoid, reduce or mitigate impacts

10.5.1 Avoidance

The avoidance of *M. pauli-guilielmi* is not possible as the plants are located within the project area.

10.5.2 Reduction and mitigation

Reduction measures were not able to be applied to *M. pauli-guilielmi* as the plants are located within the project area and therefore unavoidable. The following specific management actions have been developed to mitigate the impacts to the *M. pauli-guilielmi* :

- Development and implementation of a peer-reviewed (by the Queensland Herbarium) Translocation Management Plan
- Post translocation monitoring of *M. pauli-guilielmi* and adaptive management measures.

These key mitigation measures as well as other species management actions specific for terrestrial flora, which are indirectly relevant to mitigating impacts to *M. pauli-guilielmi*, have been developed for the project, as shown in Appendix C. These management actions will be documented in the relevant contract documentation required for the project.

10.6 Significance of impact assessment

10.6.1 Significance of impact assessment

Impacts of the project on *M. pauli-guilielmi* have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013). The results of this assessment are detailed in Table 29.

Table 29 Significant impact assessment for *Macrozamia pauli-guilielmi*

Criteria	Response
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Lead to a long term decrease in the size of a population	**Unlikely.** The project area will result in impacts to 48 adults and 167 seedling found within two sub-populations which form part of a larger meta-population. Additionally, the works will result in impacts to potentially viable seeds within the seed bank. The removal of these individuals as well as any seeds stored in the seed bank has the potential to lead to a long term decrease in the size of a population. However, all 48 adults and 167 seedlings will be translocated to an offset site in accordance with a Translocation Management Plan that has been developed for the project. The Translocation Management Plan includes the following provisions: • Translocating all individuals directly impacted by the project (and all individuals indirectly impacted which form part of a sub-population directly impacted). • Translocating all individuals which would otherwise become fragmented from the balance of the sub-population as a result of the proposed works. • Seed collection and seed dispersal within the translocation site to counterbalance the loss of *M. pauli-guilielmi* individuals and maintain the genetic diversity of the species. In this regard, it is unlikely the proposed works will lead to a long term decrease in the size of a population.
Reduce the area of occupancy of the species	**Unlikely.** The project will directly impact 48 adults and 167 seedlings which will reduce the area of occupancy of the species. Additionally, the project will remove potential habitat for the species. However, with the implementation of mitigation measures, the proposed works will not reduce the area of occupancy of the species as all individuals directly impacted (and all individuals indirectly impacted that are within a sub-population which is directly impacted) will be translocated. A Translocation Management Plan has been developed with provisions to translocate all individuals within the two sub-populations impacted by the proposed works. The Translocation Management Plan includes provisions for the translocated *M. pauli-guilielmi* to be spaced at a minimum of two meter centres with seeds dispersed at the same density. Given the clustered nature of the existing sub-populations, with numerous adult and seedlings clustered in close proximity to each other, translocating the sub-populations has the potential to increase the area of occupancy as the translocated individuals will be spaced at lower densities than currently exist.

Criteria	Response
Fragment an existing population into two or more populations	The works will directly impact up on two sub-populations of *M. pauli-guilielmi* and will fragment the existing sub-populations. However, with the implementation of mitigation measures, the proposed works will not fragment the existing two sub-populations. The Translocation Management Plan developed for the project includes provisions for all individuals of the two sub-populations impacted by the project to be translocated to a suitable site. The Translocation Management Plan includes provisions that require the translocation site to be of a size which will accommodate either: • All individuals from both sub-populations impacted if only one translocation site is identified, or • If two translocation sites are required, maintain the current number of individuals within each sub-population
Adversely affect habitat critical to the survival of a species	**Likely.** The *National Multi-species Recovery Plan for the cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi and Macrozamia platyrhachis* (Queensland Herbarium, 2007) identifies habitat critical to the survival of the species as 'habitat where the remaining viable populations occur'. Although there is uncertainty as to what constitutes a viable population for cycads, populations with indicators of attrition and natural recruitment that display a progression of size classes (e.g. with fewer, older individuals and many juveniles) can be considered to be adequately replacing itself. For dioecious species, 500 individuals is often cited as the minimum number of individuals within a viable population (Gilpin and Soulé, 1986, cited in Queensland Herbarium, 2007). The current sub-populations all exhibit attrition and natural recruitment; however, the current known number of individuals within the identified four sub-populations is 190 adults and 194 seedlings (with the seedlings in sub-populations not quantified but noted as 'abundant'). Although the number of individuals is less than the benchmark of 500, the lack of individuals may be attributed to a lack of survey effort in the surrounding area. With due regard for the precautionary approach, and for the purposes of this assessment, the sub-populations are being considered as a viable population. In this regard, the proposed works are anticipated to adversely impact 7.85 ha of habitat critical to the survival of the species (based on the extent of occurrence of the species within the project area).
Disrupt the breeding cycle of a population	**Likely.** The project will directly impact 48 adults and 167 seedlings will impact the breeding cycle for those individuals impacted. However, disruption to the breeding cycle will be avoided via the implementation of the Translocation Management Plan which includes provisions that require the *M. pauli-guilielmi* to be translocated prior to the spring flush of new growth and the development of reproductive material. In this regard, the

Criteria	Response
	translocation of the species will not impact upon the breeding cycle of the sub-populations.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely.** The *M. pauli-guilielmi* currently occupies an extent of occurrence of 7.85 ha within the project area. The *M. pauli-guilielmi* are present within the project area as two sub-populations comprising 48 adults and 167 seedlings. The loss of 7.85 ha of suitable habitat for *M. pauli-guilielmi* is unlikely to lead to the decline of the species given that an additional 142 adults and abundant seedlings will remain in the vicinity in the form of three-subpopulations; with a large sub-population located to the north of the project. With the implementation of the Translocation Management Plan, the impacted *M. pauli-guilielmi* will be translocated to a suitable site to maintain the number of individuals and minimise the potential that the number of individuals within species declines as a result of the proposed works. In this regard, although 7.85 ha of habitat will be removed, the species is unlikely to decline as all impacted individuals will be translocated to a suitable site.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	**Unlikely.** Invasive species are not identified as a key threatening process to *M. pauli-guilielmi* (Queensland Herbarium, 2007). The Translocation Management Plan will include provisions for weed control within the translocation site to minimise the competition for resources and the potential for weeds to impact on the establishment and on-going survival of the translocated individuals.
Introduce disease that may cause the species to decline	**Unlikely.** Disease is not considered to be a key threat to the *M. pauli-guilielmi* (Queensland Herbarium, 2007).
Interfere with the recovery of the species	**Unlikely.** The *National Multi-species Recovery Plan for the cycads, Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi and Macrozamia platyrhachis* (Queensland Herbarium, 2007) identified the following as recovery actions: 1. Protect existing populations 2. Prevent loss of individuals and populations from legal harvesting and salvage 3. Prevent loss of individuals, plant parts and seeds to illegal harvesting and destruction 4. Determine habitat, ecological and reproductive needs 5. Populations managed according to the best available knowledge. 6. Recovery of populations In the absence of mitigation measures, the proposed works would interfere with the recovery of the species. However, with the implementation of the Translocation Management Plan, none of the recovery actions are compromised; while translocation of individuals will assist with the following

Criteria	Response
	recovery actions: • **Protect existing populations** – the translocation site will be legally secured from future clearing by way of a lawful mechanism (e.g. voluntary declaration) • **Recovery of populations** – the objective of this action is to translocate individual plants under immediate threat to suitable habitat in the vicinity of nearby larger populations. With consideration of the above, the translocation of the individuals is anticipated not to retard the recovery of the species.

Based on the outcomes of the significant impact assessment undertaken in Table 29 and with implementation of the Translocation Management Plan developed for the project, the proposed works are unlikely to have a significant impact on *M. pauli-guilielmi*.

10.6.2 Significant residual impact

Due to the development and required implementation of the Translocation Management Plan, a residual impact on *M. pauli-guilielmi* is not anticipated to occur from the project. A number of adaptive management and contingency measures have been included in the Translocation Management Plan. One of these measures relates to the mortality or loss of adult plants. Where mortality occurs, a program to collect seed from existing known populations on a sustainable basis is to be undertaken. This process will include propagating and planting the seedlings back into existing populations at a ratio of eight seedlings established per adult plant lost to increase the size of existing populations. This adaptive measure has been developed to reduce a residual impact occurring later in the project. The five year monitoring program proposed in the Translocation Monitoring Plan will assist in assessing the long-term survival of the translocated individuals.

10.6.3 Offset strategies

No offset strategies are required for impacts to *M. pauli-guilielmi* as the project is not considered to result in a significant impact on the species (refer to Table 29).

11. Lowland Rainforest of Subtropical Australia TEC

11.1 Conservation status and documentation

11.1.1 Conservation Status

The Lowland Rainforest of Subtropical Australia Threatened Ecological Community (TEC) is listed as 'critically endangered' under the EPBC Act.

11.1.2 Threats to the ecological community

Current threats to the Lowland Rainforest of Subtropical Australia TEC are documented in the *Commonwealth Listing Advice on Lowland Rainforest of Subtropical Australia* (TSSC, 2011) and include:

- Land clearing
- Impacts associated with fragmentation of remnants
- Weeds
- Private native forestry

11.1.3 Assessment guidelines

In order for a rainforest community to be afforded protection under the EPBC Act as an MNES, the rainforest community must meet key diagnostic criteria and condition thresholds; including canopy cover, patch size, native vegetation cover and species diversity. Refer to the Flora Survey Report (GHD, 2016b) for a full discussion on the assessment and distribution of the Lowland Rainforest of Subtropical Australia TEC within the survey area.

11.2 Survey effort

Field surveys for the TEC were undertaken by BAAM (2016) in March 2015, May 2015 and February 2016. GHD (2016b) also undertook targeted surveys in July 2016. Targeted surveys for the community included a random meander survey technique through areas previously identified as potentially suitable habitat in accordance with State's *Flora Survey Guidelines – Protected Plants, version 1.1 2014*. Survey effort for the TEC is summarised in Table 30.

Table 30 Summary of survey effort for the threatened ecological community

Survey methods	Survey	Survey effort undertaken
Random meander survey technique through potentially suitable habitat	BAAM, 2015 and 2016	Total of 144 person hours over three events: • 6-7 March 2015 (2 ecologists x 16 hrs) • 5-7 May 2015 (2 ecologists x 24 hrs) • 22-25 February 2016 (2 ecologists x 32 hrs)
	GHD, 2016	Total of 160 person hours over one event • 25-29 July 2016 (4 ecologists x 40 hrs)

11.3 Records

11.3.1 Desktop and field records

The Lowland Rainforest of Subtropical Australia TEC was identified on the EPBC Act Protected Matters Search Report as having the potential to occur within 10 km of the project. Flora surveys undertaken for the project identified two separate patches of Lowland Rainforest of Subtropical Australia TEC at two locations within the survey area as follows (refer to Figure 7):

- Six Mile Creek – the Lowland Rainforest of Subtropical Australia TEC was recorded along riparian vegetation along the waterway throughout the project area
- Woondum State Forest – the Lowland Rainforest of Subtropical Australia TEC was recorded within the survey area but outside the project area. Clearing within the project area will encroach within the 50 m buffer of the recorded TEC.

The Flora Survey Report (GHD, 2016b) attached to the referral document contains a full discussion on the Lowland Rainforest of Subtropical Australia TEC within the project area and survey area. Distribution mapping showing the extent of the patch and an additional 50 m buffer zone are shown on Figure 7. The Threatened Species Scientific Committee's listing advice for the Lowland Rainforest of Subtropical Australia TEC (TSSC, 2011), states that a 50 m buffer zone is required to be placed around the outer edge of the patch to preserve the communities' habitat and also identifies that impacts to vegetation within the 50 m buffer may constitute a significant impact (TSSC, 2011).

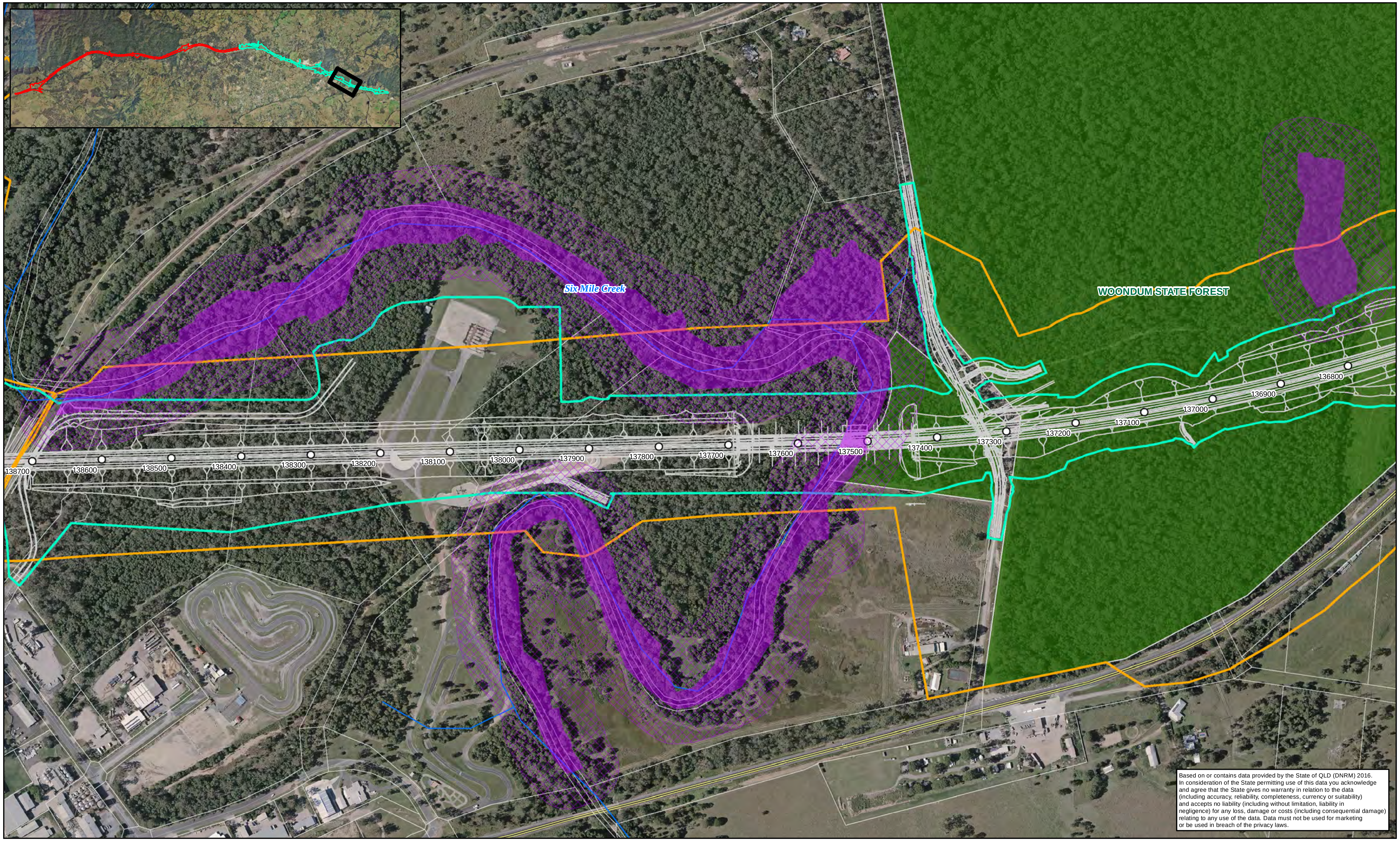
11.4 Habitat suitability

11.4.1 Habitat within the project area

The Lowland Rainforest of Subtropical Australia TEC is typically associated with the following Regional Ecosystems (RE):

- 12.3.1 Complex to simple notophyll vine forest – Gallery rainforest (notophyll vine forest) on alluvial plains.
- 12.5.13 Microphyll to notophyll vine forest +/- *Araucaria cunninghamii*.
- 12.8.3 Complex notophyll vine forest – complex notophyll vine forest on Cainozoic igneous rocks.
- 12.8.4 Complex notophyll vine forest with Araucaria species on Cainozoic igneous rocks.
- 12.8.13 Araucarian complex microphyll vine forest on Cainozoic igneous rocks.
- 12.11.1 Simple notophyll vine forest often with abundant Archontophoenix cunninghamiana ("gully vine forest") on metamorphics +/- interbedded volcanics.
- 12.11.10 Notophyll vine forest +/- Araucaria cunninghamii on metamorphics +/- interbedded volcanics.
- 12.12.1 Simple notophyll vine forest usually with abundant Archontophoenix cunninghamiana ("gully vine forest") on Mesozoic to Proterozoic igneous rocks.
- 12.12.16 Notophyll vine forest on Mesozoic to Proterozoic igneous rocks.

Of the REs which have the potential to conform to the Lowland Rainforest of Subtropical Australia TEC, only RE 12.3.1 and RE 12.11.10 are present within the survey area; with both REs supporting the Lowland Rainforest of Subtropical Australia TEC.



Paper Size A3

0 25 50 100 150 200

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- 100m Chainage
- Highway
- Local Connector Road
- Street/Local Road
- Watercourse
- Survey Area
- Cadastral Boundary
- TEC (GHD 2016)
- TEC 50 m Buffer
- Protected Areas
- Contract 2

Project Area

- Contract 1

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)

Lowland Rainforest of Subtropical Australia TEC

Job Number	41-29914
Revision	0
Date	27 Mar 2017

Figure 7

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6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: GHD: TEC, TEC 50m Buffer (2016); TMR: Imagery (2014). DNRM: Cadastre (2016), Watercourses (2010), Road Network (2016), Protected Areas (2014). GHD: Project Area (March 2017), Road Design (November 2016). Created by: sc

11.4.2 Habitat critical to the survival of the ecological community

Habitat critical to the survival of the ecological community is not clearly defined in the Commonwealth listing advice; however, in addition to the actual TEC itself, a buffer zone that extends 50 m beyond the trunks of the outermost trees in the patch is required to assist in the preservation of the patch. In this regard, vegetation within 50 m of the outer edge of the TEC is likely to be considered habitat critical for the survival of the ecological community.

11.5 Measures to avoid, reduce or mitigate impacts

11.5.1 Avoidance

Avoidance of impacts on the TEC known to occur on the southern bank of Six Mile Creek is not possible due to the required construction of the project. The project is able to avoid impacts on TEC known to occur adjacent to Woondum State Forest due to the community being located outside the project area.

11.5.2 Reduction and mitigation

The following measures have been incorporated into either the Business Case or Detailed Design phase of the project to reduce impacts on the Lowland Rainforest of Subtropical Australia TEC known to occur on the southern bank of Six Mile Creek:

- A review of design and construction methodologies employed for the Six Mile Creek bridge structure to avoid impacts to the TEC. The review of the design and construction methodologies for bridge construction included:
  - Altering the bridge spans from 33 metre span (Business Case phase) to a main span of 46.4 in length made continuous using 38 m long super T-girders (Detailed Design phase) to reduce impacts to the waterway and associated riparian vegetation.
  - Individual span widths have been rationalised during the Detailed Design phase due to environmental concerns associated with either Six Mile Creek or the TEC.
  - Raising the deck level by 770 mm during the Detailed Design phase to account of critical 1% AEP design storm event and climate change.
  - Increase in spacing between northbound and southbound bridge structures to 1360 mm to allow for increase in natural light.
  - Consideration of specific construction methodologies such as pile structure, timing of construction program, use of a launching truss, use of scaffolding, use of steel casings.
- Nomination of specific construction methodologies for the construction of the bridge in the contract documentation to reduce impacts to the area.
- Nomination of timing requirements for the construction of the bridge structure.
- Nomination of timing requirements for instream stream works and bank stability works.
- Nomination of specific treatments for bank stability works on either bank of Six Mile Creek.
- Requirement for no temporary crossings to be constructed over Six Mile Creek.
- The bridge over Six Mile Creek spans the main channel of the waterway and piers have been positioned to avoid disturbance of the northern bank through the use of sheet piles to reduce impacts to the TEC confirmed present on the northern bank.

These key mitigation measures as well as other species management actions specific for terrestrial flora, which are indirectly relevant to mitigating impacts to Lowland Rainforest of Subtropical Australia TEC, have been developed for the project, as shown in Appendix C. These management actions will be documented in the relevant contract documentation required for the project.

11.6 Significance of impact assessment

The potential impacts to the Lowland Rainforest of Subtropical Australia TEC as a result of project have been assessed against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) in Table 31.

Table 31 Significant impact assessment for the Lowland Rainforest of Subtropical Australia TEC

Criteria	Response
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Reduce the extent of an ecological community	**Likely.** The project will result in the direct loss of 0.82 ha of the TEC and 4.67 ha of the 50 m buffer area of the Lowland Rainforest of Subtropical Australia TEC along Six Mile Creek. The project is unlikely to reduce the extent of the patch of Lowland Rainforest of Subtropical Australia TEC within Woondum State Forest; however, the project will encroach on 0.52 ha of the 50 m buffer of the TEC.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**Likely.** The works will result in the fragmentation of the TEC along Six Mile Creek. Although the TEC along Six Mile Creek is only present along the northern bank of the waterway at the location where the project area crosses Six Mile Creek, the proposed works will result in 0.82 ha of the TEC being impacted which will result in the TEC being fragmented. This fragmentation will result in a 4.55 ha patch of TEC to the west of the project (between the existing Bruce Highway and the new highway) and a 9 ha patch to the east of the project (between the project and the North Coast Rail alignment). It is noted that the TEC assessments undertaken for this project did not extend beyond the existing Bruce Highway and the North Coast Rail alignment and so the extent of the TEC beyond these areas is unknown. The works will not fragment or increase the fragmentation of the TEC within Woondum State Forest as the project area is to the west of the TEC and does not directly impact the TEC at this location. No additional areas of RE 12.3.1 or RE 12.11.10 which have the potential to support the TEC will be impacted by the project.
Adversely affect habitat critical to the survival of an ecological community	**Likely.** The project will result in the permanent removal of approximately 0.82 ha of riparian vegetation on the northern bank of Six Mile Creek which comprises the TEC as well as 4.67 ha of the 50 m buffer area. Habitat critical to the survival of the ecological community is not clearly defined in the Commonwealth listing advice;

Criteria	Response
	however, in addition to the actual TEC itself, a buffer zone that extends 50 m beyond the trunks of the outermost trees in the patch is required to assist in the preservation of the patch. In this regard, the clearing of 4.67 ha of vegetation within 50 m of the outer edge of the TEC is likely to be considered habitat critical for the survival of the ecological community. The project area extends to within 50 m of the TEC at Woondum State Forest and the removal of vegetation within the 50 m buffer zone is considered to be adversely impacting habitat critical to the survival of the ecological community. As a result, the clearing of the 50 buffer will result in the clearing of 0.52 ha of habitat critical to the survival of the ecological community.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**Unlikely.** The project will not modify or destroy abiotic factors necessary for the ecological community which will result in adverse impacts to the TEC outside of the project area. Given the provision for weed control and rehabilitation planting of disturbed areas within the contract documentation, minimal impacts to the retained area of the TEC along Six Mile Creek and the TEC within Woondum State Forest are anticipated as a result of the project.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**Unlikely.** The project will permanently remove 0.82 ha of the TEC within the project area at Six Mile Creek. This is approximately 6 % of the TEC covered by the field survey at this location which is unlikely to cause a substantial change in the species composition of an occurrence of the ecological community. The dominant species present along the northern bank of Six Mile Creek within the project area are present along the length of the TEC surveyed along Six Mile Creek and therefore the loss of these species will not alter the species composition of the entire patch of the TEC. The project will not directly impact the TEC within Woondum State Forest and will therefore not cause a substantial change in the species composition of an occurrence of an ecological community. Impacts to the 50 m buffer area of the TEC at Six Mile Creek and Woondum State Forest will result in the removal of predominantly non-rainforest species and is anticipated not cause significant changes to the species composition of the TEC at either location.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: *— assisting invasive species, that are harmful to the listed ecological*	**Unlikely.** While the majority of the TEC at Six Mile Creek was observed to support low levels of weeds, individual areas along Six Mile Creek were observed to be highly impacted by the restricted pest species *Macfadyena unguis-cati* (cats claw creeper), which forms a dense cover at intermittent locations including the location of the creek crossing. Weeds were observed at low densities within the patch of TEC at Woondum State Forest. Given the provision for weed control and rehabilitation planting of disturbed areas within the

Criteria	Response
community, to become established, or *— causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or*	contract documentation, the works are unlikely to cause a substantial reduction in the quality of the TEC at Six Mile Creek or Woondum State Forest by assisting invasive species. The works will not result in the regular mobilisation of fertilisers, herbicides or other chemicals or pollutants at Six Mile Creek or Woondum State Forest
Interfere with the recovery of an ecological community.	**Certain.** A Recovery Plan is not currently in place for the Lowland Rainforest of Subtropical Australia TEC; however, the planning, implementation and coordination of recovery actions for this TEC does not involve additional actions beyond that which are anticipated to be implemented through management plans for areas which currently contain this TEC. Conservation advice for this species outlines priority recovery actions required for this ecological community (TSSC, 2011). The conservation advice recommends, as a priority action, to '*protect and conserve remaining areas of the ecological community. Further clearance and fragmentation of this critically endangered ecological community should be avoided*'. The project will result in the direct loss of 0.82 ha of TEC and 4.67 ha area within the 50 m buffer of the extent of the Lowland Rainforest of Subtropical Australia TEC which is expected to interfere with the recovery of the TEC.
Reduce the extent of an ecological community	**Certain.** The proposed works will result in a permanent loss of 5.49 ha of habitat critical to the survival of the ecological community at Six Mile Creek. Although the works will not directly involve the removal of TEC within Woondum State Forest and therefore result in the reduction of the extent of an ecological community, the works will remove 0.52 ha of habitat critical to the survival of the ecological community within Woondum State Forest.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**Likely.** Although the TEC along Six Mile Creek is present as a relatively contiguous polygon, there are areas of discontinuity where the rainforest community displays an increase in the abundance of *Eucalyptus* genera species. Irrespective of the relatively small patches of discontinuity of the TEC along Six Mile Creek, the project will result in the removal of 0.82 ha of TEC which will result in the fragmentation of the ecological community at Six Mile Creek. The proposed works will not fragment or increase fragmentation of the ecological community within Woondum State Forest.

0.82 ha of the Lowland Rainforest of Subtropical Australia TEC is proposed to be removed along the northern bank of Six Mile Creek (which accounts for 6% of the Lowland Rainforest of Subtropical Australia TEC surveyed along a 2.7 km stretch of the waterway). The works will remove 5.49 ha of habitat critical to the survival of the TEC at Six Mile Creek and 0.52 ha of habitat critical to the survival of the TEC at Woondum State Forest. Based on the outcomes of the significant impact assessment undertaken in Table 31, the proposed works are likely to have a significant impact on the Lowland Rainforest of Subtropical Australia TEC.

11.6.1 Significant residual impact

Although a number of avoidance measures and mitigation measures have been developed for the project, the works will result in the loss of 5.49 ha of habitat critical to the survival of the TEC along Six Mile Creek and 0.52 ha of habitat critical to the survival of the TEC at Woondum State Forest (refer to Figure 7). This disturbance is anticipated to have a significant residual impact on the TEC.

11.6.2 Offset strategies

The *Commonwealth Conservation Advice on Lowland Rainforest of Subtropical Australia* (TSSC, 2011) identifies a number of specific actions under the following broad priority categories as well as a number of research priorities:

Priority management actions

- Habitat loss, disturbance and modification
- Impacts from residential and peri-urban development
- Invasive species
- Trampling, browsing or grazing
- Frequent fire regimes
- Conservation information
- Enable recovery of additional sites.

An appropriate direct offset to compensate for the significant residual impact to the polygon of TEC which directly interests the project area at Six Mile Creek would be the control of weeds within the TEC. During the flora surveys undertaken for the project, the weed *Macfadyena unguis-cati* (cats claw creeper) was observed to be present at high densities within the TEC. In this regard, TMR propose to undertake a biological control of the species in conjunction within the manual and chemical control of the declared pest. Biological control species include the Tingid bug (*Carvalhotingis visenda*) and the leaf-mining jewel beetle (*Hylaeogena jureceki*) which are currently being utilised within the broader catchment to control *Macfadyena unguis-cati* (cats claw creeper). This program will be undertaken in consultation with local relevant stakeholders (i.e. Gympie Regional Council and Mary River Catchment Coordinating Committee). Initial discussions with the relevant stakeholders has been undertaken to date to discuss the feasibility of the program and the potential for an early release of the biological control to assist in an early establishment of the two beetles prior to undertaking manual and chemical control. The program is proposed to be undertaken along the riparian vegetation of Six Mile Creek which supports the TEC this includes areas both upstream and downstream of the project.

The control of *Macfadyena unguis-cati* (cats claw creeper) combined with revegetation using rainforest species within the TEC patch would assist in improving the ecological characteristics and resilience of the TEC patch and would address the following two priority management actions including:

- Invasive species
- Enable recovery of additional sites

TMR are developing a draft EPBC Act Offsets Proposal for consideration by the Minister as part of the EPBC Act assessment process. It is anticipated that a final EPBC Act Offsets Proposal will be a conditional requirement on the project to be submitted and approved prior to commencement of major civil construction activities.

12. Conclusion

This MNES Significant Impact Assessment report has been prepared as an assessment tool to determine which MNES the project is anticipated to have a significant impact upon. The primary purpose of this report was to provide an assessment for each MNES which is either 'known' or 'likely' to occur against the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013) to quantify the following:

- The proposed mitigation measure for each MNES.
- Whether habitat present within the project area or survey area has been assessed as 'habitat critical to the survival of the species' in accordance with the national recovery plan for the species (where available) or the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013).
- Whether an 'important population' of a species is present within the project area or survey area in accordance with the national recovery plan for the species (where available) or the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DoE, 2013).
- Whether the project will result in a significant residual impact on each MNES.
- The proposed offset strategies for each MNES where a significant residual impact is anticipated.

The results of the significant impact assessments identified that the project has the potential to have a significant impact on the following MNES and therefore offset strategies have been proposed for each of the following MNES:

- Black-breasted button-quail (*Turnix melanogaster*)
- Koala (*Phascolarctos cinereus*)
- Lowland Rainforest of Subtropical Australia TEC

A summary of whether the project area supports habitat critical to the survival of the species, whether the locally occurring population is considered an important population for the species, and whether the project will result in a significant impact to the MNES is provided in Table 32 below.

Table 32 Significant impact assessment summary

MNES	Habitat critical to the survival of the species within the project area	Important population present	Significant impact	Offset proposed
Black-breasted button-quail	Yes	Unlikely	Yes	Yes
Koala	Yes	Yes	Yes	Yes
Greater glider	Unlikely	Unlikely	Unlikely	No
Grey-headed flying-fox	Unlikely	No	Unlikely	No
Migratory species	Unlikely	No	Unlikely	No

MNES	Habitat critical to the survival of the species within the project area	Important population present	Significant impact	Offset proposed
Mary River cod	Yes	Yes	Unlikely	No
Mary River turtle	Unlikely	Unlikely	Unlikely	No
White-throated snapping turtle	Unlikely	Unlikely	Unlikely	No
Macrozamia pauli-guilielmi	Yes	Yes	Unlikely	No
Lowland rainforest of subtropical Australia TEC	Yes	N/A	Yes	Yes

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Appendices

Appendix A – Terrestrial Fauna Species Mitigation Measures

Table A Terrestrial Fauna Species Mitigation Measures

Phase	Management actions	Effectiveness of the management action
Design Phase	In accordance with TMR's *Environmental Processes Manual* TMR will prepare environmental contract documentation (including MRTS51 – Environmental Management, MRTS52 – Erosion and Sediment Control and MRTS16 – Landscape and Revegetation Works, and associated annexure) to address specific requirements to be managed during the construction phase of the project.	This mitigation measure will assist in minimising indirect impacts to MNES and their habitat through a reduction in sediment loss and associated water quality impacts. Furthermore, this mitigation measure will reduce impacts on terrestrial MNES through inclusion of management measures for vegetation clearing, fauna management and general environmental management.
	A Species Management Program – high risk will be developed for all endangered, vulnerable, near threatened or special least concern and colonial breeding fauna species listed under the State's NC Act, where an active breeding place has been confirmed.	This mitigation measure will assist in mitigating impacts to fauna and their breeding habitat listed under the NC Act.
	In accordance with TMR's *Environmental Processes Manual* revegetation and landscaping plans are required to be developed in accordance with TMR's MRTS16 – Landscape and Revegetation Works and associated annexure.	This mitigation measure may also assist in recreating habitat for MNES following the disturbance from the project. Revegetation of areas adjacent to Six Mile Creek bridge and areas of Woondum State Forest may assist in recreating habitat for the black-breasted button-quail.
	Inclusion of fauna exclusion fencing at appropriate locations to prevent movement of fauna into the project area. Fauna fencing will be erected along areas of bushland and on either side (200 m length) of proposed fauna connectivity structures, including bridges, to encourage use of these structures. Fauna fencing will be installed in accordance with Road and Traffic Authority (NSW's) Standard Drawing and include the following specifications:	Fauna fencing is referenced in TMR's *Fauna Sensitive Road Design Manual Volume 2: Preferred Practises* (TMR, 2002) as an effective management measure to reduce vehicle collisions with fauna on linear infrastructure.

Phase	Management actions	Effectiveness of the management action
	• Galvanised wire 50 chain-link fence, with additional 0.5 m overhang "floppy top" (outward of road formation). • 3 m buffer free of vegetation (excluding grasses) on habitat side of the fence. In addition to installing the fauna fencing, the fauna fencing is to be maintained in accordance with the TMR Road Maintenance Performance Contract.	
	Incorporation of four fauna connectivity structures and 10 bridge structures (eight over water, two over roads) along the length of the project. Each fauna connectivity structure is proposed to be dual purpose (drainage and fauna) and will be a minimum 3 x 3 metre box culvert (for use by large general fauna species) incorporating a dry ledge and fauna furniture. Fauna connectivity structure locations have been selected based on known populations of fauna being present (including koala populations), large areas of suitable habitat on either side of the project, and the length and skew of the required connectivity structure to encourage fauna to enter, as fauna are known to not use connectivity structures which involve a dark entry point. The locations of the fauna connectivity structures (each of which is relevant to the koala) is shown on Figure 3. Fauna furniture will be provided including hard wood horizontal and vertical logs within and outside the culvert to provide a dry passage for koalas and other arboreal species whilst also providing refuge from predators. Koala refuge poles will also be provided at various intervals (approximately 3 m) between the end of the horizontal logs and connecting habitat. A fauna connectivity structure will be constructed at Chainage 137100 m	Fauna connectivity structures are referenced in TMR's *Fauna Sensitive Road Design Manual Volume 2: Preferred Practises* (TMR, 2002) as an effective management measure to maintain habitat connectivity and minimise impacts on existing populations and fauna individuals moving across linear infrastructure. A recent study undertaken by researchers at Griffith University found that retrofitted structures (i.e. drainage structures such as culverts and bridges) underneath road infrastructure or a road surface were utilised by koalas in 130 separate events (Dexter *et. al*, 2016).

Phase	Management actions	Effectiveness of the management action
	(Woondum State Forest) to maintain habitat connectivity between habitats located to the east and west of the project area (refer to Figure 2). This fauna connectivity structure is also required to accommodate koalas due to previous records of the species and suitable habitat present. Landscaping is proposed adjacent to the wing walls of the fauna connectivity structure to encourage the black-breasted button-quail to use the structure and to provide refuge and shelter from predators. Fauna connectivity structures are required to be regularly inspected and maintained for effectiveness, in accordance with the Road Maintenance Performance Contract.	
	Vegetation clearing limits will be defined under the contract documentation, to minimise the extent of vegetation clearing whilst allowing construction to occur, taking into account erosion and sediment control devices. A plan of clearing limits will be prepared by the Construction Contractor and clearing shall not proceed on site until the limits of clearing have been deemed suitable by the Contract Administrator.	This mitigation measure will minimise the vegetation clearing required for the project and reduce impacts to MNES species and supporting habitat.
	The contract documentation will specify that additional workspace areas and haul routes are to be placed in previously cleared areas, where possible.	This mitigation measure will minimise the vegetation clearing required for the project and reduce impacts to MNES species and supporting habitat.
	No-go zones will be nominated in the contract documentation. These will be clearly set out and marked prior to construction activities commencing. No works are to be undertaken in these areas, nor are these areas to be used as storage of materials/plant.	Nomination of no-go zones have been incorporated into TMR projects for a number of years and has been found to be effective in keeping machinery and personnel out of environmentally sensitive areas. Incorporation of no-go zones

Phase	Management actions	Effectiveness of the management action
		will assist in minimising additional impacts to MNES or their habitat.
	The contract documentation will require the Construction Contractor to develop a clear staged approach to vegetation clearing prior to the commencement of works. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins). The staging of works will be required to be deemed suitable by the Contract Administrator prior to clearing works commencing.	This mitigation measure will reduce impacts on MNES occurring within the staged area to be cleared by allowing fauna to move out of the disturbed area.
	Each dual bridge proposed over major waterways has been separated to allow for natural light to filter between the two structures.	Bridges are able to act as fauna connectivity structures by allowing fauna to move underneath each bridge as referenced in TMR's *Fauna Sensitive Road Design Manual Volume 2: Preferred Practises* (TMR, 2002). Insufficient light under a bridge is noted in the aforementioned guidelines as an inefficiency of underpasses and therefore by allowing light to penetrate through to the existing ground surface, the use of these structures as an underpass increases (TMR, 2002).
Construction Phase	The Construction Contractor will prepare a project specific Erosion and Sediment Control Plan (ESCP) and Environmental Management Plan (Construction) (EMP(C)) to meet the requirements of MRTS51 – Environmental Management and MRTS52 – Erosion and Sediment Control and other project specific approval conditions.	This mitigation measure will reduce impacts on terrestrial MNES through inclusion of management measures for vegetation clearing, fauna management and general environmental management.
	The Construction Contractor will undertake a pre-clearing weed survey	This mitigation measure will assist in minimising indirect

Phase	Management actions	Effectiveness of the management action
	and report areas of existing weed infestation and identifying treatment and management requirements in accordance with Annexure MRTS51.1 – Environmental Management.	impacts to MNES and their habitat through a reduction in weed invasion and habitat degradation.
	The Construction Contractor will perform an environmental induction to all site personnel to outline responsibilities in relation to MNES.	This mitigation measure will assist in training all onsite personnel in regards to MNES species and their environmental obligations where MNES are found onsite.
	The Construction Contractor will be required to manage weed species and pests in accordance with the contract documentation, including. • Implementing weed management strategies during construction (including monitoring, treatments and reporting during construction), washdown of vehicles prior to entering the project area and conducting weed inspections as part of the rehabilitation monitoring and reporting. • Preparing hygiene declaration forms for all plant/vehicles working within the project area.	This mitigation measure will assist in minimising indirect impacts to MNES and their habitat through a reduction in weed invasion and habitat degradation.
	A terrestrial fauna specialist will be appointed by the Construction Contractor prior to construction commencing and approved by the Contract Administrator for the handling, capture and release of native fauna (e.g. a licensed spotter catcher issued under the *Nature Conservation (Administration) Regulation 2006*), for the assessment and/or removal of native fauna.	This mitigation measure will assist in identifying MNES present within the clearing area and allow these species to be moved away from the impact area, where possible.
	Prior to vegetation clearing in each zone, the terrestrial fauna specialist will undertake a pre-clearing survey to identify and mark habitat features (i.e. hollow bearing logs, hollow bearing trees, areas of wetland vegetation, banks along waterways with burrows etc.). The terrestrial fauna specialist will also be	This mitigation measure will assist in identifying MNES present within the clearing area and allow these species to be moved away from the impact area, where possible.

Phase	Management actions	Effectiveness of the management action
	required to identify the fauna species likely or known to be present within the stage to be cleared based on existing habitat and previous records, as identified during the targeted surveys. Results of the pre-clearance survey are to be reported by the Construction Contractor in the monthly report to the Contract Administrator, prior to clearing commencing in an area.	
	Hollow timber, woody debris and bush rock which is suitable for fauna habitat will be relocated to retained habitat areas outside the clearing area adjacent to the project area, where possible.	This mitigation measure may provide shelter habitat for the black-breasted button-quail where habitat features are moved within Woondum State Forest.
	The terrestrial fauna specialist will undertake an immediate pre-clearance survey 24 hours ahead of vegetation clearing for each stage, to search habitat features previously marked for fauna and/or breeding activity. A two stage approach to clearing will be implemented where hollow bearing trees have been identified. Non-hollow bearing trees will be cleared before hollow bearing trees, to allow fauna an opportunity to move away and allow time to concentrate rescue efforts on the trees that are most likely to be inhabited. Sequential vegetation clearing to be applied onsite. Vegetation clearing is to occur from disturbed areas and clear towards areas of vegetation to be retained. Hollow bearing trees will be felled after a minimum 24 hr delay after clearing of non-habitat trees. The terrestrial fauna specialist will be on site for all clearing works including clearing of hollow bearing trees. Individual hollows of felled hollow bearing trees will be inspected using a torch or similar by the terrestrial fauna specialist and the relevant fauna contingency actions initiated. Once the trees are deemed clear by the terrestrial	This mitigation measure will assist in identifying MNES present within the clearing area and allow these species to be moved away from the impact area, where possible.

Phase	Management actions	Effectiveness of the management action
	fauna specialist further processing can occur.	
	For each stage of clearing the terrestrial fauna specialist will prepare and submit a post-clearing report within the Construction Contractors monthly report submitted to the Construction Administrator.	This mitigation measure will allow for TMR to keep a record of MNES which have been recorded and moved out of the project area.
	If there is more than one machine clearing vegetation, or if the Construction Contractor is clearing in more stage of works, more than one terrestrial fauna specialist will be required.	This mitigation measure will assist in identifying MNES present within the clearing area and allow these species to be moved away from the impact area, where possible.
	Grubbing and removal of ground cover and understorey will be delayed until immediately prior to earthworks occurring within that particular stage of works.	This mitigation measure will assist in minimising erosion and sediment control thereby protecting water quality and ultimately MNES and their habitat.
	Where possible, cleared native vegetation will be mulched and reused onsite during establishment of erosion and sediment control, rehabilitation and stabilisation activities. Should the mulch be required to be stockpiled, the material will be stockpiled in a manner where endemic seeds remain viable and weeds are treated.	This mitigation measure will allow for the retention of endemic and native seeds within the soil profile to facilitate the establishment of endemic vegetation communities, while also assisting in managing erosion and sediments entering waterways.
	The Construction Contractor will implement of construction vehicle speed limits within the project area.	This mitigation measure will assist in minimising direct impact on MNES terrestrial fauna species.
	Where possible, during construction avoid positioning direct artificial lighting towards retained bushland.	This mitigation measure will assist in minimising indirect impacts on MNES species during construction.
	Where possible, exposed areas will be progressively rehabilitated as soon as reasonably practical to avoid extended periods of soil exposure.	This mitigation measure will assist in reinstating endemic species along waterways to encourage the establishment and resilience

Phase	Management actions	Effectiveness of the management action
		of local native species, which in turn will provide habitat to MNES.
	Strategic planting adjacent to targeted fauna connectivity structures will occur to improve and maintain habitat connectivity for MNES, where possible. Specifically, for the black-breasted button-quail low shrubs will be considered in the planting list for revegetation adjacent to the proposed fauna connectivity structure.	This mitigation measure will assist in reducing ongoing impacts such as vehicle strike or mortality to MNES during the operational phase of the project.
	Dust and noise impacts to MNES will be managed in accordance with the procedures in the EMP(C).	This mitigation measure will assist in reducing indirect noise and air quality impacts on MNES and their habitat.
	Construction fauna monitoring will be required as part of the SMP - high risk to be developed for the project.	This mitigation measure will assist in determining the success of mitigation measures employed during the construction phase, for impacts on MNES fauna species.
	Upon completion of the works within the bed and banks of waterways, banks are to be stabilised (through appropriate measures) and revegetated, where applicable, within similar native endemic species appropriate to their position in the landscape or in accordance with a Landscape Plan for the specific waterway.	This mitigation measure will assist in reinstating endemic species along watercourses to encourage the establishment and resilience of local native species.
Post Construction Phase	Undertake regular maintenance and inspections of fauna exclusion fencing and fauna underpasses in accordance with contract documentation, to preserve or restore the effectiveness of fauna fencing.	Maintenance of fauna fencing is required as per Chapter 5 of TMR's *Fauna Sensitive Road Design Manual Volume 2: Preferred Practises* (TMR, 2002).
	Weed management will be required to be undertaken post-construction in accordance with the Road Maintenance Performance Contract (RMPC).	Post-construction weed management is required as per TMR's *Environmental Processes Manual*. Weed invasion is listed as a key threat to each MNES due to the impacts on habitat

Phase	Management actions	Effectiveness of the management action
		degradation, therefore the management of weeds will assist in a conservational gain for each MNES.
	Key aspects of the waterway revegetation actions will include stabilisation, replanting, weed control, and restriction of public access and grazing, where applicable.	This mitigation measure will assist in recreating habitat for MNES following the disturbance of habitat due to the project.

Appendix B – Aquatic Fauna Species Mitigation Measures

Table B Aquatic Fauna Species Mitigation Measures

Phase	Management actions	Effectiveness of the management action
Design Phase	In accordance with TMR's *Environmental Processes Manual* TMR will prepare environmental contract documentation (including MRTS51 – Environmental Management, MRTS52 – Erosion and Sediment Control and MRTS16 – Landscape and Revegetation Works and associated annexures) to address specific requirements to be managed during the construction phase of the project.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in sediment loss and associated water quality impacts.
	In accordance with TMR's *Environmental Processes Manual* revegetation and landscaping plans are required to be developed in accordance with TMR's MRTS16 – Landscape and Revegetation Works and associated annexures.	This mitigation measure will assist in reducing pollutants and sediment from the operation of the highway entering the receiving environment as acting as a filtration system. This mitigation measure may also assist in recreating habitat for MNES following the disturbance from the project.
	Vegetation clearing limits will be defined under the contract documentation, to minimise the extent of vegetation clearing whilst allowing construction to occur taking into account erosion and sediment control devices. A plan of clearing limits will be prepared by the Construction Contractor and clearing shall not proceed on site until the limits of clearing have been deemed suitable by the Contract Administrator.	This mitigation measure will minimise the vegetation clearing required for the project, reduce increased erosion and sediment risk and therefore reduce impacts to MNES species.
	The contract documentation will specify that additional workspace areas and haul routes are to be placed in previously cleared areas, where possible.	This mitigation measure will minimise the vegetation clearing required for the project and reduce impacts to MNES species.
	No-go zones will be nominated in the contract documentation. These will be clearly set out and marked prior to construction activities commencing. Nomination of no-go zones in consultation with contract administrator. No works are to be undertaken in these areas, nor are these areas	Nomination of no-go zones has been incorporated into TMR projects for a number of years and is effective in keeping machinery and personnel out of environmentally sensitive areas. Incorporation of no-go

Phase	Management actions	Effectiveness of the management action
	to be used as storage of materials/plant.	zones will assist in minimising additional impacts to MNES or their habitat.
	The contract documentation will require the Construction Contractor to develop a clear staged approach to vegetation clearing prior to the commencement of works. Staged vegetation clearing will also require that the Construction Contractor is initially only permitted to clear for pioneering works (i.e. establishment of fencing and sediment basins). The staging of works will be required to be deemed suitable by the Contract Administrator prior to clearing works commencing.	By permitting the clearing for pioneering works will assist in the establishment of erosion and sediment control measures to reduce impacts on aquatic MNES.
	Incorporation of eight bridge structures over waterways including Six Mile Creek, Deep Creek and Curra Creek rather than culverts to allow for the movement of fish upstream and downstream of the project area.	Fauna connectivity structures are referenced in TMR's *Fauna Sensitive Road Design Manual Volume 2: Preferred Practises* (TMR, 2002) as an effective management measure to maintain habitat connectivity and minimise impacts on existing populations and fauna individuals moving across linear infrastructure.
	Each dual bridge proposed over major waterways including Six Mile Creek, Deep Creek and Curra Creek has been designed to span the low flow channel with abutments also located outside the bed and banks of the waterway to avoid impacts to aquatic fauna species during operation of the bridge.	Kapitzke (2010) recommends using a bridge span to span the waterway while retaining the natural stream channel form as the best solution to overcome barriers to aquatic species movements.
	Each dual bridge proposed over major waterways has been separated to allow for natural light to filter between the two structures.	Bridges are able to act as fauna connectivity structures by allowing fauna to move underneath each bridge as referenced in TMR's *Fauna Sensitive Road Design Manual Volume 2: Preferred Practises* (TMR, 2002). Insufficient light under a bridge is noted in the aforementioned guidelines as an inefficiency of underpasses and therefore by allowing light

Phase	Management actions	Effectiveness of the management action
		to penetrate through to the existing ground surface the use of these structures as an underpass increases (TMR, 2002).
	Progressive design review including construction methodologies employed for the construction of the bridge over Six Mile Creek has occurred during the Detailed Design phase due to the environment sensitivity of this waterway. The final design of the bridge includes a main span of 46.4 in length made continuous using 38 m long super T-girders to span the low flow channel and lower sections of the bed and banks of the waterway. Specific construction methodologies for the construction of the Six Mile Creek bridge will be included in the contract documentation developed for the project and will include items such as: • Bank stabilisation to occur during dry periods and prior to the commencement of piling • Short term construction related works including crane pads to be constructed once instream erosion and sediment controls are installed (i.e. sediment bunds etc.) • Nomination of timeframes for construction of bridge structure.	Design and construction methodologies review will assist in reducing impacts to Six Mile Creek which has been identified as habitat critical to the survival of the Mary River cod.
	Baseline water quality monitoring of major waterways intersected by the project has been undertaken for six months to gain an appreciation of baseline flow characteristics and response to rainfall events. An additional six months monitoring is currently being undertaken.	This mitigation measure will assist in determining project specific water quality performance criteria to match the existing current waterway characteristics and therefore maintain existing habitat conditions for MNES.
	Permanent water quality improvement devices (bio-retention systems) have been incorporated into the design at each major waterway crossing (including Six Mile Creek, Deep Creek and Curra Creek) to reduce pollutant loads entering the receiving environment.	The management of stormwater and pollutant loads entering sensitive environments will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in water quality.
	Spill containment devices have been incorporated on structures over Six Mile Creek,	This mitigation measure will assist in minimising indirect

Phase	Management actions	Effectiveness of the management action
	Deep Creek and Curra Creek to trap oils and fuels from entering these waterways	impacts to aquatic MNES and their habitat through a reduction in water quality impacts.
	Discharge and receiving water quality performance criteria will be developed and included in the contract documentation with consideration of available data specific to the local catchment.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in water quality and habitat degradation.
	Contract documentation developed for the project will nominate requirements and locations for receiving water quality monitoring for pre, during and post construction.	This mitigation measure will assist in monitoring the effectiveness of the mitigation and management measures proposed on MNES and their habitat.
Construction Phase	The Construction Contractor will prepare a project specific ESCP and EMP(C) to meet the requirements of MRTS51 – Environmental Management and MRTS52 – Erosion and Sediment Control and other project specific approval conditions.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in sediment loss and associated water quality impacts.
	The Construction Contractor will undertake a pre-clearing weed survey and report areas of existing weed infestation and identifying treatment and management requirements in accordance with Annexure MRTS51.1 – Environmental Management.	This mitigation measure will assist in minimising indirect impacts to MNES and their habitat through a reduction in weed invasion and habitat degradation.
	As part of the ESCP and EMP(C) that will be developed for the project, measures will be implemented to store potential pollutants offsite and/or in bunded storage areas. Spill kits and MSDS for all chemicals used onsite will be readily available. All machinery used on site will be well maintained to minimise the potential for oil/fuel leaks. All machinery will be refuelled and maintained at least 30 m from watercourses or drainage lines	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through minimisation of potential spills which could lead to habitat degradation.
	The Construction Contractor will perform an environmental induction to all site personnel to outline responsibilities in relation to MNES including the Mary River cod, Mary River turtle and white-throated snapping turtle.	This mitigation measure will assist in training all onsite personnel in regards to MNES species and their environmental obligations

Phase	Management actions	Effectiveness of the management action
		where MNES are found onsite.
	The EMP(C) will include a requirement to restrict the use of herbicides and growth retardants to control vegetation, as well as fire retardants and insecticides over and adjacent to dams, drainage lines and waterways within the project area due to the potential indirect impacts on MNES and other threatened fauna.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in water quality and habitat degradation.
	The Construction Contractor will be required to manage weed species and pests in accordance with the contract documentation, including. • Implementing weed management strategies during construction (including monitoring, treatments and reporting during construction), washdown of vehicles prior to entering the project area and conducting weed inspections as part of the rehabilitation monitoring and reporting. • Preparing hygiene declaration forms for all plant/vehicles working within the project area.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in weed invasion and habitat degradation.
	Staged construction approach to be implemented where possible prior to bulk vegetation clearing within each stage of works: • Vegetation clearing for pioneering works to be undertaken initially. • Installation of fences and sediment basins as pioneering works. • Sediment basins and clean water drains to be installed. • Cross drainage to be installed prior to bulk earthworks in each stage of works to enable clean water to be directed through the site.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in water quality and habitat degradation.
	The Construction Contractor will be required to undertake instream, bank stability works and works within the bed and banks of Six Mile Creek during dry periods and periods of low flow.	The completion of instream works during dry periods and periods of low flow will assist in reducing impacts and degradation to water quality and aquatic MNES habitat.
	The Construction Contractor will be required to undertake instream works within Deep Creek and Curra Creek during periods of low flow.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a

Phase	Management actions	Effectiveness of the management action
		reduction in water quality and habitat degradation.
	Suitable ESC's to be installed in adjacent and upstream of waterways prior to works commencing. The following will occur in relation to erosion and sediment controls: • Erosion and sediment controls to be installed in accordance with the IECA Best Practise Erosion and Sediment Control Manual and will be approved by the contract administrator • Early installation of sediment basins • Early installation of permanent drainage works, where possible • Monthly independent audits of erosion and sediment controls, with auditing report submitted to the contract administrator and TMR.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in water quality and habitat degradation.
	Where flow is present, the Construction Contractor will be required maintain flow of waterways during construction of temporary diversions, temporary waterway crossings or appropriately sized bunds.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in water quality and habitat degradation.
	Where appropriate, external catchment drainage lines will be diverted around disturbed areas via cross drains and drainage channels.	This mitigation measure will assist in minimising indirect impacts to aquatic MNES and their habitat through a reduction in water quality and habitat degradation.
	Grubbing and removal of ground cover and understorey is to be delayed until immediately prior to earthworks occurring within that particular stage of works.	This mitigation measure will assist in minimising erosion and sediment control thereby protecting water quality and ultimately MNES and their habitat.
	Vegetation clearing of riparian vegetation at Six Mile Creek, Deep Creek and Curra Creek shall be minimised where possible and delayed until necessary.	This mitigation measure will assist in minimising erosion and sediment control thereby protecting water quality and ultimately MNES and their habitat.
	All dewatering activities are to be supervised by an aquatic fauna specialist appointed by the	This mitigation measure will assist in identifying MNES

Phase	Management actions	Effectiveness of the management action
	Construction Contractor, who must have demonstrated experience in the capture and relocation of aquatic MNES. The aquatic fauna specialist must hold all relevant permits including a current General Fisheries Permit, a Rehabilitation Permit and an Animal Ethics Permit.	present within water features requiring dewatering within the project area and allow for these species to be relocated.
	An aquatic fauna specialist is required to undertake pre-clearance surveys prior to any dewatering activities (including those relating to dams, waterway diversions etc.) to identify whether any burrows are present within the project area. The aquatic fauna specialist will be required to prepare a report following the dewatering activities. This report is to be provided to the Contract Administrator within the monthly report.	This mitigation measure will assist in identifying MNES present within water features requiring dewatering within the project area and allow for these species to be relocated.
	Where possible, cleared native vegetation will be mulched and reused onsite during rehabilitation and stabilisation activities. Where mulch is required to be stockpiled, the material will be stockpiled in a manner where endemic seeds remain viable and weeds are treated.	This mitigation measure will allow for the retention of endemic and native seeds within the soil profile to facilitate the establishment of endemic vegetation communities while, also assisting in managing erosion and sediments entering waterways.
	Where possible, during construction avoid positioning direct artificial lighting towards retained bushland or aquatic features (i.e. waterways or dams).	This mitigation measure will assist in minimising indirect impacts on MNES species during construction.
	Where possible, exposed areas are to be progressively rehabilitated as soon as reasonably practical to avoid extended periods of soil exposure.	This mitigation measure will assist in reinstating endemic species along waterways to encourage the establishment and resilience of local native species which in turn will provide habitat to MNES.
	Dust and noise impacts to MNES will be managed in accordance with the procedures in the EMP(C).	This mitigation measure will assist in reducing indirect noise and air quality impacts on MNES and their habitat.
	Upon completion of the works within the bed and banks of waterways, banks are to be stabilised	This mitigation measure will assist in reinstating endemic

Phase	Management actions	Effectiveness of the management action
	(through appropriate measures) and revegetated, where appropriate, within simular naïve endemic species appropriate to their position in the landscape or in accordance with a Landscape Plan for the specific waterway. The revegetation area will also be subjected to weed control, and restriction of public access and grazing, where applicable.	species along watercourses to encourage the establishment and resilience of local native species while also assisting in stabilising batters to assist in ESC.
Post Construction Phase	Weed management will be required to be undertaken post-construction in accordance with the RMPC developed for the project.	Post-construction weed management is required as per TMR's *Environmental Processes Manual*. Weed invasion is listed as a key threat to each MNES due to the impacts on habitat degradation, therefore the management of weeds will assist in a conservational gain for each MNES.

Appendix C – Terrestrial Flora Species Mitigation Measures

Table C Terrestrial Flora Mitigation Measures

Phase	Management actions	Effectiveness of the management action
Design Phase	In accordance with TMR's *Environmental Processes Manual*, TMR will prepare environmental contract documentation (including MRTS51 – Environmental Management, MRTS52 – Erosion and Sediment Control and MRTS16 – Landscape and Revegetation Works, and associated annexures) to address specific requirements to be managed during the construction phase of the project.	This mitigation measure will reduce impacts on MNES through inclusion of management measures for vegetation clearing and general environmental management.
	A Translocation Management Plan has been prepared to remove all *M. pauli-guilielmi* plants from the project area to a nominated site outside the project area to mitigate impacts to the species. The Translocation Management Plan will also include details on the maintenance requirements for translocated plants and monitoring and reporting requirements. The Translocation Management Plan has been developed based on the following consultation and reviews: • Review of the *National Guidelines for the Translocation of Threatened Plants in Australia* (Vallee *et al*., 2004), a *Translocation Protocol for Cycads in Queensland* (Forster, 2004), and the *National multi-species Recovery Plan for Cycads* (Queensland Herbarium, 2007) • A review of two approved translocation plans previously developed for the translocation of *M. pauli-guilielmi* as conditions of approval under the EPBC Act, namely AECOM (2011) and OPUS (2012) • The results of monitoring	This mitigation measure has been developed to manage impacts to MNES rather than having a residual impact on MNES. The *Translocation Compliance Report - Macrozamia pauli-guilielmi* (Opus, 2015) developed as part of the Maryborough Cooloola Road upgrade works which involved the translocation of 143 *M. pauli-guilielmi* identified that although translocated plant mortality exceeded 10%, the combined total of translocated individuals and seedlings exceeded the original number of individuals translocated. The current Translocation Management Plan includes provisions for the planting of seeds within the offset site which will assist in maintaining the current number of individuals translocated.

Phase	Management actions	Effectiveness of the management action
	the translocation success of a previous translocation of *M. pauli-guilielmi*, and recommendations for translocation and monitoring provided therein, as reported in Vegetation Matters (2013, 2015) • Consultation and advice received from Dr Paul Forster, Principal Botanist at the Queensland Herbarium and lead author of the national cycad recovery plan.	
	In accordance with TMR's *Environmental Processes Manual* revegetation and landscaping plans are required to be developed in accordance with TMR's MRTS16 – Landscape and Revegetation Works and associated annexures.	This mitigation measures may also assist in recreating habitat for MNES following the disturbance from the project.
	Vegetation clearing limits will be defined under the contract documentation, to minimise the extent of vegetation clearing whilst allowing construction to occur taking into account erosion and sediment control devices. This will minimise the potential for impacts to sub-populations located outside the project area. A plan of clearing limits will be prepared by the Construction Contractor and clearing shall not proceed on site until the limits of clearing have been deemed suitable by the Contract Administrator.	This mitigation measure will minimise the vegetation clearing required for the project and reduce impacts to MNES located outside the project area.
	The contract documentation will specify that additional workspace areas and haul routes are to be placed in previously cleared areas, where possible and will not be located where they impact upon *M. pauli-guilielmi* or the TEC.	This mitigation measure will minimise the vegetation clearing required for the project and reduce impacts to MNES.
	No-go zones will be nominated in the	Nomination of no-go zones have

Phase	Management actions	Effectiveness of the management action
	contract documentation and will be located to minimise potential impacts to *M. pauli-guilielmi* and the TEC located outside the project area. These will be clearly set out and marked prior to construction activities commencing. No works are to be undertaken in these areas, nor are these areas to be used as storage of materials/plant.	been incorporated into TMR projects for a number of years and is effective in keeping machinery and personnel out of environmentally sensitive areas. Incorporation of no-go zones will assist in minimising additional impacts to MNES. The proposed works may indirectly impact a cluster of 16 adults and two seedling *M. pauli-guilielmi*, which area identified as sub-population 1 in BAAM's *Detailed Terrestrial Flora Surveys* (2016). This sub-population is outside of the project area and is unlikely to be impacted by the highway upgrade. However, to mitigate against potential indirect impacts, an exclusion zone will be established in this area to restrict clearing and access
	Progressive design review including construction methodologies employed for the construction of the bridge over Six Mile Creek has occurred during the Detailed Design phase due to the environment sensitivity of this waterway. The final design of the bridge includes a main span of 46.4 in length made continuous using 38 m long super T-girders to span the low flow channel and lower sections of the bed and banks of the waterway. Specific construction methodologies for the construction of the Six Mile Creek bridge will be included in the contract documentation developed for the project and will include items such as: • Bank stabilisation to occur during dry periods and prior to the commencement of piling • Short-term construction related works including crane pads to be constructed once instream ESC's are installed (i.e. sediment bunds	Design and construction methodologies review will assist in reducing impacts to Six Mile Creek and the TEC.

Phase	Management actions	Effectiveness of the management action
	etc.) • Nomination of timeframes for construction of bridge structures.	
Construction phase	The Construction Contractor will prepare a project specific ESCP and EMP(C) to meet the requirements of MRTS51 – Environmental Management and MRTS52 – Erosion and Sediment Control and other project specific approval conditions as outlined in MRTS51 and Annexures MRTS51.1 – Environmental Management and MRTS52.1 1 – Erosion and Sediment Control which will form part of the project contract documentation. The clearing of additional *M. pauli-guilielmi* will not be permitted under the contract documentation.	This mitigation measure will reduce impacts on MNES through inclusion of management measures for vegetation clearing, fauna management and general environmental management.
	The Construction Contractor will undertake a pre-clearing weed survey and report areas of existing weed infestation and identifying treatment and management requirements in accordance with Annexure MRTS51.1 – Environmental Management.	This mitigation measure will assist in minimising indirect impacts to MNES and their habitat through a reduction in weed invasion and habitat degradation.
	The Construction Contractor will be required to implement TMR's Translocation Management Plan for *M. pauli-guilielmi* prior to vegetation clearing. All known individuals of *M. pauli-guilielmi* are to be removed from the project area and established within the offsite relocation site.	This mitigation measure has been developed to manage impacts to *M. pauli-guilielmi* rather than having a residual impact on *M. pauli-guilielmi*.
	The Construction Contractor will perform an environmental induction to all site personnel to outline responsibilities in relation to MNES.	This mitigation measure will assist in training all onsite personnel in regards to MNES and their environmental obligations where MNES are found within the project area.
	The Construction Contractor will be required to manage weed species and pests in accordance with the contract documentation. • Implementing weed management	This mitigation measure will assist in minimising indirect impacts to MNES and their habitat through a reduction in weed invasion and habitat

Phase	Management actions	Effectiveness of the management action
	strategies during construction (including monitoring, treatment and reporting during construction), washdown of vehicles prior to entering the project area and conducting weed inspections as part of the rehabilitation monitoring and reporting. • Preparing hygiene declaration forms for all plant/vehicles working within the project area.	degradation.
	Where additional *M. pauli-guilielmi* are found within the project area during the construction phase, the Construction Contractor will be required to notify the Contract Administrator and the management, mitigation measures and relocation strategies within the TMR's Translocation Management Plan are to be enacted.	This mitigation measure has been developed to manage impacts to *M. pauli-guilielmi*.
	The Construction Contractor shall minimise and where possible delay until necessary the clearing of riparian vegetation at Six Mile Creek.	This mitigation measure will assist in minimising indirect impacts to the TEC and associated habitat.
	Where possible, cleared native vegetation will be mulched and reused onsite during rehabilitation and stabilisation activities. Should the mulch be required to be stockpiled, the material will be stockpiled in a manner where endemic seeds remain viable and weeds are treated.	This mitigation measure will allow for the retention of endemic and native seeds within the soil profile to facilitate the establishment of endemic vegetation communities while, also assisting in managing erosion and sediments entering waterways.
	Upon completion of the works within the bed and banks of waterways, banks are to be stabilised (through appropriate measures) and revegetated, where appropriate, within simular naïve endemic species appropriate to their position in the landscape or in accordance with a Landscape Plan for the specific waterway.	This mitigation measure will assist in reinstating endemic species along watercourses to encourage the establishment and resilience of local native species while also assisting in stabilising batters to assist in ESC.

Phase	Management actions	Effectiveness of the management action
Post Construction Phase	As required in the Translocation Management Plan, the Construction Contractor will be required to undertake opportunistic monitoring of the health of translocated *M. pauli-guilielmi* individuals and the presence of any degrading factors will be undertaken every two weeks for the first six months, in conjunction with the watering program. Formal monitoring events of the *M. pauli-guilielmi* individuals translocated will be undertaken twice each year during the first two years, in early summer (October to November) to assess the health of plants following the spring flush of new growth, and in autumn (May), to assess the extent of seed production and to manually disperse any ripe seed.	This mitigation measure is proposed to monitor the success of the translocation of *M. pauli-guilielmi* individuals. A monitoring program is being proposed to monitor the health of the individuals during the construction phase of the project, with adaptive management strategies to be developed in the event that individuals within the sub-population display decreased health. In the event that individuals within the sub-population display decreased health to an extent that the individuals are likely to suffer mortality, all individuals will be translocated to the translocation site.
	Key aspects of the waterway revegetation actions will include stabilisation, replanting, weed control, and restriction of public access and grazing, where applicable.	This mitigation measure will assist in recreating habitat for the TEC following the disturbance from the project.
	Weed management will be required to be undertaken post-construction in accordance with the contract documentation and the RMPC.	Post-construction weed management is required as per TMR's *Environmental Processes Manual*. Weed invasion is listed as a key threat to each MNES due to the impacts on habitat degradation and therefore the management of weeds will assist in a conservational gain for each MNES.

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Appendix L –*Detailed Terrestrial Flora Surveys Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (BAAM, 2016)

DETAILED TERRESTRIAL FLORA SURVEYS

BRUCE HIGHWAY COOROY TO CURRA (SECTION D: WOONDUM TO CURRA)

Prepared for
Advisian on behalf of Department of Transport and Main Roads

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Document Control Sheet

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Project Author/s: Dr Penn Lloyd

Project Summary: Detailed targeted surveys for threatened and near threatened flora species along the proposed alignment of the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra).

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Purpose of Report

Biodiversity Assessment and Management Pty Ltd has produced this report in its capacity as {consultants} for and on the request of Advisian on behalf of Department of Transport and Main Roads (the "Client") for the sole purpose of providing the results of detailed targeted surveys for threatened and near threatened flora species along the proposed alignment of the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) (the "Specified Purpose"). This information and any recommendations in this report are particular to the Specified Purpose and are based on facts, matters and circumstances particular to the subject matter of the report and the Specified Purpose at the time of production. This report is not to be used, nor is it suitable, for any purpose other than the Specified Purpose. Biodiversity Assessment and Management Pty Ltd disclaims all liability for any loss and/or damage whatsoever arising either directly or indirectly as a result of any application, use or reliance upon the report for any purpose other than the Specified Purpose.

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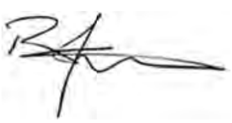
Biodiversity Assessment and Management Pty Ltd

Date: 24/06/2016



Managing Director

EXECUTIVE SUMMARY

PURPOSE OF THE REPORT

This report has been prepared to document the results of targeted terrestrial flora surveys undertaken to establish an accepted standard of information regarding the presence or absence of plant species listed as threatened or near threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or Queensland *Nature Conservation Act 1992* (NC Act), as well as the distribution, quality and significance of habitat for these species within the study area of the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project (the Project), including Stage D1 (Woondum Interchange to Sandy Creek Road) and Stage D2 (Sandy Creek Road to Curra Interchange).

APPROACH

The study involved two stages, a desktop assessment followed by a targeted field survey. The desktop component reviewed online databases and previous ecological studies undertaken in the study area to compile a list of endangered, vulnerable and near-threatened (EVNT) flora species that are known to occur or could potentially occur in the study area, identify the preferred habitat requirements, and confirm the survey requirements in accordance with established survey guidelines for these species to be targeted in the field survey. The field survey was undertaken over four days 22-25 February 2016 by a team of two experienced ecologists. The survey included timed random meanders searching for EVNT flora species at 26 locations with the study area that were selected to provide a spatially replicated stratified random survey of the range of habitat types present. Wherever an EVNT flora species was encountered, detailed information on the population size or density and supporting habitat characteristics was recorded.

KEY RESULTS

The desktop assessment identified one flora species known to occur, Zamia Palm (*Macrozamia pauli-guilielmi*: EPBC Act: endangered; NC Act: endangered), one species as likely to occur, Slender Milkvine (*Marsdenia coronata*: NC Act: vulnerable), and a further 17 species that may occur in the study area. Two threatened flora species were detected during the field survey: Zamia Palm and Slender Milkvine.

The field assessment identified three distinct and highly localized sub-populations of Zamia Palm in the Stage D2 portion of the study area, with a fourth sub-population confirmed 1.3 km east of the study area. The three sub-populations in the study area were growing in remnant eucalypt forest in soft, sandy soils derived from sandstone (Land Zone 10) and ranged in size from 15 to 61 adult plants, with between two and 109 seedlings present, confirming successful reproduction. The fourth sub-population was growing in remnant eucalypt forest in gravelly soils derived from metasediments (Land Zone 11) and included at least 98 adult plants and numerous seedlings. Due to the extensive coverage of the previous and present surveys, there is a low probability of undetected Zamia Palm sub-populations occurring on un-surveyed portions of the study area.

Slender Milkvine was encountered in a variety of eucalypt forest types during nearly half of the random meanders. At some locations it was widely distributed and relatively common, particularly on Land Zone 11 in Curra State Forest. Estimated Slender Milkvine densities ranged between two and 88 adult plants per hectare, with between 11 and 148 seedlings per hectare.

Despite extensive survey effort in suitable habitats over several surveys, no other EVNT flora species have been encountered; therefore it is concluded that there is a low probability that any of the 17 species assessed as having potential to occur in the study area may actually occur.

POTENTIAL IMPACTS ON EVNT FLORA SPECIES

Based on the proposed Project footprint, a total of 48 adult and 167 seedling Zamia Palms will be directly impacted by Stage D2 of the Project. A further 44 adults and 27 seedlings will be indirectly impacted due to their close proximity to the proposed Project footprint and/or population fragmentation and isolation by the Project.

Based on the proposed Project footprint, a total of 78.18 ha of known habitat (12.56 ha in Stage D1 and 65.62 ha in Stage D2) and 38.37 ha of potential habitat for Slender Milkvine (19.74 ha in Stage D1 and 18.63 ha in Stage D2) will be directly impacted by the Project.

RECOMMENDATIONS

The residual impact of the Project on Zamia Palm will likely require mitigation and offsetting in accordance with the Commonwealth EPBC Act Environmental Offsets Policy and the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. A suitable mitigation and offset action for Zamia Palm would be to salvage and translocate plants proposed to be impacted by the project to suitable habitat(s) in the local region. Different options for such translocation are presented. Translocation should be undertaken in accordance with a translocation management plan prepared for the Project.

The residual impact of the Project on Slender Milkvine will likely require mitigation and offsetting in accordance with the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. Due to the relatively high abundance of Slender Milkvine in known habitat areas within the proposed Project footprint, the translocation of plants is unlikely to be cost-effective as a mitigation and offsetting action. Instead, a habitat offset should be considered, based on the area of known habitat to be impacted by the Project. Given the apparent success of seedling establishment in proximity to parent plant locations from the previous season, the collection of seed from plants within the proposed Project footprint for subsequent manual dispersal to establish plants in habitat offset areas could be an effective mitigation and offsetting action.

DETAILED TERRESTRIAL FLORA SURVEYS

BRUCE HIGHWAY COOROY TO CURRA
(SECTION D: WOONDUM TO CURRA)

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Table of Terms and Abbreviations

ALA	Atlas of Living Australia
BAAM	Biodiversity Assessment and Management Pty Ltd
DTMR	Queensland Department of Transport and Main Roads
EHP	Queensland Department of Environment and Heritage Protection
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	Endangered, Vulnerable or Near Threatened
NC Act	Queensland *Nature Conservation Act 1992*
RE	Regional Ecosystem

1.0 INTRODUCTION

1.1 BACKGROUND

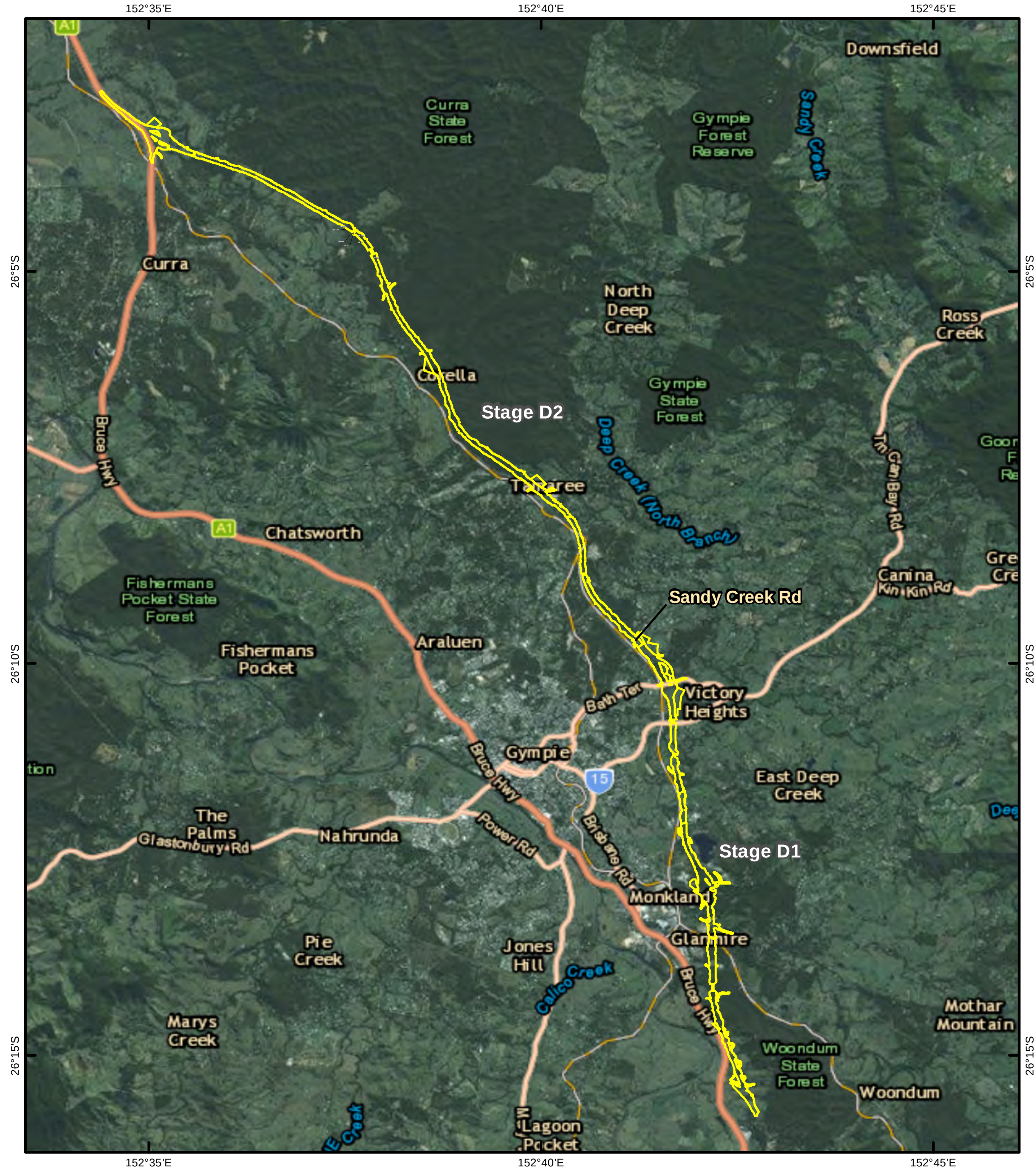
The Bruce Highway (Cooroy to Curra) project involves a 62 km upgrade and realignment of the Bruce Highway between Cooroy and Curra, including a bypass of Gympie township. One of Queensland's highest priority road projects, it is designed to meet strategic transport needs of the Sunshine Coast and Gympie regions well into the future. Section D of the project comprises 30 km of predominantly green-field, four-lane dual carriageway from Woondum Road to Curra, including a bypass of the Gympie township and side roads (see **Figure 1.1**). Section D of the project (the Project) comprises two stages, namely Stage D1 (Woondum Interchange to Sandy Creek Road) and Stage D2 (Sandy Creek Road to Curra Interchange). A Review of Environmental Factors (REF) and Environmental Management Plan (Planning) for the Section D Project identified a number of environmental factors requiring additional investigations and approvals prior to the commencement of construction. These included specific investigations of flora species listed as threatened or near threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or Queensland *Nature Conservation Act 1992* (NC Act), as well as the distribution, quality and significance of habitat for these species within the proposed Project footprint and surrounding landscape. A flora survey conducted in the Section D study area to inform the REF (reported in Jacobs 2015) conducted plot-based flora surveys as a component of Regional Ecosystem (RE) ground-truthing, assessed habitat suitability for threatened and near threatened flora species, and searched for threatened and near threatened flora species during these activities. As this survey was primarily focused on ground-truthing vegetation communities, it did not include extensive, targeted surveys for threatened and near threatened flora species.

The study area for the Project is the area selected for the purposes of conducting flora and fauna surveys, and includes the extent of the cut and fill batters provided in the concept design for the highway as at January 2015, plus a buffer of approximately 200 metres on either side. The study area was not moved following slight modifications to the design after January 2015. Consequently, the width of the buffer varies and may be 50 metres or less in some places. The Project footprint is the likely impact area associated with the construction of the Project and takes into account the potential areas for site offices, drainage structures, access tracks, erosion and sediment control devices, and borrow/spoil areas. The Project footprint is based on the final Business Case design at November 2015, with the following assumptions:

- The toe of embankments plus 25 metres will be cleared of vegetation to provide adequate room for haul routes, light vehicle access and drainage structures, stockpiles and temporary sediment basins.
- The top of cuttings plus 15 metres will be cleared of vegetation to provide adequate room for drainage structures and light vehicle access tracks.
- Where cuttings may be laid back to win more material, or spoil areas required to dispose of material, to balance earthworks, an additional footprint area has been provided.
- Proposed site office locations as identified in the constructability review.

1.2 AIMS AND OBJECTIVES

The primary aim of the detailed terrestrial flora surveys is to complement earlier flora surveys and undertake sufficient survey effort by experienced flora ecologists to establish an accepted standard of information regarding the presence or absence of threatened and near threatened plant species, as well as the distribution, quality and significance of habitat for these species within the study area. The surveys are required to be undertaken in accordance with established threatened flora species survey guidelines, or other relevant sources where no guidelines currently exist.



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:129,000 at A4
0 0.5 1 2 3 4 Kilometers

LEGEND

Cooroy to Curra Section D - Project Footprint

Figure:	**1-1**
Title:	Location of the project
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

BAAM ECOLOGICAL CONSULTANTS

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Document Location: D:\GIS\Jobs\0402-001 C2C Secion D FloraSurvey\GIS\MXDs\ReportMaps\Figure1-1 Location of the study area.mxdDate: 3/04/2016 3:28:43 PM

2.0 APPROACH TO THE STUDY

The study involved two stages, a desktop assessment followed by a detailed and targeted field survey.

2.1 DESKTOP ASSESSMENT

The objectives of the desktop assessment were to:

- compile a list of endangered, vulnerable and near-threatened (EVNT) flora species that are known to occur or could potentially occur in the study area based on database records in the vicinity of the study area; these species are to be targeted in the detailed flora surveys;
- identify the preferred habitat requirements for each of the EVNT flora species to be targeted, particularly with respect to the Regional Ecosystem (RE) vegetation communities that occur within the study area; and
- confirm the survey requirements in accordance with established survey guidelines for each of the EVNT flora species to be targeted in the field surveys.

The list of EVNT flora species was compiled through a review of the following:

- the Flora and Fauna chapter of the Review of Environmental Factors (Business Case) for the project, which identified EVNT flora species that are known to occur or could potentially occur in the study area based on database searches (dated February 2015) and field surveys undertaken over six days from the 5th to the 10th of December 2011 (BAAM 2012) and nine days over the periods 2-7 March and 5-7 May 2015 (Jacobs 2015);
- the EPBC Act Protected Matters Search Tool database;
- the Wildlife Online database; and
- the Atlas of Living Australia (ALA) database.

The preferred habitat requirements for each of the EVNT flora species to be targeted were identified from review of:

- online species profiles, including the Species Profile and Threats (SPRAT) database (DoE 2015), WetlandInfo database (EHP 2016) and the Plant Information Network System database of the National Herbarium of NSW (PlantNET 2016);
- published literature, e.g. Leiper *et al*. (2008) and species recovery plans (Queensland Herbarium 2007); and
- essential habitat factors derived from the Queensland Essential Habitat database.

2.2 FIELD SURVEY

The primary objectives of the targeted field survey were to:

- search for EVNT flora species during a structured survey program aimed at stratified sampling of the different RE vegetation communities within the study area that are known to provide preferred habitat for the targeted EVNT species to ensure that the full range of potential habitats are systematically sampled;
- collect a range of information on the population area and size (or extent), reproductive state, age structure and supporting habitat of any EVNT flora species found during the survey;

- census the total sub-population sizes of known locations of the endangered Zamia Palm (*Macrozamia pauli-guilielmi*) that have been previously found in the study area;
- survey for sub-populations of Zamia Palm in potentially suitable habitat (adjacent to known sub-populations) that will be fragmented and isolated by the proposed Project footprint;
- survey for sub-populations of Zamia Palm in potentially suitable core contiguous habitat in Curra State Forest (i.e. to the east of the Project footprint) that could potentially be supplemented by plants translocated from the proposed Project footprint; and
- opportunistically record the locations of key habitat features such as hollow bearing trees.

No species-specific survey guidelines are available in Queensland or nationally for most threatened plant species (DotE 2016a). Therefore, a combination of methods from DEC (2004) and EHP (2014) threatened species survey guidelines was implemented. The most effective method of searching a wide area for threatened flora species that are naturally rare is through the implementation of a random meander survey technique through potentially suitable habitat, rather than undertaking transect or plot-based surveys (DEC 2004). This technique allows for substantially greater coverage than a plot-based survey and is less time consuming. As the name suggests, the random meander technique involves traversing areas of suitable habitat in no set pattern, but roughly back and forth, whilst searching for particular plant species, usually threatened species.

The locations of random meanders were selected using a stratified random survey design to obtain spatially replicated, representative surveys of each of the different REs present within the study area for the Project, and focussed particularly on the proposed Project footprint and on REs known to provide preferred habitat for the targeted species.

3.0 RESULTS AND DISCUSSION

3.1 DESKTOP ASSESSMENT

The Review of Environmental Factors (Business Case) for the project found one EVNT flora species, *Macrozamia pauli-guilielmi*, occurring within the study area, and assessed that a further one species, *Marsdenia coronata*, is likely to occur and 15 species have potential to occur (**Table 3.1**). The updated database searches identified a further two species as having potential to occur based on database records in the study area, namely *Aponogeton elongatus* subsp*. elongatus* and *Ricinocarpos speciosus* (**Table 3.1**). The preferred habitat characteristics of these species and recommended survey approach and timing are summarized in **Table 3.1**. An analysis of the optimal survey timing for each of these species, summarized in **Table 3.2**, identified the period November to February as optimal for all species except *Pterostylis chaetophora*. The optimal survey timing for the latter species is during its flowering season in late August to early September; however the species can still be detected and identified on the basis of its leaves outside of this period.

Table 3.1. Species known, likely or with the potential to occur in the Section D project study area, proposed survey methodology consistent with survey guidelines and recommended survey times.

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
Macrozamia pauli-guilielmi	Zamia Palm	E	E	Known	Essential habitat REs 12.3.11, 12.9-10.4, 12.9-10.17, 12.11.14; within study area, refined on the basis of field surveys to include REs 12.9-10.4 and 12.9-10.17.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round.** A low-growing perennial with 1 m tall leaf fronds.
Marsdenia coronata	Slender Milkvine		V	Likely	Essential habitat REs 12.11.3, 12.11.5e, 12.11.16, 12.9-10.4, 12.9-10.17b; in sclerophyll forest, particularly on slopes with small, rocky outcrops and where *Lophostemon confertus* is present in the understorey.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**November to April** - when flowering/ fruiting.
Aponogeton elongatus subsp. *elongatus*			NT	Potential	Aquatic, in rivers and streams with thick sediments or in floodplain billabongs. Essential habitat RE 12.3.11.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – An aquatic herb, flowers and fruits from October to March.
Archidendron lovelliae	Bacon Wood	V	V	Potential	Wetter forest on sandy loam, including riparian areas; REs 12.3.1 and 12.3.11.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – A small tree (flowers December to February, fruits March to May).
Arthraxon hispidus	Hairy-Joint Grass	V	V	Potential	Highest potential in non-remnant, swampy grassland within the study area.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Spring to autumn**. An inconspicuous grass that grows spring-summer and dies off in winter.

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
Baloghia marmorata	Jointed Baloghia	V	V	Potential	Rainforest, including regrowth RE 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub or small tree that flowers during winter (Leiper *et al*. 2008).
Bosistoa transversa (includes B. selwynii)	Three Leaved Bosistoa, Heart-leaved Bosistoa	V		Potential	Rainforest, including regrowth RE 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a tree that flowers between January and May (DotE 2016h).
Floydia praealta	Ball Nut	V	V	Potential	Rainforest, including RE 12.3.1.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a small tree that flowers and fruits from January to June (DotE 2016f).
Fontainea rostrata	Deep Creek Fontainea	V	V	Potential	REs 12.3.1, 12.11.10; rainforest and riparian forest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – A tree or shrub. Flowers in spring, fruits in summer (ALA 2016).
Macadamia integrifolia	Macadamia Nut	V	V	Potential	Dry rainforest; REs 12.3.1 regrowth 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a small tree that flowers and fruits from January to June (DotE 2016g).
Macadamia ternifolia	Maroochy Nut	V	V	Potential	Rainforest, including RE 12.3.1 and regrowth 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A	**Year round** - flowers winter to spring and fruits between December and March (DotE

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
						combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	2016d).
Picris conyzoides	Fleabane Hawkweed		V	Potential	RE 12.3.3; open eucalypt forest and woodland in lower rainfall areas.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Spring to summer** - no flowering information available. Two other *Picrus* spp. in SEQ known to flower in Spring (Stanley & Ross 1986).
Pterostylis chaetophora	-		E	Potential	Sclerophyll forest; REs 12.9-10.4; 12.9-10.17b.	This is a cryptic ground orchid with a persistent underground tuber, so detection is problematic and can only be detected with the appearance of leaf rosettes and flowers. No species-specific survey guidelines for Queensland. Draft Survey Guidelines for Australia's Threatened Orchids (Commonwealth of Australia 2013) to be applied.	**August to September** – an inconspicuous, small terrestrial orchid. Two records of flowering from Gympie Region are from late August and early September (ALA 2016).
Ricinocarpos speciosus	-		V	Unlikely	Wet montane eucalypt forest.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub that flowers in spring (Leiper *et al*. 2008).
Samadera bidwillii	Quassia	E	E	Potential	REs 12.3.1, 12.3.11, 12.11.10; rainforest and open forest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub or small tree that flowers in November–March ((DotE 2016e).

Species name	Common name	EPBC	NCA	Type of presence	Habitat (including Regional Ecosystems (REs) present in the study area)*	Proposed survey methodology in accordance with Commonwealth/ State Guidelines	Recommended timing for targeted surveys
Sophora fraseri	Brush Sophora	V	V	Potential	Vine thickets and dry rainforests; REs 12.3.1 and regrowth 12.11.10.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub that flowers from spring to autumn (Leiper *et al*. 2008).
Symplocos harroldii	Hairy Hazelwood		NT	Potential	Dry rainforests; RE 12.11.10.	No species-specific survey guidelines in Queensland or nationally. A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a small tree that flowers during summer (Leiper *et al*. 2008).
Triunia robusta	Glossy Spicebush	E	E	Potential	REs 12.3.1, 12.11.16; wet rainforest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a shrub or small tree that flowers during spring (Leiper *et al.* 2008).
Xanthostemon oppositifolius	Southern Penda	V	V	Potential	REs 12.3.1, 12.11.16; wet rainforest.	No species-specific survey guidelines in Queensland or nationally (DoE 2016). A combination of methods from DEC (2004) and DEHP (2014) threatened species survey guidelines was implemented.	**Year round** – a tree that flowers and fruits from winter to spring.

* Regional Ecosystems (REs) present in the study area (see **Figure 3.1** for mapped distribution) comprise the following:
RE 12.3.1: Gallery rainforest (notophyll vine forest) on alluvial plains.
RE 12.3.3d: *Eucalyptus moluccana* woodland on alluvial plains.
RE 12.3.11: *Eucalyptus tereticornis* +/- *E. siderophloia*, *Corymbia intermedia* open forest on alluvial plains.
RE 12.9-10.4: *Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks.
RE 12.9-10.17b: *Corymbia citriodora* subsp. *variegata* mixed open forest to woodland on sedimentary rocks.
RE 12.11.3: *Eucalyptus siderophloia*, *E. propinqua* +/- *E. microcorys*, *Lophostemon confertus, Corymbia intermedia, E. acmenoides* open forest on metamorphics +/- interbedded volcanics.
RE 12.11.5e: *Corymbia citriodora* subsp. *variegata* open forest on metamorphics +/- interbedded volcanics, usually including *Eucalyptus siderophloia*, *E. propinqua* and *E. acmenoides*.
RE 12.11.10: Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics.
RE 12.11.14: *Eucalyptus crebra, E. tereticornis, Corymbia intermedia* woodland on metamorphics +/- interbedded volcanics.
RE 12.11.16: *Eucalyptus cloeziana* open forest on metamorphics +/- interbedded volcanics.

Table 3.2 Optimum survey times (represented by blue shading) for target species.

Target species	Optimum survey times											
	summer			autumn			winter			spring		
	D	J	F	M	A	M	J	J	A	S	O	N
Known species												
Macrozamia pauli-guilielmi												
Likely species												
Marsdenia coronata												
Potential species												
Aponogeton elongatus subsp. *elongatus*												
Archidendron lovelliae												
Arthraxon hispidus												
Baloghia marmorata												
Bosistoa transversa												
Floydia praealta												
Fontainea rostrata												
Macadamia integrifolia												
Macadamia ternifolia												
Pterostylis chaetophora												
Picris conyzoides												
Ricinocarpos speciosus												
Samadera bidwillii												
Sophora fraseri												
Symplocos harroldii												
Triunia robusta												
Xanthostemon oppositifolius												

The Atlas of Living Australia database search identified four specimen records for *Macrozamia pauli-guilielmi* in the vicinity of the study area, collected from two sites in Curra State Forest, as follows:

- October 1997 (D. Halford). Curra State Forest (S.F.700), Keliher Logging Area, 14 km NNW of Gympie. Eucalypt open forest with shrubby understorey, hilly terrain, simple slope, southerly aspect, stony dark brown light clay. Female plant, frond 70 cm long erect, dark green. Occasional.
- October 1997 (D. Halford). Curra State Forest (S.F.700), Keliher Logging Area, 14 km NNW of Gympie. Eucalypt open forest with shrubby understorey, hilly terrain, simple slope, southerly aspect, stony dark brown light clay. Frond 80 cm long, erect male. Occasional.
- April 2011 (P.I. Forster). Curra State Forest (S.F.700), Keliher Logging Area; 14 km NNW of Gympie. Open forest of *Corymbia intermedia*, *C. citriodora*, *Eucalyptus acmenoides*, *E. propinqua*, *Lophostemon confertus*, dense shrubby understorey, south facing ridge; gravelly clay soil from metasediments. Small cycad, subterranean caudex; leaves 2-6, 70-80 cm long, leaflets dark green with whitish-yellow petiolules; male cones green (aseasonal). Very common at locality.
- October 1997 (D Halford). Curra State Forest (S.F.700), Tamaree Logging Area, 12 km NNW of Gympie. Eucalypt open forest, hilly terrain, crest, stony dark reddish brown loam. Frond 70 cm high, female plant. Only one male and one female plant seen.

The first three specimens correspond to the same location (1.3 km east of the study area) and sub-population, whereas the fourth specimen was collected from an occurrence of the species approximately 2 km south of the other collecting site and located at the edge of the study area. The localities of these records, which also correspond to the locations of essential habitat mapping for the species, were targeted during the field survey as a component of the search for sub-populations in core habitat for the species in Curra State Forest.

3.2 FIELD SURVEY

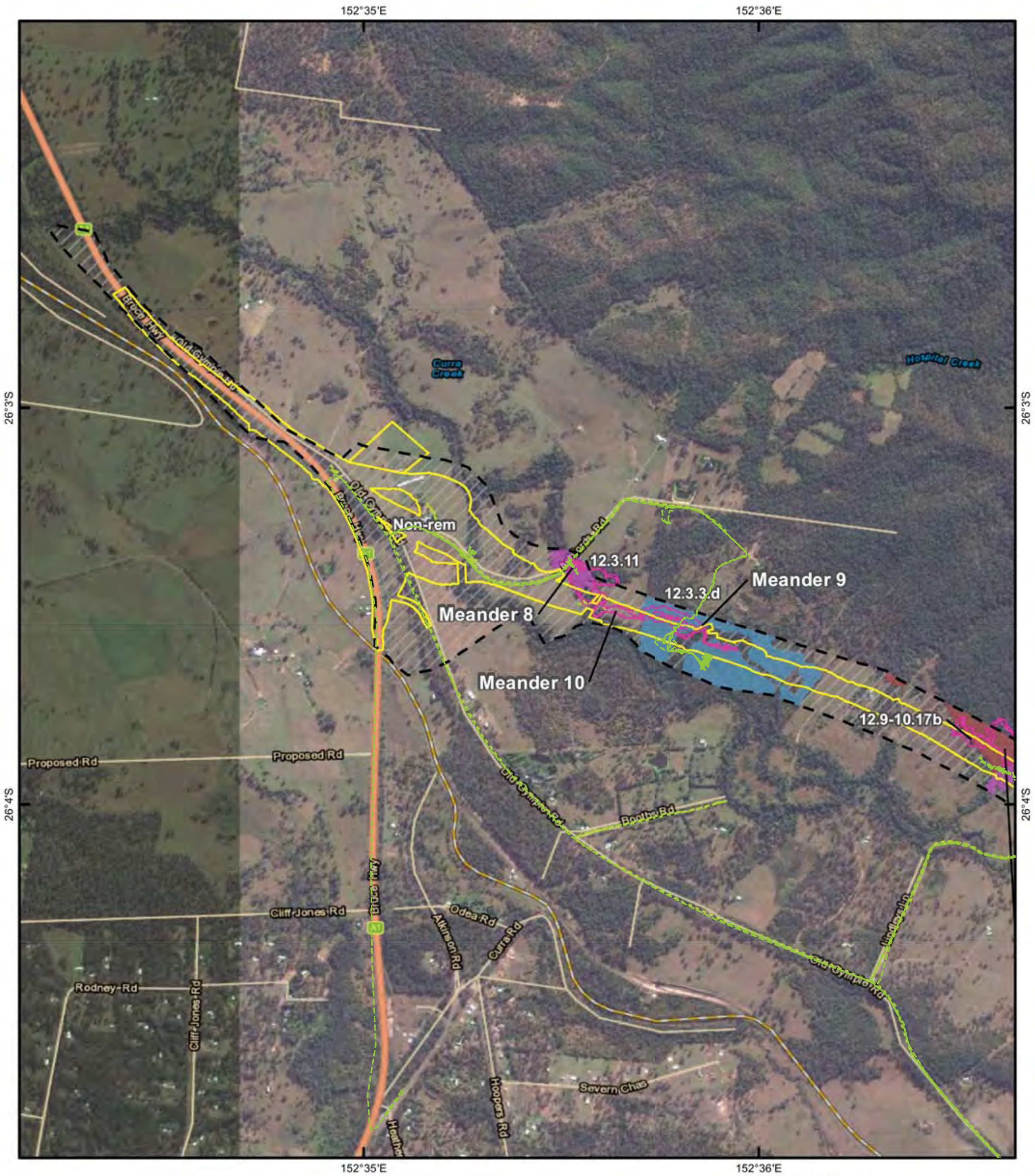
The targeted flora field survey was undertaken over four days from 22 to 25 February 2016 by two experienced flora ecologists, Lui Weber and Dr Penn Lloyd. The timing of the field survey fell within the optimal survey period for all species except *Pterostylis chaetophora*. Details of the survey locations, survey effort and EVNT plant species encountered are summarised in **Table 3.3**, and mapped in relation to the RE mapping for the study area in **Figure 3.1**. This RE mapping represents the refined and ground-truthed mapping of RE vegetation communities undertaken during 2015 for the Review of Environmental Factors (Business Case) for the project.

Two EVNT flora species were encountered during the field survey, namely Zamia Palm (*Macrozamia pauli-guilielmi*) and Slender Milkvine (*Marsdenia coronata*). Zamia Palm was found only in the Stage D2 portion of the study area, whereas Slender Milkvine was found in both Stages D1 and D2 of the study area. The survey results with respect to these two species are presented and discussed in more detail in the sections that follow. A complete list of all flora species identified in the study area during the present and previous surveys is provided in **Appendix A**.

Table 3.3. Summary of targeted flora field survey random meander locations in the study area.

Date	Meander	Duration (mins)*	Regional Ecosystem	EVNT plants encountered
22/02/2016	1	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	2	2 x 32	12.11.5e	*Marsdenia coronata*
22/02/2016	3	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	4	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	5	2 x 30	12.11.5e	*Marsdenia coronata*
22/02/2016	6	2 x 70	12.9-10.4	*Macrozamia pauli-guilielmi* (sub-population 2) and *Marsdenia coronata*
22/02/2016	7	2 x 15	12.9-10.4	
23/02/2016	8	2 x 60	12.3.11	
23/02/2016	9	2 x 30	12.3.3d	
23/02/2016	10	2 x 10	Non-remnant (grassland)	
23/02/2016	11	2 x 80	12.9-10.17b & 12.3.11	*Macrozamia pauli-guilielmi* (sub-population 1)
23/02/2016	12	2 x 40	12.9-10.4	
23/02/2016	13	2 x 30	12.9-10.4	
23/02/2016	14	2 x 70	12.11.5e	*Marsdenia coronata*
24/02/2016	15	2 x 45	12.3.11 & 12.11.5e	
24/02/2016	16	2 x 35	12.3.11 & 12.9-10.17b	
24/02/2016	17	2 x 60	12.11.3 & 12.11.5e	
24/02/2016	18	2 x 65	12.11.3	*Marsdenia coronata*
24/02/2016	19	2 x 30	12.11.3	
24/02/2016	20	2 x 145	12.11.3/12.11.14	*Marsdenia coronata*
25/02/2016	21	2 x 65	12.11.5e	*Macrozamia pauli-guilielmi* (sub-population 4)
25/02/2016	22	2 x 40	12.9-10.4	*Macrozamia pauli-guilielmi* (sub-population 3)
25/02/2016	23	2 x 35	12.3.1	
25/02/2016	24	2 x 30	12.11.14	
25/02/2016	25	2 x 25	12.11.16	*Marsdenia coronata*
25/02/2016	26	2 x 105	12.11.10/12.11.3	

* Each random meander involved the two field observers traversing the area either independently or at least 10 m apart to obtain independent meanders for survey effort replication.



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

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LEGEND

Macrozamia ALA record
Study Area
Project Footprint
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4
Non-rem

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Figure: 3-1 (1 of 7)

Title: Locations of flora survey random meanders in relation to Regional Ecosystems

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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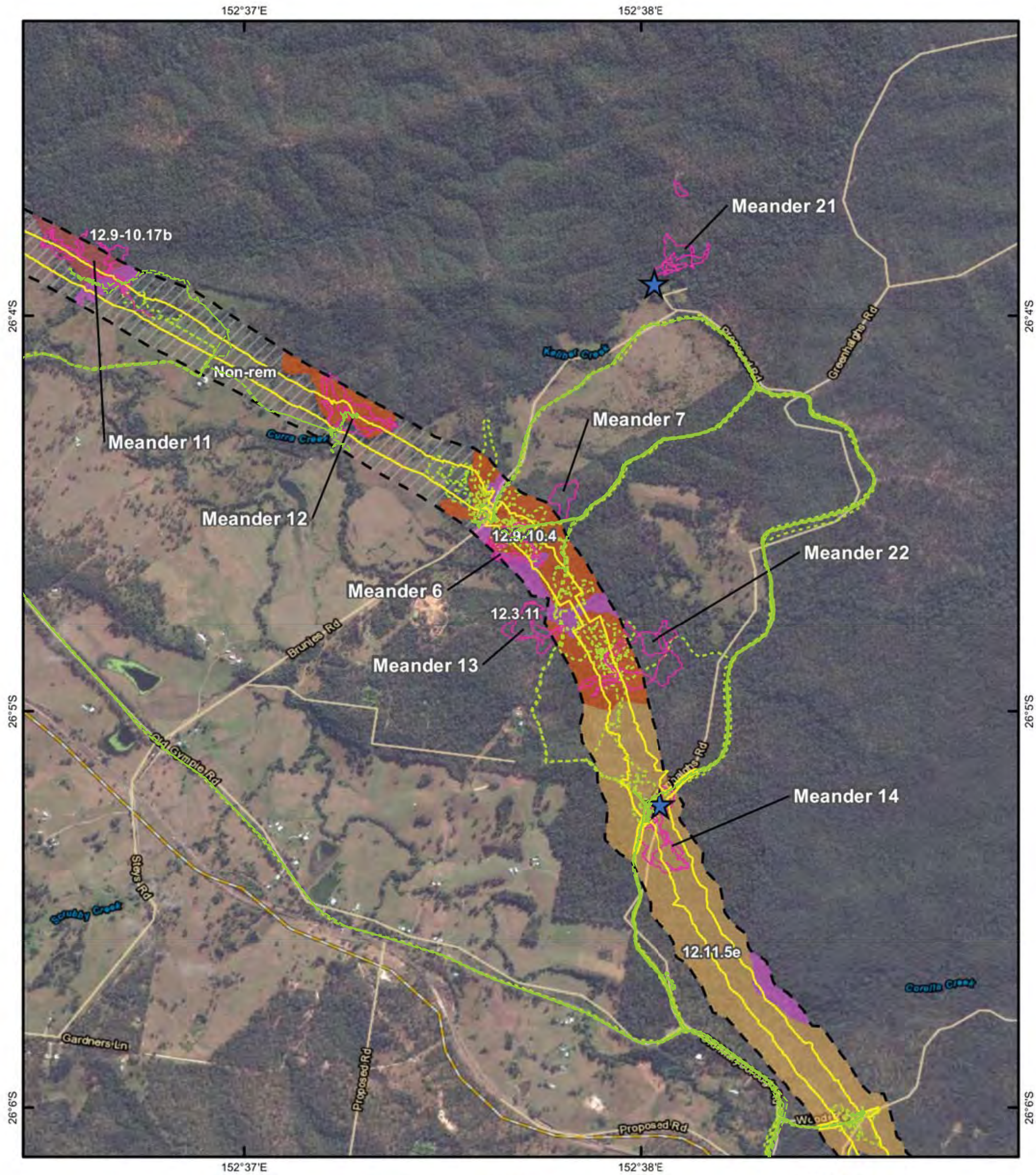

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Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

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0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

12.11.14	12.3.11
12.11.16	12.3.3.d
12.11.3	12.3.7
12.11.3/12.11.14	12.9-10.17b
12.11.5e	12.9-10.4
12.3.1	Non-rem

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Figure: 3-1 (2 of 7)

Title: Locations of flora survey random meanders in relation to Regional Ecosystems

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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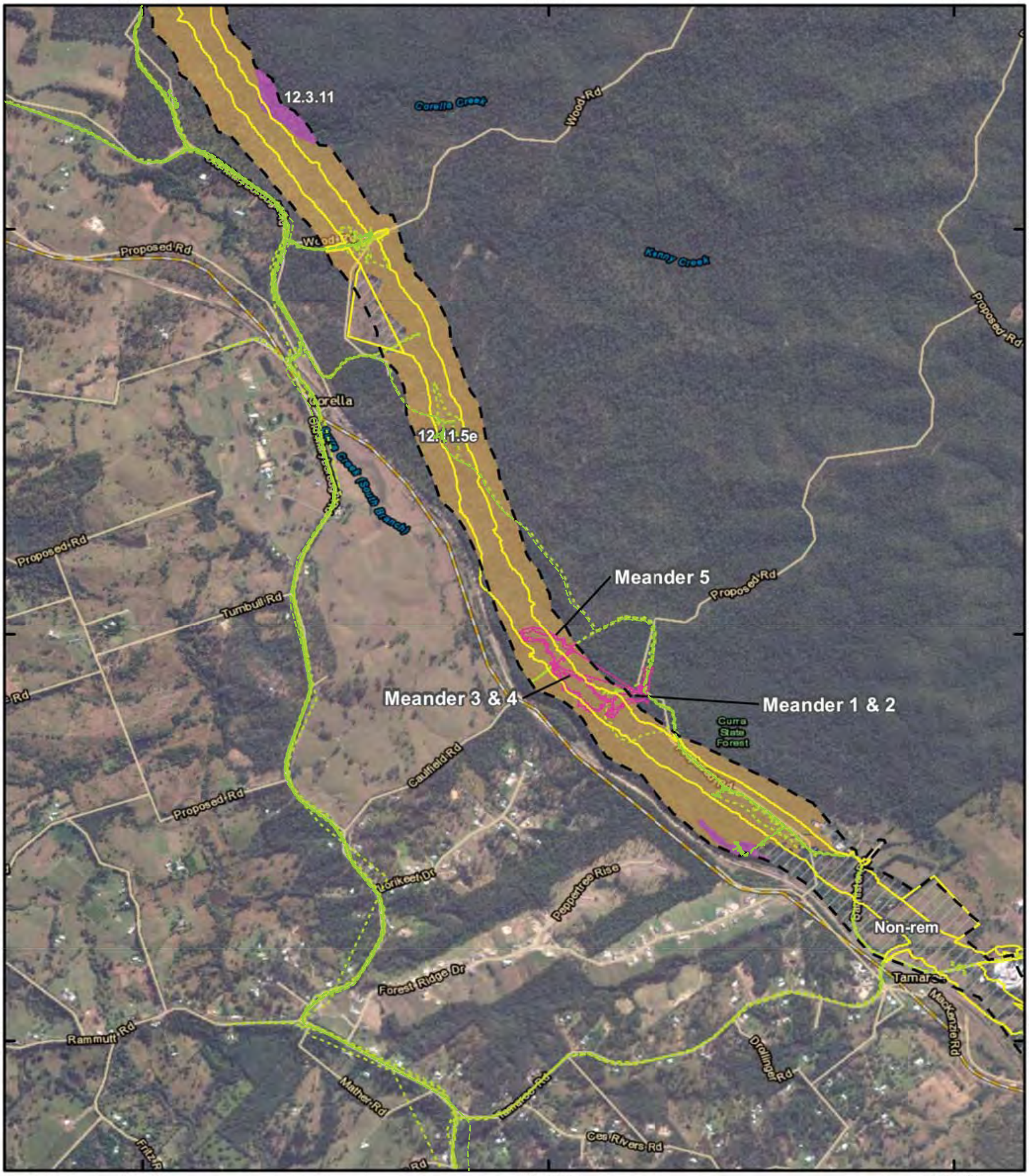

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

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LEGEND

- Macrozamia ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

12.11.14	12.3.11
12.11.16	12.3.3.d
12.11.3	12.3.7
12.11.3/12.11.14	12.9-10.17b
12.11.5e	12.9-10.4
12.3.1	Non-rem

Figure:	3-1 (3 of 7)
Title:	Locations of flora survey random meanders in relation to Regional Ecosystems
Project:	Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)
Client:	Advisian on behalf of QLD Dept. of Transport and Main Roads

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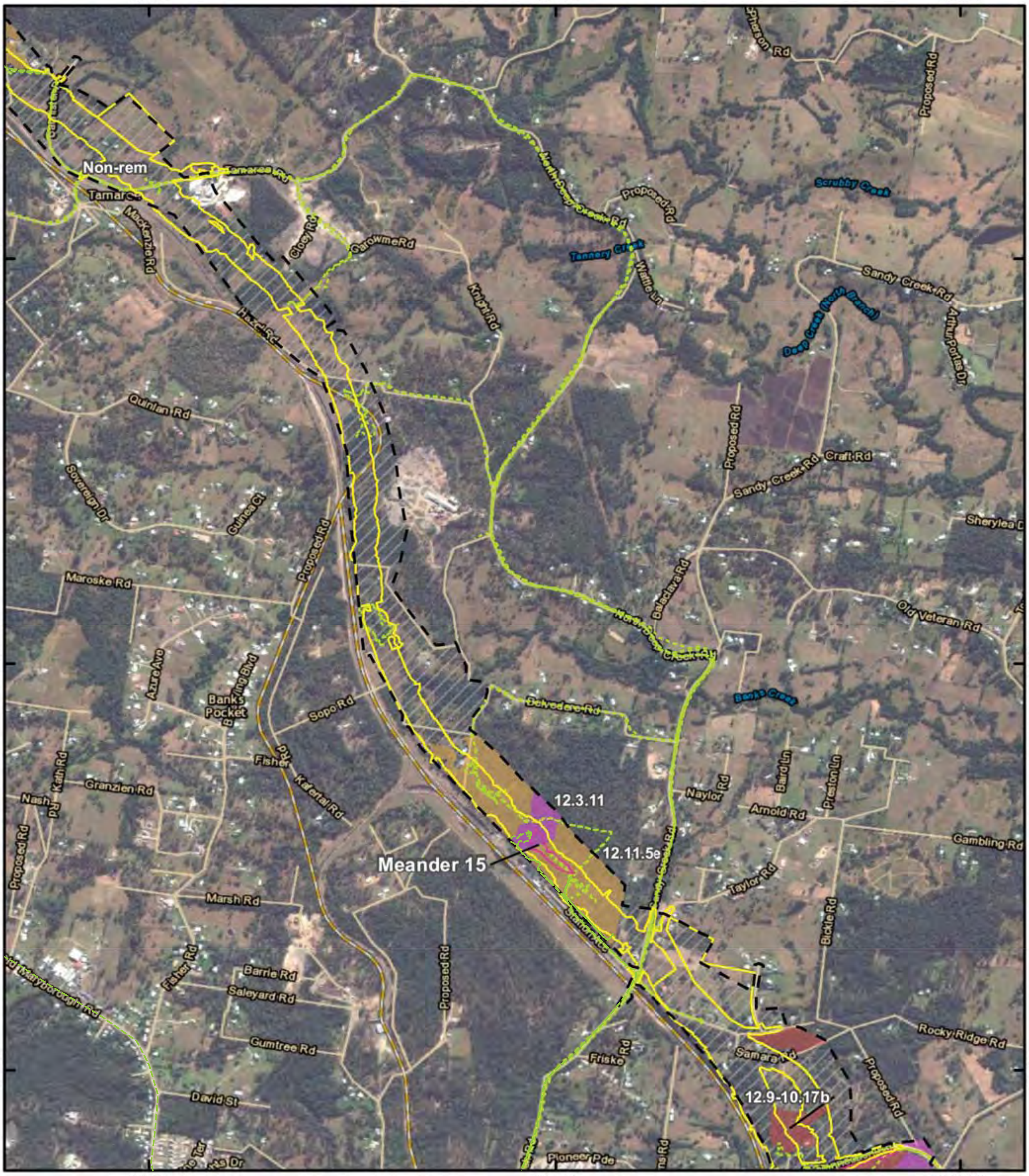
Drawn By: MG Reviewed by: PL Date: 3/04/2016



Notes: imagery sourced from ArcGIS Online (c) 2016

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Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Figure:	3-1 (4 of 7)
Title:	Locations of flora survey random meanders in relation to Regional Ecosystems
Project:	Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)
Client:	Advisian on behalf of QLD Dept. of Transport and Main Roads

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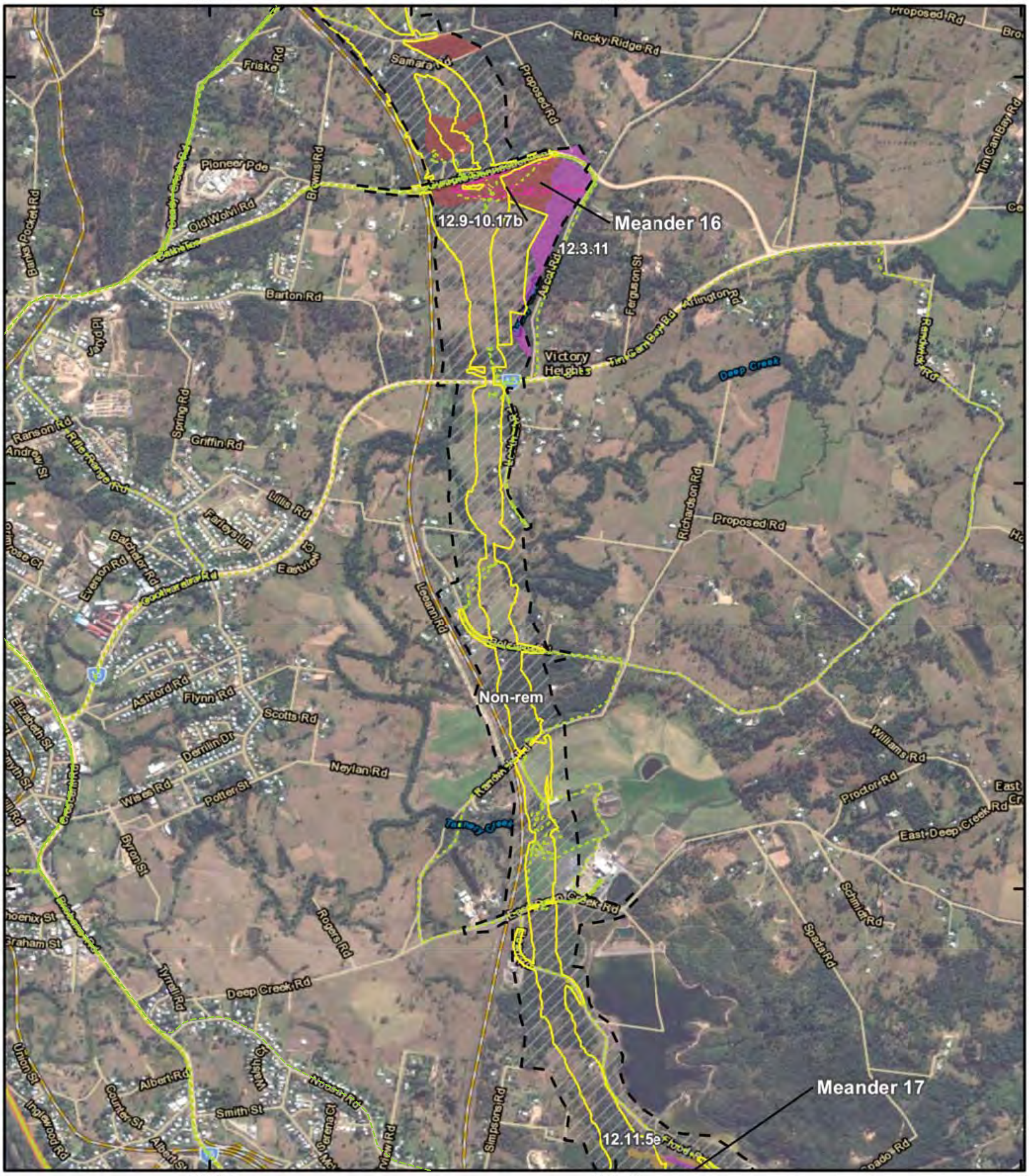

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Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Figure: 3-1 (5 of 7)

Title: Locations of flora survey random meanders in relation to Regional Ecosystems

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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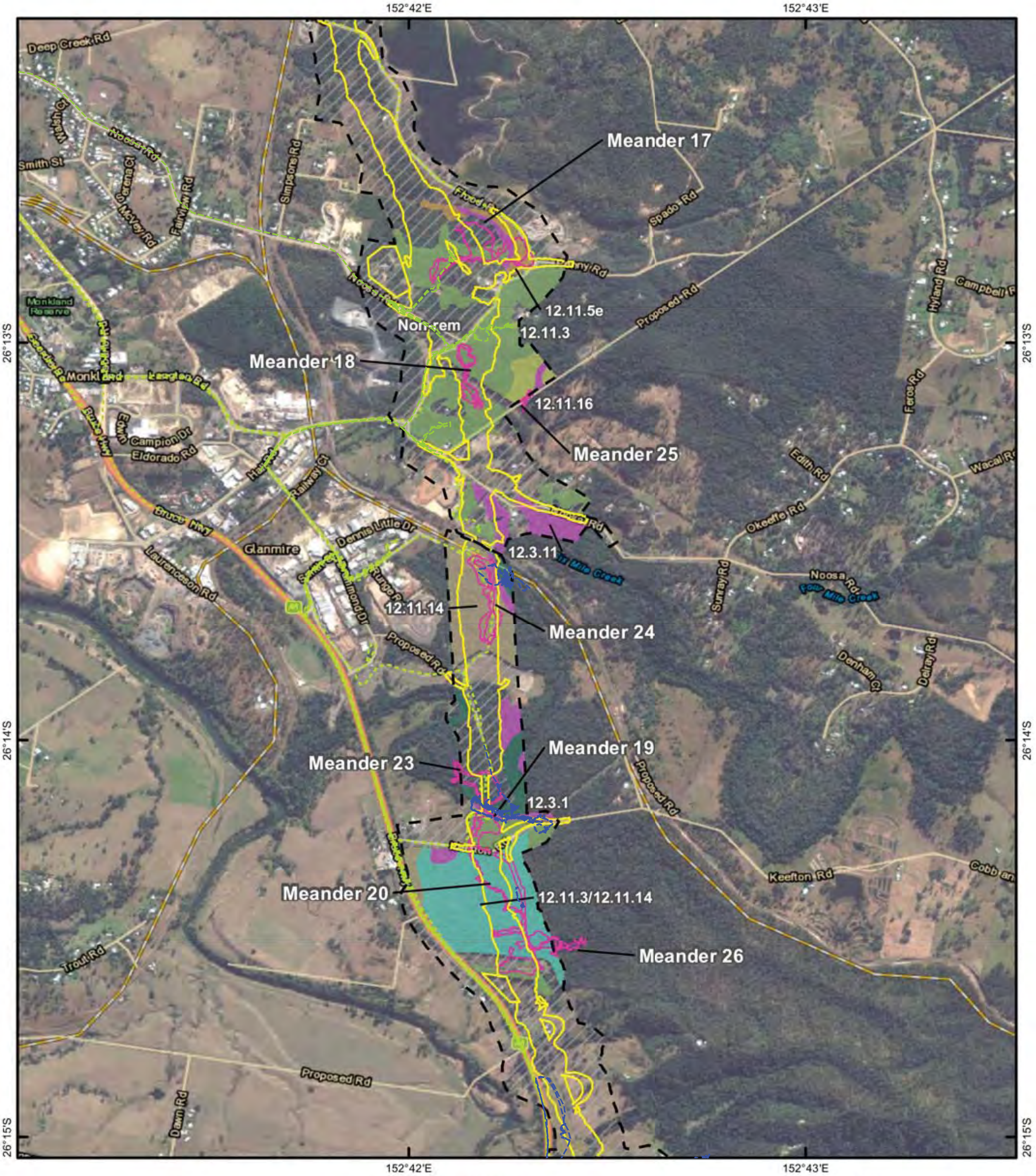

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

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0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG   Reviewed by: PL   Date: 3/04/2016

Figure:	3-1 (6 of 7)
Title:	Locations of flora survey random meanders in relation to Regional Ecosystems
Project:	Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)
Client:	Advisian on behalf of QLD Dept. of Transport and Main Roads

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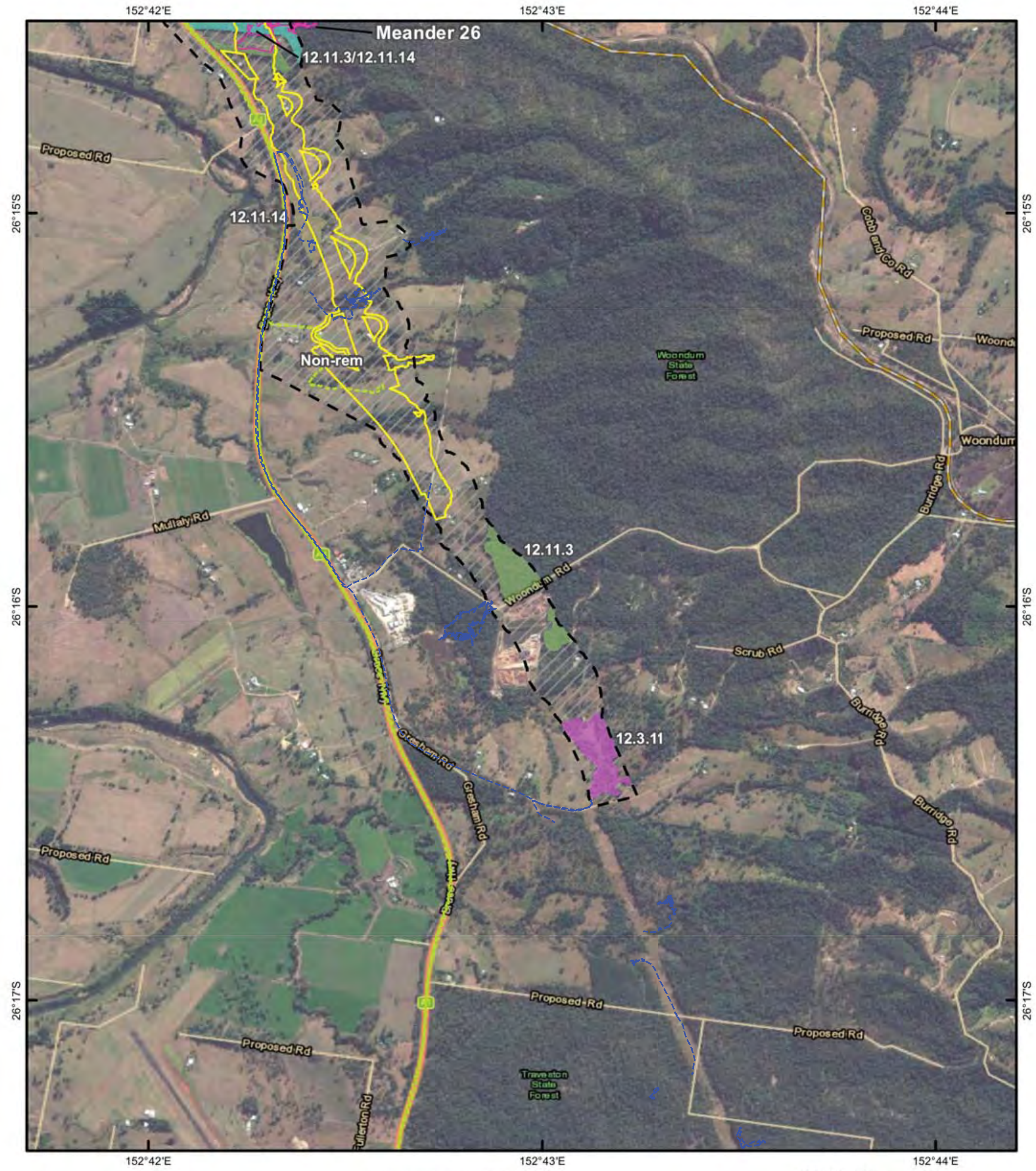

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

Macrozamia ALA record
Study Area
Project Footprint
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4
Non-rem

Drawn By: MG Reviewed by: PL Date: 3/04/2016

Figure: 3-1 (7 of 7)

Title: Locations of flora survey random meanders in relation to Regional Ecosystems

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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3.2.1 Zamia Palm (Macrozamia pauli-guilielmi)

Field survey results

Zamia Palm has a swollen underground stem from which several leaf fronds grow to a height of up to 1 m (**Photo 1**). A diagnostic feature is a spirally twisted leaf rachis. Wherever Zamia Palm was found during the field survey, the broader vicinity was searched to establish the total size of the sub-population in the area. Based on the results of the present survey and previous surveys, three sub-populations of Zamia Palm have been detected within or in close proximity to the Project footprint. The locations of these sub-populations are mapped in **Figure 3.2**, and details of the sub-population sizes and supporting habitats are summarised in **Table 3.4**. The three sub-populations were all found growing in soft, sandy soils derived from sandstone (Land Zone 10), in two different REs, namely RE 12.9-10.4 (*Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks) and RE 12.9-10.17b (*Corymbia citriodora* subsp. *variegata* mixed open forest to woodland on sedimentary rocks) (**Table 3.4**). All the most suitable habitat areas for the species on Land Zone 10 within the Project footprint area have been surveyed during the various surveys; therefore further sub-populations are not expected to occur elsewhere on the proposed Project footprint area on Land Zone 10. In addition, suitable habitat on Land Zone 10 immediately to the west of sub-populations 2 and 3 was searched to establish whether any sub-populations may become isolated by the Project and therefore potentially subject to indirect impacts; however no Zamia Palms were located in this area. A further sub-population (sub-population 4) was confirmed at the site of historical specimen records (from 1997 and 2011) located 1.3 km east of the study area (**Figure 3.2, Table 3.4**).

Sub-population 4 was found growing in a different substrate (Land Zone 11) to the other sub-populations, in RE 12.11.5e (*Corymbia citriodora* subsp. *variegata* open forest on metamorphics +/- interbedded volcanics, usually including *Eucalyptus siderophloia*, *E. propinqua* and *E. acmenoides*). No Zamia Palm plants were located at the location of the 1997 specimen record of two adult plants at the edge of the study area on Land Zone 11; part of this area was found to have been disturbed by logging activities, which may have impacted on the original plants. Due to the extensive coverage of the previous and present surveys, there is a low probability of undetected Zamia Palm sub-populations occurring on un-surveyed portions of the study area.

The presence of seedlings (**Photo 3**) in all sub-populations suggests that all have reproduced successfully in the recent past, even the relatively small sub-population 1. Many female plants in sub-populations 2 to 4 had green, growing cones, whereas many male plants had old, open cones (see **Photos 2** and **4**). The presence of cones and multiple seedlings indicate healthy, successfully reproducing sub-populations.

The Zamia Palm sub-populations are highly localised and discrete, despite extensive suitable habitat in adjoining areas. This pattern of occurrence is typical of the species (Queensland Herbarium 2007), and is thought to be a consequence of very limited dispersal opportunities following the extinction of megafauna (which previously dispersed the seeds) from the area tens of thousands of years ago (Snow and Walter 2007, Hall and Walter 2013).

Photo 1. *Macrozamia pauli-guilielmi* – male (left) and female (right) plants in sub-population 3.

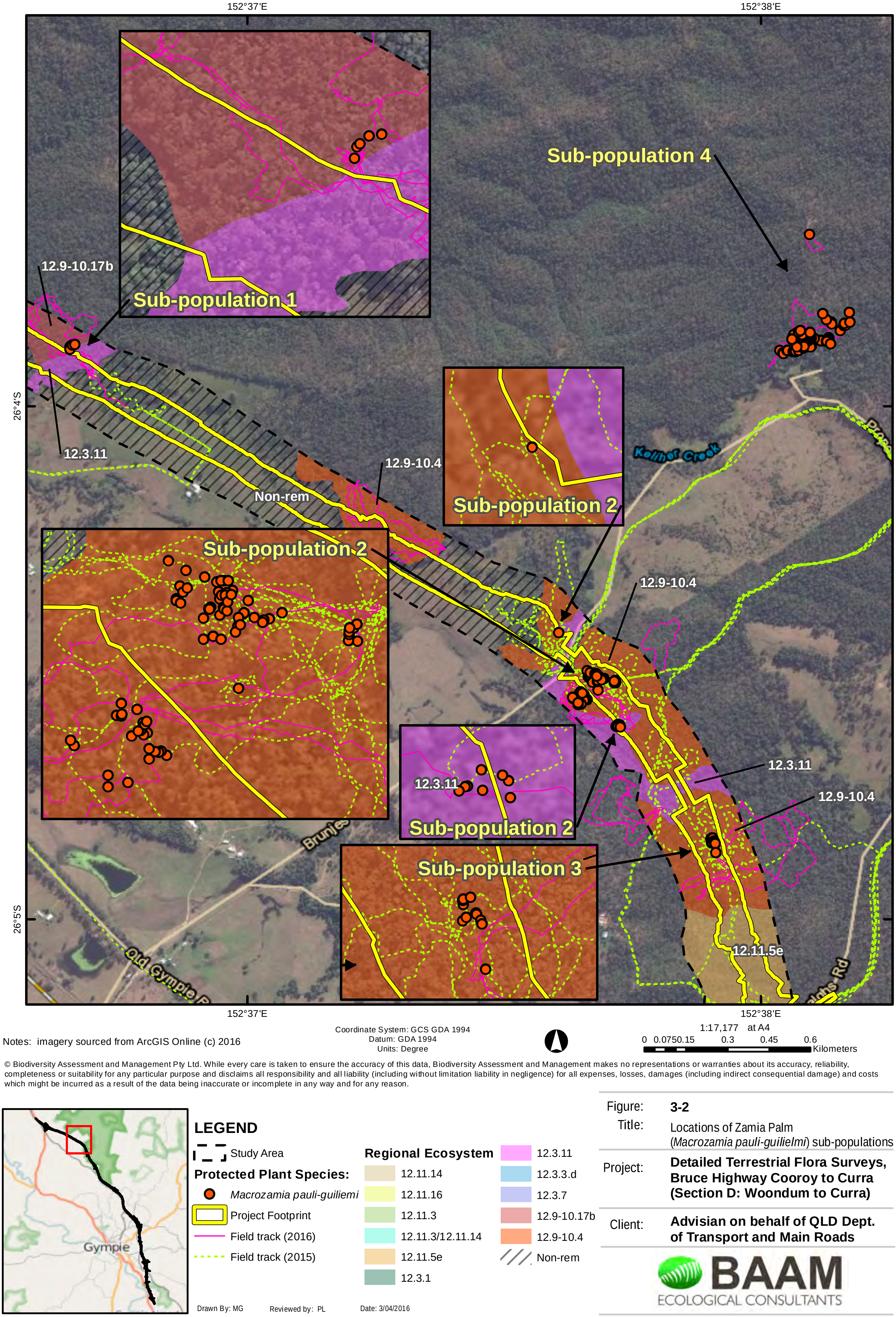
Photo 2. *Macrozamia pauli-guilielmi* – female plant with ripe seed cone shedding seeds.

Photo 3. *Macrozamia pauli-guilielmi* – cluster of seedlings near the base of a female plant.

Photo 4. *Macrozamia pauli-guilielmi* – male plant with old cone.

Photo 5. *Macrozamia pauli-guilielmi* habitat of sub-population 2 in good condition.

Photo 6. *Macrozamia pauli-guilielmi* habitat of sub-population 1 invaded by *Lantana camara** and *Passiflora suberosa** weeds.



Notes: imagery sourced from ArcGIS Online (c) 2016

Figure:	3-2
Title:	Locations of Zamia Palm (*Macrozamia pauli-guilielmi*) sub-populations
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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Drawn By: MG Reviewed by: PL Date: 3/04/2016

Table 3.4. Details of Zamia Palm (*Macrozamia pauli-guilielmi*) sub-populations in the study area.

	Sub-population size	RE	Habitat description
1	16 adults, 2 seedlings.	12.9-10.17b	Structure and position: Remnant open forest, canopy ht 19 m, on lower, south-facing footslope adjacent to creek. Tree1: *Corymbia citriodora* (d), *Eucalyptus acmenoides, E. longirostrata, E. siderophloia*. Tree2: *Lophostemon confertus, E. acmenoides, E. longirostrata, E. siderophloia*. Shrub: *Lantana camara** (d), *Lophostemon confertus, Jagera pseudorhus*. Ground: *Megathyrsus maximus*, Passiflora suberosa*, Themeda triandra*. Substrate: soft sand derived from sandstone, sandstone outcrop nearby. Comments: Zamia Palms becoming overgrown by *Lantana camara** and *Passiflora suberosa** weeds.
2	61 adults, at least 109 seedlings.	12.9-10.4	Structure and position: Remnant open forest, canopy ht 14-18 m, on hill crest and north-facing and south-facing slopes between two creeks. Tree1: *Eucalyptus racemosa* subsp. *racemosa* (d), with *E. acmenoides, Corymbia trachyphloia, C. intermedia* and *Angophora leiocarpa* subdominant. Tree2: *Acacia disparrima* (d) with *Alphitonia excelsa* and *Banksia integrifolia* associated. Shrub: *Lantana camara** (d) with scattered *Banksia integrifolia, Acacia disparrima, A. excelsa* and *Leucopogon juniperinus*. Ground: *Imperata cylindrical* (d) with *Lomandra multiflora, Hibbertia* sp., *Xanthorrhoea johnsonii* and *Gahnia aspera*. Substrate: soft sand derived from sandstone, several sandstone outcrops through the sub-population. Comments: A few Zamia Palms becoming overgrown by *Lantana camara** weeds.
3	15 adults, 83 seedlings.	12.9-10.4	Structure and position: Remnant open forest, canopy ht 15-20 m, on lower, gently sloping north-facing footslope adjacent to creek. Tree1: *Eucalyptus racemosa* subsp. *racemosa, E. propinqua, Corymbia intermedia, Angophora leiocarpa*. Tree2: *Lophostemon suaveolens, Acacia disparrima*. Shrub: *Lantana camara** (d), Tree1 and Tree2 species saplings. Ground: *Aristida gracilipes, Imperata cylindrica* and *Themeda triandra,* with *Lomandra multiflora, Xanthorrhoea johnsonii* and *Gahnia aspera*. Substrate: soft sand derived from sandstone, sandstone outcrop nearby. Comments: A few Zamia Palms becoming overgrown by *Passiflora suberosa** weeds; habitat of southern end of population subject to substantial recent logging.
4	At least 98 adults, abundant seedlings.	12.11.5e	Structure and position: Remnant open forest, canopy ht 15-20 m, on moderate to steeply-sloping, south-facing hillslope adjacent to creek. Tree1: *Corymbia intermedia, C. citriodora, Eucalyptus acmenoides, E. propinqua*. Tree2: *Lophostemon confertus (d).* Shrub: *Lantana camara**, *Lophostemon confertus* (d). Ground: *Themeda triandra*. Substrate: shallow, loamy, gravelly soils derived from metasediments. Comments: A large, dispersed population that may extend further east of the portion surveyed; a few Zamia Palms on the western edge of the sub-population becoming overgrown by *Lantana camara** weeds.

Potential impacts of the Project on Zamia Palm

Key threats to Zamia Palm include habitat loss and clearing of plants, illegal removal of plants (for which the potential is greater in closer proximity to roads), inappropriate fire regimes, loss of individuals affecting the ability of the species to be viable into the future, and loss of critical pollinators and mycorrhizal fungi (Queensland Herbarium 2007, Department of the Environment 2016). A further threat observed in the study area is the threat posed by invasive weeds such as *Lantana camara* and *Passiflora suberosa* overgrowing and shading Zamia Palm plants; this threat is exacerbated by habitat disturbance and edge effects.

Potential impacts of the Project on Zamia Palm include loss of habitat, loss of individuals from dispersed sub-populations, fragmentation of sup-populations causing isolation of small groups of individuals and disturbance leading to weed invasion that may affect the viability of isolated plants into the future, and increased risk of illegal removal of plants in proximity to new roads that increase accessibility of the plants.

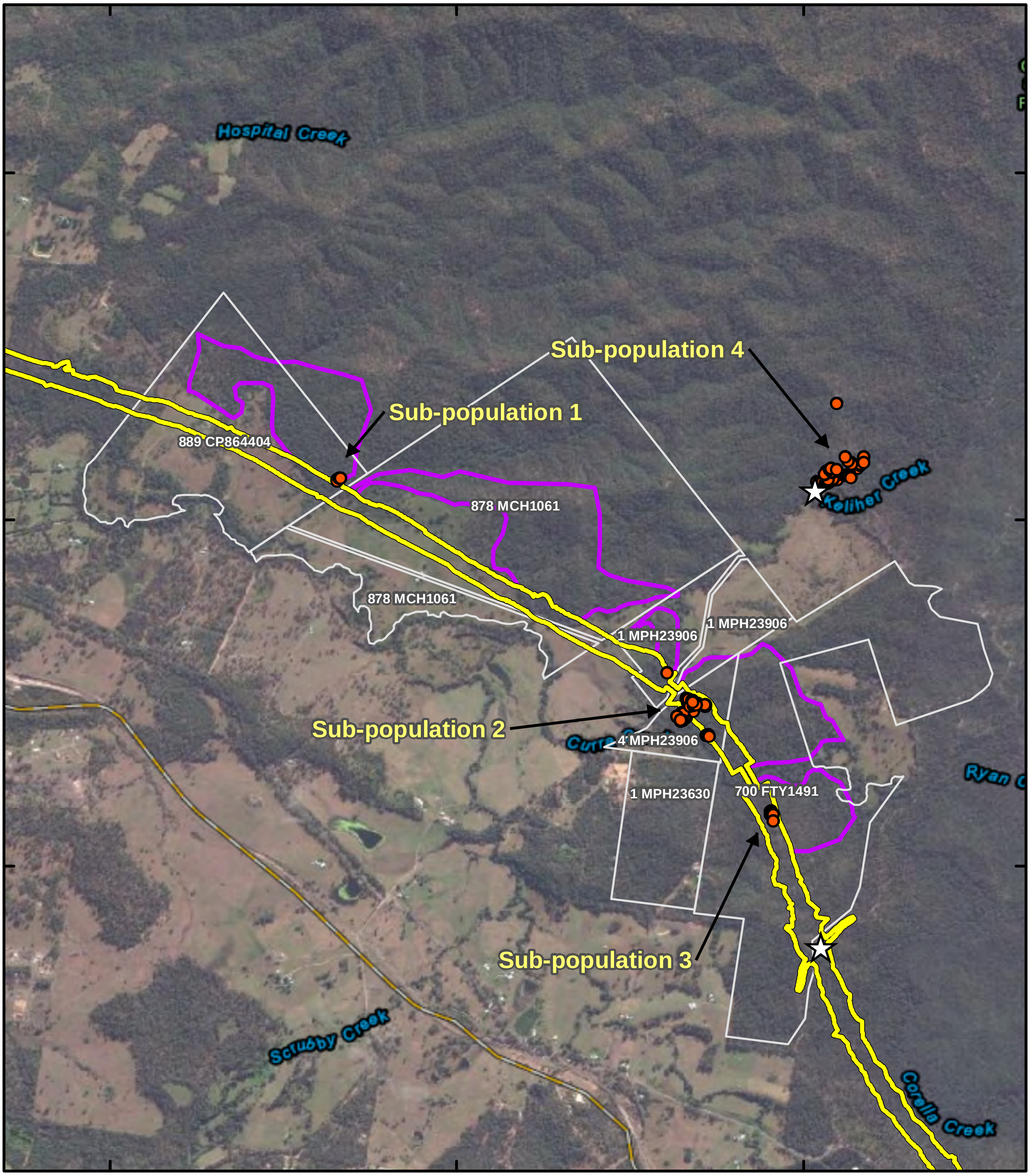
The number of Zamia Palm plants likely to be directly impacted (i.e. within the proposed Project footprint) and indirectly impacted (due to close proximity to the proposed Project footprint and/or fragmentation/isolation) by the Project are detailed in **Table 3.5**.

Table 3.5. Summary of Zamia Palm (*Macrozamia pauli-guilielmi*) plants within the Project footprint (direct impact) or close to the Project footprint (indirect impact).

Sub-population	Plants directly impacted	Plants indirectly impacted (distance from Project footprint)
1	None	16 adults, 2 seedlings (10 m to 30 m)
2	33 adults, 84 seedlings	28 adults, 25 seedlings (1 m to 50 m)
3	15 adults, 83 seedlings	None
4	None	None
Total	48 adults, 167 seedlings	44 adults, 27 seedlings

The residual impact of the Project on Zamia Palm subpopulations will likely require mitigation and offsetting in accordance with the Commonwealth EPBC Act Environmental Offsets Policy and the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. A suitable mitigation and offset action for Zamia Palm would be to salvage and translocate plants proposed to be impacted by the Project to suitable habitat(s) in the local region (Queensland Herbarium 2007, Department of the Environment 2016). Ideally, translocated plants should be translocated into or close to existing nearby sub-populations that are at risk of decline and local extinction (Queensland Herbarium 2007, Department of the Environment 2016). However, the only sub-population known to occur locally (sub-population 4 shown on **Figure 3.2**) is a large, healthily reproducing population that is located on a different substrate type, namely gravelly soils derived from metasediments (Land Zone 11) to the sub-populations to be translocated, which are growing in soft sands derived from sandstone (Land Zone 10). Zamia Palms depend critically on mutualistic associations with mycorrhizal fungi and cyanobacteria in their root systems that respectively facilitate the uptake of mineral nutrients and water from the soil and fix nitrogen for the plant in nutrient-poor soils. The mycorrhizal fungi and cyanobacteria symbionts are expected to be sensitive to substrate type; therefore translocation of plants between different substrate types may compromise the success of the translocation and presents a risk to the translocation program. Five patches of suitable habitat with the same substrate type as the plants to be translocated (i.e. Land Zone 10) are present to the east of the current sub-populations (see **Figure 3.3**):

- Curra State Forest (lot/plan 700 FTY1491) to the east of sub-population 3 and south of Curra Creek. The suitable habitat area on Land Zone 10 is relatively restricted and in close proximity to the Project footprint, but is gently sloping and can be accessed on existing tracks.
- Curra State Forest (lot/plan 700 FTY1491) and the freehold property on lot/plan 4 MPH23906 to the east of sub-population 2 and north of Curra Creek. The suitable habitat area on Land Zone 10 occurs on relatively steep, rocky slopes in close proximity to the Project footprint.
- The freehold property on lot/plan 1 MPH23906 to the north-east of sub-population 2. The small patch of suitable habitat on Land Zone 10 occurs on a steep rocky slope in close proximity to the Project footprint.



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

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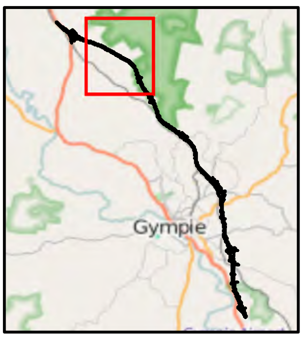

LEGEND

Protected Plant Species:

- Macrozamia pauli-guiliemi
- Macrozamia ALA record
- Suitable Zamia Palm offset habitat
- Property boundaries
- Project Footprint

Figure:	**3-3**
Title:	Locations of suitable Zamia Palm (*Macrozamia pauli-guilielmi*) offset habitat
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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Drawn By: MG Reviewed by: PL Date: 4/04/2016

Document Location: D:\GIS\Jobs\0402-001 C2C Secion D FloraSurvey\GIS\MXDs\ReportMaps\Figure3-3 Suitable Zamia Palm offset habitat.mxdDate: 4/04/2016 10:12:05 AM

- The freehold property on lot/plan 878/MCH1061 to the south-east of sub-population 1 and north-west of sub-population 2. This is the most suitable site for translocation as the suitable habitat area is extensive, more distant from the Project footprint than other potential sites, yet relatively close to (within 1 km of) the existing large sub-population 4 in Curra State Forest. Much of the suitable habitat area on this property has not yet been surveyed; therefore there may be existing sub-populations of Zamia Palm on this site.
- The freehold property on lot/plan 889/CP864404 immediately to the east of sub-population 1. The suitable habitat area on 889/CP864404 is relatively large, but is relatively close to the Project footprint and more distant from sub-population 4.

The selection of the translocation site should be informed by the proposed land use and protection status of the land involved.

Slender Milkvine (Marsdenia coronata)

Field survey results

Slender Milkvine was encountered during nearly half of the random meanders (see **Table 3.3**), and at some locations it was widely distributed and relatively common, particularly on Land Zone 11 in Curra State Forest. The locations of the plants detected are mapped in **Figure 3.4**, and details of the supporting habitats associated with each meander are summarised in **Table 3.6**. Slender Milkvine was rarely encountered on surveys of REs on Land Zone 9-10; indeed only a single concentrated cluster of 5 adult plants and 16 seedlings was found on a sandstone outcrop in RE 12.9-10.4 (**Table 3.6**). Three flowering and fruiting specimens from different locations were collected and submitted to the Queensland Herbarium for confirmation of identification; these were confirmed as Slender Milkvine. Photographs of the different habitats in which the species was located, together with similar species encountered, are presented in **Appendix B**.

Slender Milkvine is a relatively inconspicuous species of climbing vine, characterised by opposite, relatively narrow, oval-shaped leaves with whitish veins that exude a milky, white latex when plucked (**Photos 7** to **10**). Adult plants and seedlings were typically only detected within 3 m of either side of the random meander track, yet the survey recorded a total of 649 plants, comprising 177 adults and 472 seedlings in the limited total area surveyed. Seedlings tended to be clustered in the close vicinity of dead climbing stems that likely represent the remains of the previous season's adult, reproducing plants. Due to this pattern of occurrence, it is appropriate to quantify the density of the species in supporting habitats. To calculate plant densities, the random meander survey tracks on which Slender Milkvine was detected were buffered by 3 m to estimate the total area of habitat surveyed. These details are summarised in **Table 3.6**. Estimated Slender Milkvine densities ranged between 2 and 88 adult plants per hectare, with between 11 and 148 seedlings per hectare (**Table 3.6**).

Based on the results of the field survey and the known preferred habitat characteristics of the species (see **Table 3.1**), the habitat mapping characterised habitat for the species as:

- **Known habitat** – all remnant RE polygons that intersect with a *Marsdenia coronata* record from the field surveys (includes polygons of REs 12.9-10.4, 12.11.3, 12.11.5e and 12.11.16).
- **Potential habitat** – polygons of remnant REs 12.9-10.4, 12.9-10.17b, 12.11.3, 12.11.5e and 12.11.16 that do not intersect with a *Marsdenia coronata* record from the field surveys, including polygons in which the species was not located during the field survey.
- **Not generally suitable** – all other remnant RE polygons (REs 12.3.1, 12.3.3, 12.3.11 and 12.11.14) and non-remnant areas that do not provide suitable habitat for the species.

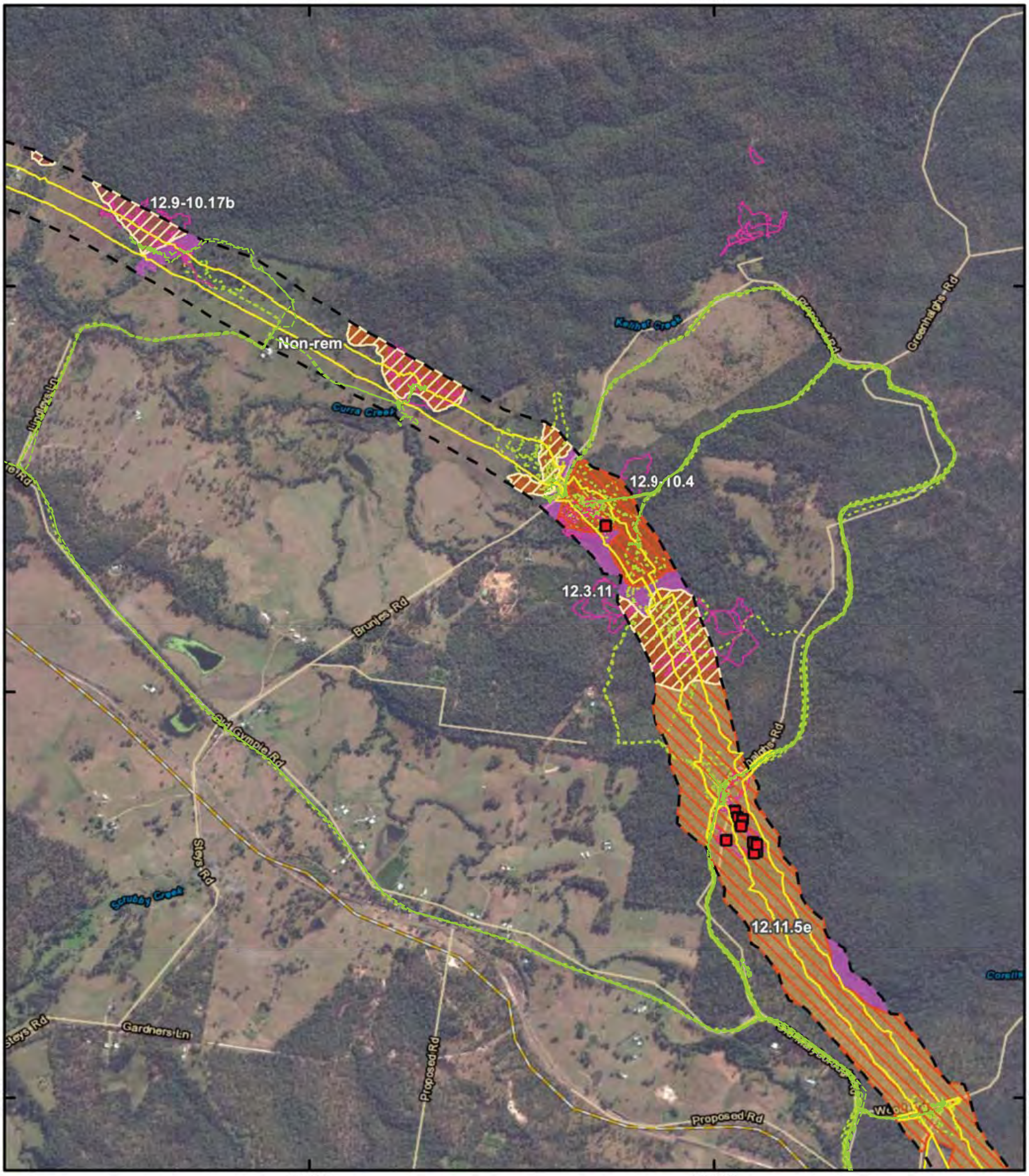
The distributions of the different Slender Milkvine habitat areas in the study area are mapped in **Figure 3.4**.

Photo 7. *Marsdenia coronata* adult vine in a shrub.

Photo 8. *Marsdenia coronata* flowers.

Photo 9. *Marsdenia coronata* seed pod.

Photo 10. *Marsdenia coronata* seedling.



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Study Area
- Direct Footprint Area

Protected Plant Species record:

- *Marsdenia coronata*

Marsdenia coronata:

- Known habitat
- Potential habitat
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4

Date: 10/03/2016

Figure:	**3-4 1 of 5**
Title:	**Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats**
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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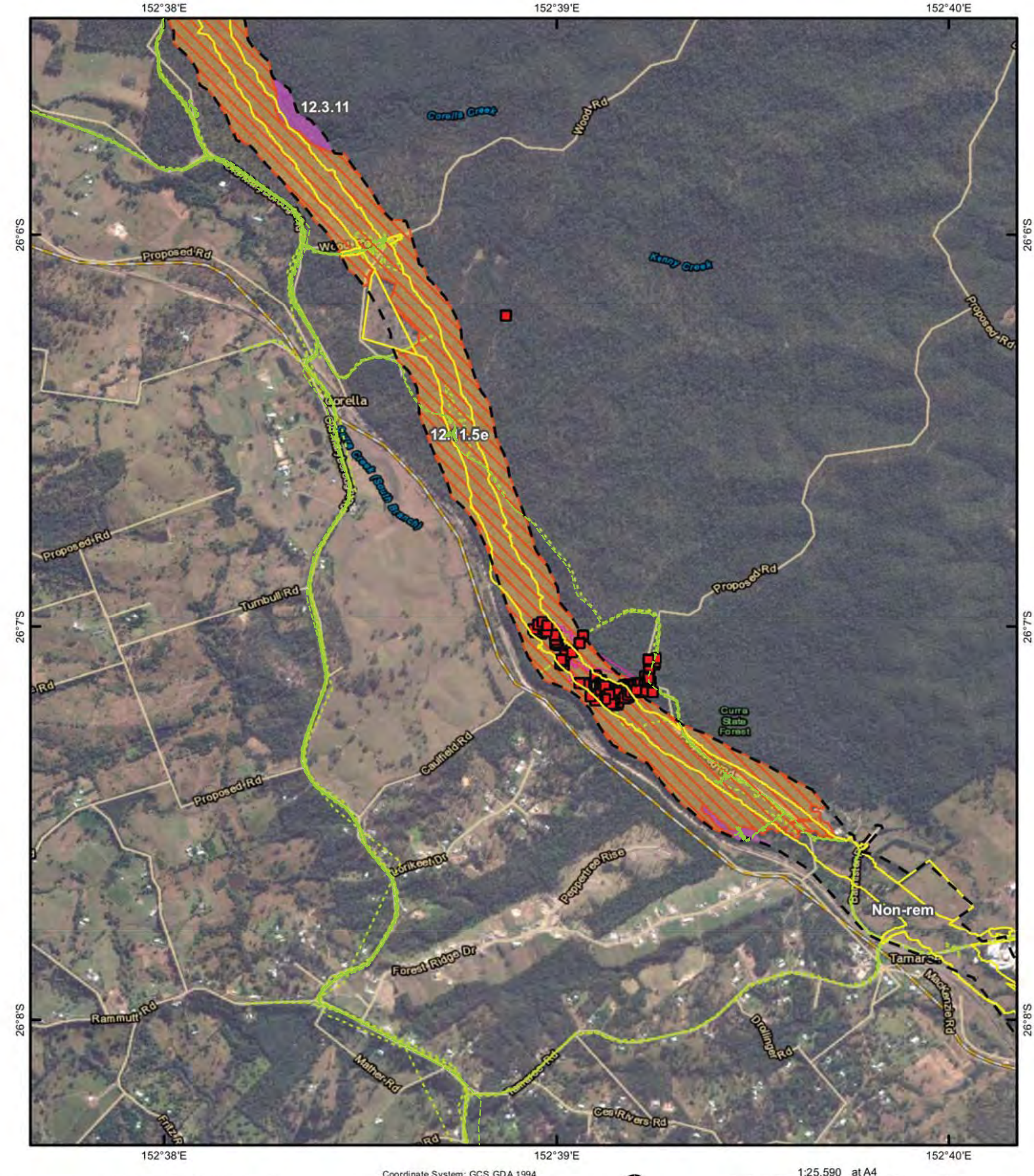

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

Study Area

Direct Footprint Area

Protected Plant Species record:

Marsdenia coronata

Marsdenia coronata:

Known habitat

Potential habitat

Field Track (2011)

Field Track (2015)

Field Track (2016)

Regional Ecosystem

12.11.14
12.11.16
12.11.3
12.11.3/12.11.14
12.11.5e
12.3.1
12.3.11
12.3.3.d
12.3.7
12.9-10.17b
12.9-10.4

Date: 10/03/2016

Figure:	**3-4 2 of 5**
Title:	**Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats**
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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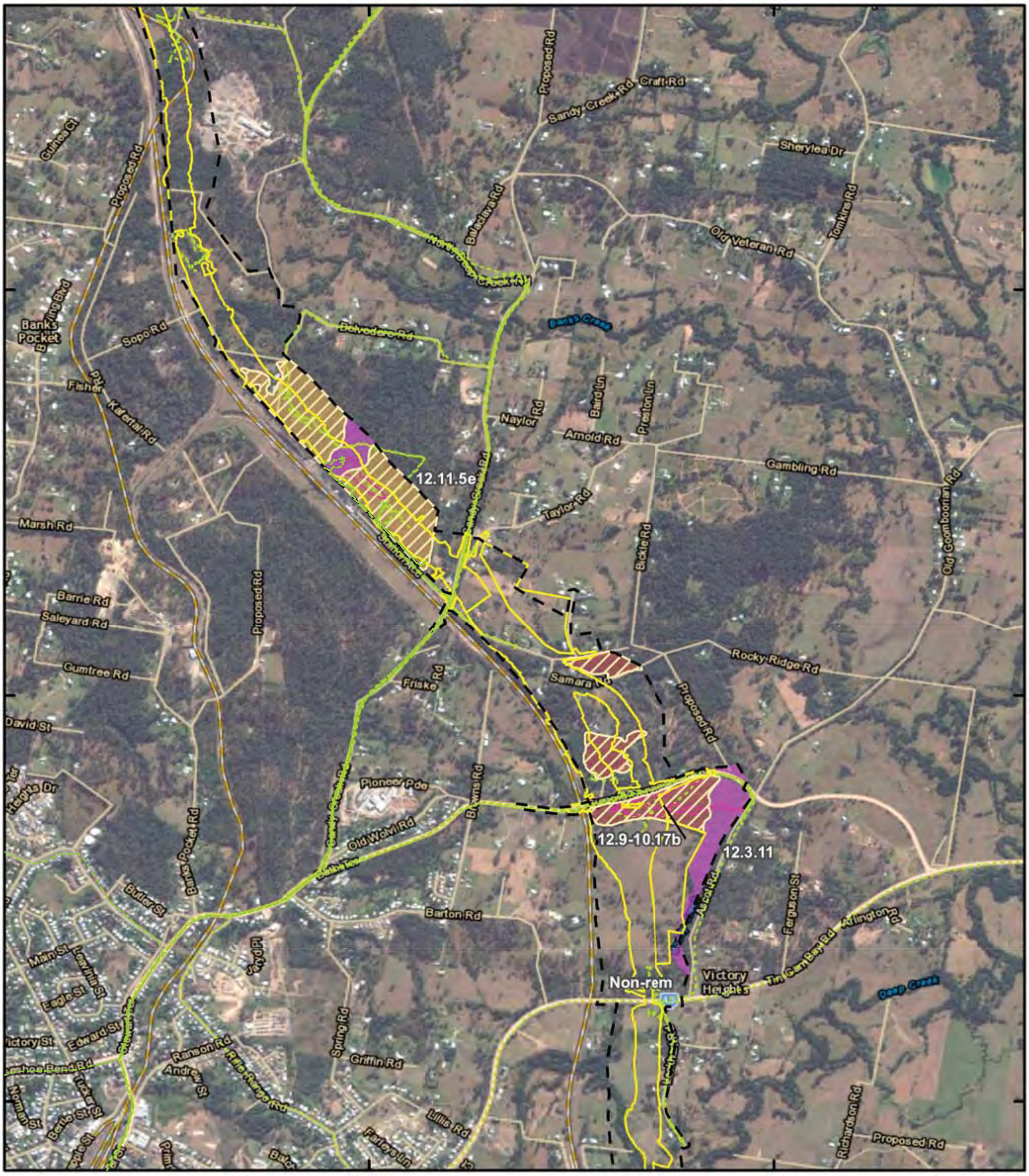

152°41'E 152°42'E

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Study Area
- Direct Footprint Area

Protected Plant Species record:

- *Marsdenia coronata*

Marsdenia coronata:

- Known habitat
- Potential habitat
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

12.11.14	12.3.1
12.11.16	12.3.11
12.11.3	12.3.3.d
12.11.3/12.11.14	12.3.7
12.11.5e	12.9-10.17b
	12.9-10.4

Date: 10/03/2016

Figure: 3-4 3 of 5

Title: Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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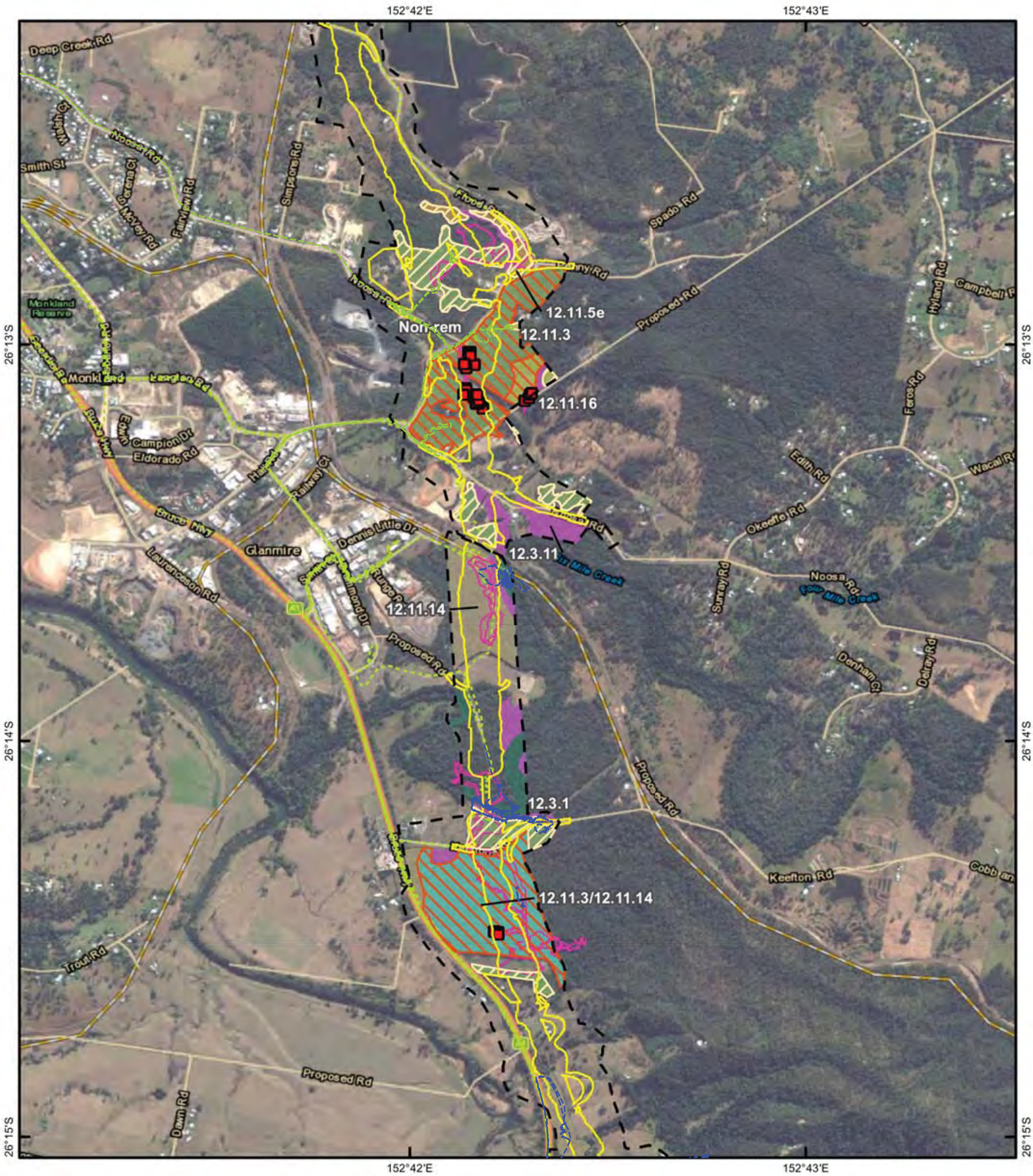

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

Study Area

Direct Footprint Area

Protected Plant Species record:

Marsdenia coronata

Marsdenia coronata:

Known habitat

Potential habitat

Field Track (2011)

Field Track (2015)

Field Track (2016)

Regional Ecosystem

12.11.14	12.3.1
12.11.16	12.3.11
12.11.3	12.3.3.d
12.11.3/12.11.14	12.3.7
12.11.5e	12.9-10.17b
	12.9-10.4

Date: 10/03/2016

Figure: 3-4 4 of 5

Title: Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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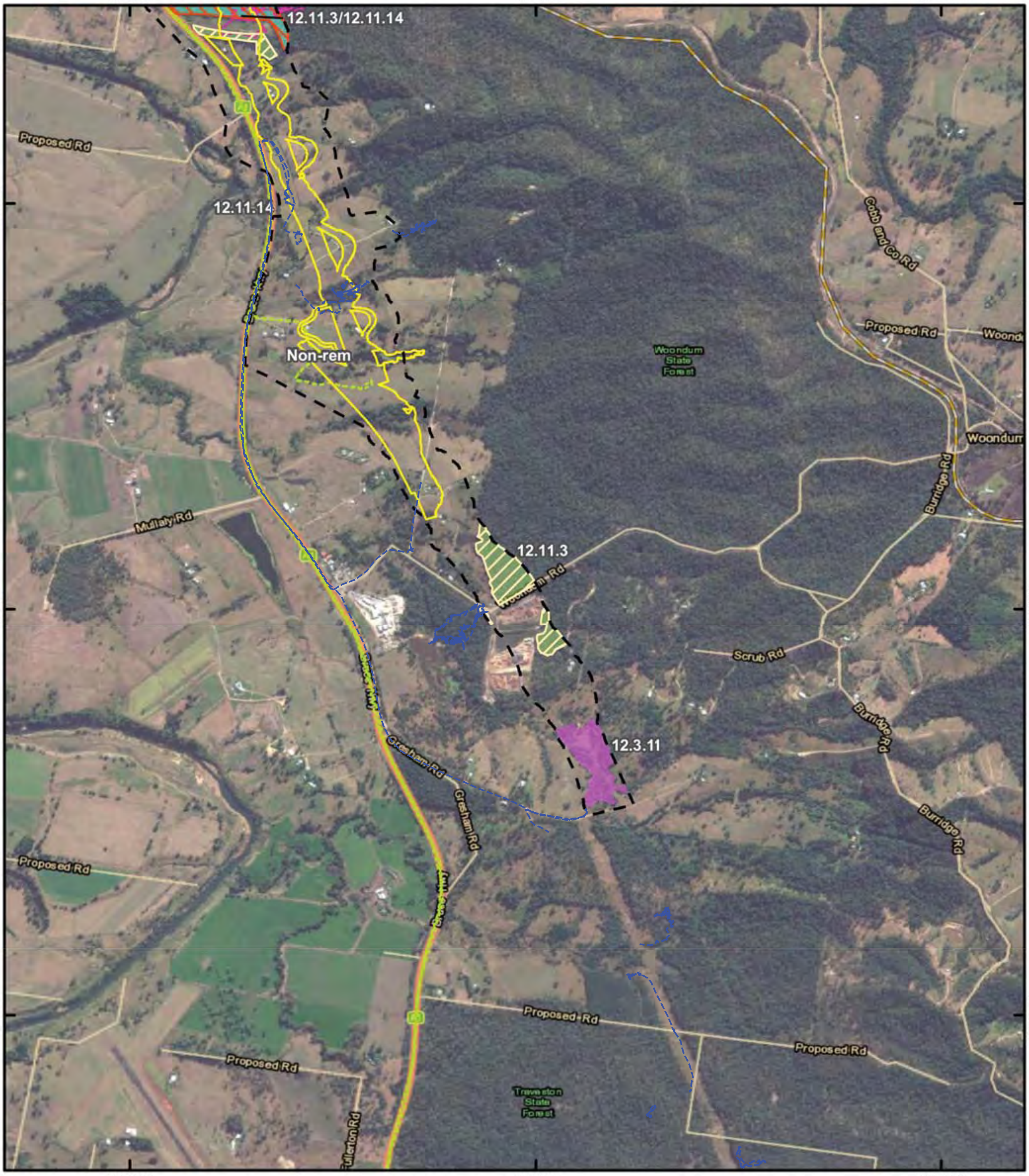

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4
0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

Study Area
Direct Footprint Area

Protected Plant Species record:

Marsdenia coronata

Marsdenia coronata:

Known habitat
Potential habitat
Field Track (2011)
Field Track (2015)
Field Track (2016)

Regional Ecosystem

12.11.14	12.3.1
12.11.16	12.3.11
12.11.3	12.3.3.d
12.11.3/12.11.14	12.3.7
12.11.5e	12.9-10.17b
	12.9-10.4

Date: 10/03/2016

Figure: 3-4 5 of 5

Title: Locations of Slender Milkvine (*Marsdenia coronata*) occurrences and habitats

Project: Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)

Client: Advisian on behalf of QLD Dept. of Transport and Main Roads

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Table 3.6. Details of Slender Milkvine (*Marsdenia coronata*) supporting habitats and occurrences in the study area.

Meander (Stage)	Regional Ecosystem	Habitat description	*M. coronata* plants encountered	Survey area (ha)	*M. coronata* density (plants per ha)
1 (D2)	12.11.5e	Structure and position: Remnant open forest, canopy ht 18 m, on hillslope with gentle gradients. Tree1: *Corymbia citriodora* (cd), *Eucalyptus fibrosa* (cd), *E. longirostrata*. Tree2: *E. fibrosa, E. acmenoides, E. longirostrata* Shrub: *Acrotriche aggregata*, *Carissa ovata, Petalostigma triloculare, Lophostemon confertus,* Ground: *Entolasia stricta, Lomandra confertifolia, Lepidosperma laterale*. Substrate: gravelly soils derived from metasediments. Comments: Widely dispersed *Marsdenia coronata* on slopes; abundant seedlings, one adult flowering, one adult fruiting.	35 adults 38 seedlings	0.40	88 adults 95 seedlings
2 (D2)	12.11.5e	Same as for Meander 1.	21 adults 70 seedlings	0.54	39 adults 131 seedlings
3 (D2)	12.11.5e	Structure and position: Remnant open forest, canopy ht 22 m, on hillslope with moderate gradients. Tree1: *Corymbia citriodora* (cd), *Eucalyptus acmenoides* (cd). Tree2: *E. fibrosa, E. acmenoides, E. longirostrata* Shrub1: *Petalostigma triloculare, Acacia complanata,* Tree1 and Tree2 saplings. Shrub2: *Myrsine angusta, Acrotriche aggregata* Ground: *Entolasia stricta, Lomandra laxa, Dianella caerulea*. Substrate: loamy gravelly soils derived from metasediments. Comments: *Marsdenia coronata* absent in gullies but widely dispersed on slopes and ridge crests; seedlings patchily abundant.	12 adults 42 seedlings	0.44	27 adults 95 seedlings
4 (D2)	12.11.5e	Same as for Meander 3.	19 adults 77 seedlings	0.48	40 adults 161 seedlings
5 (D2)	12.11.5e	Same as for Meander 3.	19 adults 47 seedlings	0.77	25 adults 61 seedlings
6 (D2)	12.9-10.4	Structure and position: Remnant open forest/woodland, canopy ht 16 m, on minor ridge crest with sandstone rock outcrop. Tree1: *Corymbia intermedia*, *Eucalyptus acmenoides*, *Angophora leiocarpa*. Tree2: *Lophostemon confertus, Acacia disparrima, A. concurrens.* Shrub: *Lantana camara**. Ground: *Imperata cylindrica, Lomandra longifolia, Xanthorrhoea johnsonii*. Substrate: shallow soft sand derived from sandstone on a sandstone rock outcrop. Comments: *Marsdenia coronata* highly localised to a single cluster on the rock outcrop; Land Zone 9-10 clearly not typical habitat for the species.	5 adults 16 seedlings	1.26	4 adults 13 seedlings

Meander (Stage)	Regional Ecosystem	Habitat description	*M. coronata* plants encountered	Survey area (ha)	*M. coronata* density (plants per ha)
14 (D2)	12.11.5e	Structure and position: Remnant open forest, canopy ht 20 m, on south-facing hillslope and gullies. Tree1: *Eucalyptus fibrosa* (d), *E. citriodora*. Tree2: *Lophostemon confertus* (d), *E. fibrosa, E. citriodora.* Shrub: *Acrotriche aggregata, Carissa ovata, Daviesia villifera, Leucopogon juniperinus* Ground: *Entolasia stricta, Lomandra longifolia, Lepidosperma laterale*. Substrate: thin gravelly soils derived from metasediments. Comments: *Marsdenia coronata* scattered on slopes and in gullies; seedlings patchily abundant, one adult flowering.	17 adults 26 seedlings	1.32	13 adults 20 seedlings
18 (D1)	12.11.3 (upper hillslope)	Structure and position: Remnant open forest, canopy ht 15 m, steep upper hillslope. Tree1: *Lophostemon confertus* (cd), *Corymbia intermedia* (cd), *Eucalyptus acmenoides* (cd), *E. longirostrata*. Tree2: *Lophostemon confertus, Acacia disparrima.* Shrub: *Lantana camara** (d). Ground: *Passiflora suberosa*, Imperata cylindrica*. Substrate: thin gravelly soils derived from metasediments. Comments: *Marsdenia coronata* widespread on steep south-facing slope; abundant seedlings.	39 adults 128 seedlings	0.86	45 adults 148 seedlings
18 (D1)	12.11.3 (lower hillslope gullies)	Structure and position: Remnant open forest, canopy ht 22 m, hillslope with moderate gradient and gullies. Tree1: *Eucalyptus acmenoides* (d), *E. propinqua, E. moluccana, E. siderophloia*. Tree2: *Lophostemon confertus, Syncarpia glomulifera* Shrub: *Lophostemon confertus, Lantana camara*, Acrotriche aggregata, Petalostigma triloculare* Ground: *Entolasia stricta, Lomandra confertifolia, Dianella caerulea*. Substrate: thin gravelly soils derived from metasediments. Comments: *Marsdenia coronata* widespread on slopes and in gullies; abundant seedlings.			
20 (D1)	12.11.3/12.11.14	Structure and position: Remnant open forest with vine forest understorey, canopy ht 16 m, emergent to 25 m, on bench/plateau. Emergent: *Eucalyptus propinqua* (d), *E. siderophloia*. Tree1: *Lophostemon confertus* (cd), *Syncarpia glomulifera* (cd), *Acacia disparrima*, *Jagera pseudorhus*. Tree2: *Alectryon reticulatus, Alphitonia excelsa, Cyclophyllum longipetalum, Pilidiostigma rhytispermum, Claoxylon australe.* Shrub: *Pavetta australis, Alyxia ruscifolia, Diospyros geminata, Alchornea ilicifolia*. Ground: *Carissa ovata, Lomandra longifolia, Passiflora suberosa**. Substrate: loamy gravelly soils derived from metasediments. Comments: *M. coronata* sparse and localised in this habitat.	4 adults 20 seedlings	1.89	2 adults 11 seedlings

Meander (Stage)	Regional Ecosystem	Habitat description	*M. coronata* plants encountered	Survey area (ha)	*M. coronata* density (plants per ha)
25 (D1)	12.11.16	Structure and position: Remnant tall open forest, canopy ht 30 m, on footslope with moderate gradient. Tree1: *Eucalyptus cloeziana* (d), *E. propinqua* (associated). Tree2: *E. cloeziana, Syncarpia glomulifera* (d), *Lophostemon confertus* Tree3: *Lophostemon confertus* (d), *Syncarpia glomulifera*. Shrub: *Lantana camara** (d), *Acacia disparrima, Pilidiostigma rhytispermum, Acronychia laevis.* Ground: *Carissa ovata, Smilax australis, Lomandra longifolia, Dianella caerulea, Ottochloa gracillima*. Substrate: loamy gravelly soils derived from metasediments. Comments: *M. coronata* absent in gullies but widely dispersed on slopes and ridge crests; seedlings patchily abundant.	5 adults 8 seedlings	0.22	23 adults 36 seedlings

Potential impacts of the Project on Slender Milkvine

The total areas of the three categories of habitat for Slender Milkvine in each of the Stage D1 and Stage D2 portions of the Project footprint are summarised in **Table 3.7**.

Table 3.7. Summary of Slender Milkvine (*Marsdenia coronata*) habitat areas within the Project footprint (potential direct impact) of each of the D1 (south of Sandy Creek Road) and D2 (north of Sandy Creek Road) stages of the Project.

Habitat type	Stage D1 (ha)	Stage D2 (ha)	Total (ha)
Known habitat	12.56	65.62	78.18
Potential habitat	19.74	18.63	38.37
Not generally suitable habitat	182.37	137.25	319.62

The residual impact of the Project on Slender Milkvine will likely require mitigation and offsetting in accordance with the Queensland *Environmental Offsets Act 2014* and associated Environmental Offsets Policy. Due to the relatively high abundance of Slender Milkvine in known habitat areas within the Project footprint area, the translocation of plants is unlikely to be cost-effective as a mitigation and offsetting action. Instead, a habitat offset should be considered, based on the area of known habitat to be impacted by the Project. Given the apparent success of seedling establishment in proximity to parent plant locations from the previous season, the collection of seed from plants within the highway alignment for subsequent manual dispersal to establish plants in habitat offset areas could be an effective mitigation and offsetting action. Slender Milkvine flowers from November to March and the fruit pods mature to release their seeds three to four months later (Forster 1995, 1996). The suitable time period for collecting seed is therefore within the period March to June; however, timing may vary with rainfall during the spring and summer growing season for Slender Milkvine.

3.2.2 Other EVNT flora species with potential to occur

Thirteen of the 17 species assessed as having potential to occur in the study area during the desktop assessment are associated with rainforest or wet sclerophyll forest (see **Table 3.1**). Rainforest-associated tree species were recorded in the understorey of wet sclerophyll forest types in many parts of the study area, together with a narrow patch of RE 12.3.1 (Gallery rainforest (notophyll vine forest) on alluvial plains) and a previously unsurveyed 1 ha patch of RE 12.11.10 (notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics) in the south of the Stage D1 portion of the study area. Despite the extensive survey of habitats supporting rainforest-associated trees, none of the rainforest-associated EVNT species assessed as having potential to occur were detected. Furthermore, the survey of suitable habitats for the other four species assessed as having potential to occur did not detect these species in the study area. On the basis of these results in relation to the extensive survey effort over several surveys, it is concluded that there is a low probability that any of the 17 species assessed as having potential to occur in the study area may actually occur.

A small patch of RE 12.11.10 was encountered in the southern portion of the study area and located partially in the study area (see **Appendix D Figure 1** for the mapped location of this patch). As this patch had not been detected in a previous survey and can correspond to the Lowland Rainforest of Subtropical Australia, listed as a threatened ecological community (TEC) under the EPBC Act, it was assessed against the listing advice for this TEC to determine whether it met the key diagnostic characteristics and condition thresholds for recognition as the TEC (see **Appendix C** for assessment details). This assessment determined that the patch had high flora species richness (96 species recorded), but did not quite meet all the key diagnostic characteristics of the Lowland Rainforest of Subtropical Australia TEC. Specifically, a total of 38 woody species from Appendix A of the listing advice were detected in the patch, only two less than the 40 species required to meet the species richness condition threshold for recognition as the TEC.

3.2.3 Other key habitat features

Other key habitat features recorded opportunistically during the survey included:

- Large hollow-bearing trees;
- Large hollow logs;
- Large log piles; and
- Platelets (feeding sign) consistent with Black-breasted Buttonquail (*Turnix melanogaster*: EPBC Act: vulnerable; NC Act: vulnerable) in habitat with dense undergrowth and thick leaf litter around the perimeter of the 1 ha patch of RE 12.11.10 notophyll vine forest referred to in **Section 3.2.3** above.

The locations of these features are detailed in **Appendix D**. As these features were recorded opportunistically, they have not been comprehensively surveyed for within either the Project footprint or study area.

4.0 REFERENCES

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APPENDIX A

Flora species recorded in the study area

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Conifers							
Araucariaceae	*Agathis robusta*	LC	-	-	-	X	
Araucariaceae	*Araucaria bidwillii*	LC	-	-	-	X	
Araucariaceae	*Araucaria cunninghamii*	LC	-	-	-		X
Podocarpaceae	*Podocarpus elatus*	LC	-	-	-	X	
Cycads							
Zamiaceae	*Macrozamia pauli-guilielmi* +	E	E	-	-	X	X
Ferns							
Adiantaceae	*Adiantum aethiopicum*	LC	-	-	-		X
Adiantaceae	*Adiantum diaphanum*	LC	-	-	-		X
Adiantaceae	*Adiantum hispidulum*	LC	-	-	-	X	X
Adiantaceae	*Blechnum cartilagineum*	LC	-	-	-		X
Adiantaceae	*Cheilanthes sieberi*	LC	-	-	-	X	X
Adiantaceae	*Cheilanthes tenuifolia*	LC	-	-	-	X	X
Aspleniaceae	*Asplenium attenuatum*	LC	-	-	-		X
Aspleniaceae	*Asplenium australasicum*	LC	-	-	-		X
Blechnaceae	*Doodia aspera*	LC	-	-	-	X	X
Blechnaceae	*Doodia caudata*	LC	-	-	-	X	X
Dennstaedtiaceae	*Hypolepis muelleri*	LC	-	-	-	X	
Dennstaedtiaceae	*Pteridium esculentum*	LC	-	-	-	X	X
Dicksoniaceae	*Calochlaena dubia*	LC	-	-	-	X	X
Dryopteridaceae	*Arachniodes aristata*	LC	-	-	-		X
Polypodiaceae	*Platycerium superbum*	LC	-	-	-		X
Psilotaceae	*Psilotum nudum*	LC	-	-	-		X
Pteridaceae	*Pellaea paradoxa*	LC	-	-	-		X
Tectariaceae	*Arthropteris tenella*	LC	-	-	-		X
Thelypteridaceae	*Christella dentata*	LC	-	-	-	X	X
Higher dicots							
Acanthaceae	*Brunoniella australis*	LC	-	-	-	X	X
Acanthaceae	*Harnieria hygrophiloides*	LC	-	-	-		X
Acanthaceae	*Pseuderanthemum variabile*	LC	-	-	-	X	X
Acanthaceae	*Rostellularia adscendens*	LC	-	-	-		X
Amaranthaceae	*Alternanthera denticulata*	LC	-	-	-	X	
Anacardiaceae	*Mangifera indica**	-	-	-	-	X	
Anacardiaceae	*Rhodosphaera rhodanthema*	LC	-	-	-	X	X
Anacardiaceae	*Schinus terebinthifolius**	-	-	*3	-	X	X
Annonaceae	*Melodorum leichhardtii*	LC	-	-	-		X
Annonaceae	*Polyalthia nitidissima*	LC	-	-	-		X
Apiaceae	*Centella asiatica*	LC	-	-	-	X	X
Apocynaceae	*Alstonia constricta*	LC	-	-	-	X	X
Apocynaceae	*Alyxia magnifolia*	LC	-	-	-	X	
Apocynaceae	*Alyxia ruscifolia*	LC	-	-	-	X	X
Apocynaceae	*Asclepias curassavica**	-	-	-	-	X	X
Apocynaceae	*Carissa ovata*	LC	-	-	-	X	X
Apocynaceae	*Cynanchum bowmanii*	LC	-	-	-	X	X
Apocynaceae	*Gomphocarpus physocarpus**	-	-	-	-	X	X
Apocynaceae	*Parsonsia eucalyptophylla*	LC	-	-	-	X	
Apocynaceae	*Parsonsia brisbanensis*	LC	-	-	-		X
Apocynaceae	*Parsonsia lanceolata*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Apocynaceae	*Parsonsia paulforsteri*	LC	-	-	-		X
Apocynaceae	*Parsonsia rotata*	LC	-	-	-		X
Apocynaceae	*Parsonsia straminea*	LC	-	-	-	X	X
Apocynaceae	*Parsonsia velutina*	LC	-	-	-		X
Apocynaceae	*Secamone elliptica*	LC	-	-	-		X
Apocynaceae	*Tabernaemontana pandacaqui*	LC	-	-	-	X	X
Apocynaceae	*Tylophora benthamii*	LC	-	-	-	X	
Apocynaceae	*Marsdenia coronata* +	V	-	-	-		X
Apocynaceae	*Marsdenia lloydii*	LC	-	-	-		X
Apocynaceae	*Marsdenia microlepis*	LC	-	-	-		X
Apocynaceae	*Marsdenia rostrata* +	LC	-	-	-	X	
Araliaceae	*Astrotricha latifolia*	LC	-	-	-	X	X
Araliaceae	*Polyscias elegans*	LC	-	-	-	X	X
Araliaceae	*Trachymene incisa subsp. incisa*	LC	-	-	-	X	X
Arecaceae	*Calamus muelleri*	LC	-	-	-		X
Arecaceae	*Syagrus romanzoffiana**	-	-	-	-	X	X
Asteraceae	*Acmella grandiflora*	LC	-	-	-	X	
Asteraceae	*Ageratum conyzoides*	LC	-	-	-	X	X
Asteraceae	*Ageratum houstonianum**	-	-	-	-	X	
Asteraceae	*Baccharis halimifolia**	-	-	*2	-	X	X
Asteraceae	*Bidens pilosa**	-	-	-	-	X	X
Asteraceae	*Chrysocephalum apiculatum*	LC	-	-	-	X	X
Asteraceae	*Cirsium vulgare**	-	-	-	-	X	
Asteraceae	*Conyza sumatrensis*	LC	-	-	-	X	X
Asteraceae	*Crassocephalum crepidioides**	-	-	-	-	X	
Asteraceae	*Cyanthillium cinereum*	LC	-	-	-	X	X
Asteraceae	*Emilia sonchifolia**	-	-	-	-	X	X
Asteraceae	*Gamochaeta coarctata**	-	-	-	-	X	
Asteraceae	*Glossocardia bidens*	LC	-	-	-		X
Asteraceae	*Hypochaeris radicata**	-	-	-	-	X	X
Asteraceae	*Lagenifera stipitata*	LC	-	-	-		X
Asteraceae	*Ozothamnus diosmifolius*	LC	-	-	-	X	X
Asteraceae	*Praxelis clematidea**	-	-	-	-	X	
Asteraceae	*Pterocaulon redolens*	LC	-	-	-	X	X
Asteraceae	*Senecio amygdalifolius*	LC	-	-	-		X
Asteraceae	*Sigesbeckia orientalis*	LC	-	-	-	X	X
Asteraceae	*Sonchus oleraceus**	-	-	-	-	X	X
Asteraceae	*Praxelis clematidea*	LC	-	-	-	X	
Bignoniaceae	*Jacaranda mimosifolia**	-	-	-	-	X	X
Bignoniaceae	*Pandorea jasminoides*	LC	-	-	-		X
Bignoniaceae	*Pandorea pandorana*	LC	-	-	-	X	X
Bignoniaceae	*Macfadyena unguis-cati**	-	-	*3	-	X	X
Bignoniaceae	*Tecoma stans**	-	-	*3	-	X	
Burseraceae	*Canarium australasicum*	LC	-	-	-	X	
Byttneriaceae	*Commersonia bartramia*	LC	-	-	-	X	
Cactaceae	*Hylocereus undatus*	-	-	-	-		X
Cactaceae	*Opuntia stricta**	-	-	*2	-	X	X
Caesalpiniaceae	*Caesalpinia subtropica*	LC	-	-	-	X	
Caesalpiniaceae	*Cassia tomentella*	LC	-	-	-		X

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		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Caesalpiniaceae	*Senna acclinis*	LC	-	-	-	X	
Caesalpiniaceae	*Senna occidentalis**	-	-	-	-	X	
Caesalpiniaceae	*Senna pendula var. glabrata**	-	-	-	-	X	X
Campanulaceae	*Lobelia purpurascens*	LC	-	-	-	X	X
Campanulaceae	*Lobelia stenophylla*	LC	-	-	-		X
Capparaceae	*Capparis arborea*	LC	-	-	-		X
Capparaceae	*Capparis sarmentosa*	LC	-	-	-		X
Casuarinaceae	*Allocasuarina littoralis*	LC	-	-	-	X	X
Casuarinaceae	*Allocasuarina torulosa*	LC	-	-	-	X	X
Celastraceae	*Denhamia bilocularis*	LC	-	-	-		
Celastraceae	*Celastrus australis*	LC	-	-	-		X
Celastraceae	*Denhamia celastroides*	LC	-	-	-	X	X
Celastraceae	*Maytenus bilocularis*	LC	-	-	-	X	
Chenopodiaceae	*Einadia hastata*	LC	-	-	-	X	X
Clusiaceae	*Hypericum gramineum*	LC	-	-	-	X	X
Convolvulaceae	*Ipomoea plebeia*	LC	-	-	-	X	X
Convolvulaceae	*Polymeria calycina*	LC	-	-	-	X	X
Crassulaceae	*Bryophyllum delagoense**	-	-	*2	-		X
Cucurbitaceae	*Momordica cochinchinensis**	-	-	-	-	X	
Cunoniaceae	*Pseudoweinmannia lachnocarpa*	LC	-	-	-		X
Dilleniaceae	*Hibbertia aspera subsp. aspera*	LC	-	-	-	X	X
Dilleniaceae	*Hibbertia linearis*	LC	-	-	-	X	X
Ebenaceae	*Diospyros fasciculosa*	LC	-	-	-		X
Ebenaceae	*Diospyros geminata*	LC	-	-	-	X	X
Elaeocarpaceae	*Elaeocarpus obovatus*	LC	-	-	-	X	X
Ericaceae	*Acrotriche aggregata*	LC	-	-	-	X	X
Ericaceae	*Leucopogon juniperinus*	LC	-	-	-	X	X
Ericaceae	*Leucopogon leptospermoides*	LC	-	-	-	X	
Erythroxylaceae	*Erythroxylum* sp. Splityard Creek (L.Pedley 5360)	LC	-	-	-		X
Euphorbiaceae	*Acalypha capillipes*	LC	-	-	-	X	X
Euphorbiaceae	*Acalypha nemorum*	LC	-	-	-		X
Euphorbiaceae	*Alchornea ilicifolia*	LC	-	-	-	X	X
Euphorbiaceae	*Claoxylon australe*	LC	-	-	-	X	X
Euphorbiaceae	*Cleistanthus cunninghamii*	LC	-	-	-		X
Euphorbiaceae	*Croton insularis*	LC	-	-	-		X
Euphorbiaceae	*Croton stigmatosus*	LC	-	-	-		X
Euphorbiaceae	*Dissiliaria baloghioides*	LC	-	-	-		X
Euphorbiaceae	*Actephila lindleyi*	LC	-	-	-		X
Euphorbiaceae	*Homalanthus nutans*	LC	-	-	-	X	
Euphorbiaceae	*Homalanthus stillingiifolius*	LC	-	-	-		X
Euphorbiaceae	*Mallotus claoxyloides*	LC	-	-	-	X	X
Euphorbiaceae	*Mallotus philippensis*	LC	-	-	-	X	X
Eupomatiaceae	*Eupomatia bennettiana*	LC	-	-	-	X	X
Fabaceae	*Austrosteenisia blackii*	LC	-	-	-	X	X
Fabaceae	*Callerya australis*	LC	-	-	-	X	
Fabaceae	*Chamaecrista rotundifolia*	LC	-	-	-	X	X
Fabaceae	*Chamaecrista nomame*	LC	-	-	-		X
Fabaceae	*Daviesia ulicifolia subsp.*	LC	-	-	-	X	X

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	stenophylla						
Fabaceae	*Daviesia ulicifolia subsp. ulicifolia*	LC	-	-	-	X	
Fabaceae	*Daviesia umbellulata*	LC	-	-	-	X	
Fabaceae	*Daviesia villifera*	LC	-	-	-	X	X
Fabaceae	*Derris involuta*	LC	-	-	-		X
Fabaceae	*Desmodium rhytidophyllum*	LC	-	-	-	X	X
Fabaceae	*Desmodium varians*	LC	-	-	-		X
Fabaceae	*Flemingia parviflora*	LC	-	-	-	X	X
Fabaceae	*Galactia tenuiflora*	LC	-	-	-		X
Fabaceae	*Glycine clandestina*	LC	-	-	-	X	X
Fabaceae	*Glycine cyrtoloba*	LC	-	-	-	X	X
Fabaceae	*Glycine microphylla*	LC	-	-	-		X
Fabaceae	*Glycine tabacina*	LC	-	-	-	X	X
Fabaceae	*Hardenbergia violacea*	LC	-	-	-	X	X
Fabaceae	*Hovea acutifolia*	LC	-	-	-	X	X
Fabaceae	*Indigofera australis*	LC	-	-	-		X
Fabaceae	*Jacksonia scoparia*	LC	-	-	-	X	X
Fabaceae	*Macroptilium atropurpureum**	-	-	-	-	X	
Fabaceae	*Podolobium ilicifolium*	LC	-	-	-	X	X
Fabaceae	*Podolobium scandens*	LC	-	-	-	X	X
Fabaceae	*Pultenaea villosa*	LC	-	-	-	X	X
Fabaceae	*Tephrosia sp.*	LC	-	-	-		X
Fabaceae	*Zornia dyctiocarpa*	LC	-	-	-		X
Goodeniaceae	*Goodenia rotundifolia*	LC	-	-	-	X	X
Goodeniaceae	*Goodenia* sp. Mt Castletower (M.D. Crisp 2753)	LC	-	-	-		X
Lamiaceae	*Callicarpa pedunculata*	LC	-	-	-	X	
Lamiaceae	*Clerodendrum floribundum*	LC	-	-	-	X	X
Lamiaceae	*Gmelina leichhardtii*	LC	-	-	-	X	
Lamiaceae	*Plectranthus parviflorus*	LC	-	-	-	X	X
Lamiaceae	*Teucrium argutum*	LC	-	-	-	X	
Lamiaceae	*Vitex lignum-vitae*	LC	-	-	-		X
Lentibulariaceae	*Utricularia aurea*	LC	-	-	-		X
Loganiaceae	*Strychnos axillaris*	LC	-	-	-		X
Loranthaceae	*Amyema cambagei*	LC	-	-	-	X	
Loranthaceae	*Amyema conspicua*	LC	-	-	-		X
Loranthaceae	*Amyema pendula*	LC	-	-	-		X
Malvaceae	*Hibiscus heterophyllus*	LC	-	-	-	X	X
Malvaceae	*Seringia arborescens* +	LC	-	-	-	X	
Malvaceae	*Seringia* sp. (Chermside S.T.Blake 23068) +	LC	-	-	-		X
Malvaceae	*Sida abutifolia**	-	-	-	-	X	X
Malvaceae	*Sida cordifolia**	-	-	-	-	X	X
Malvaceae	*Sida hackettiana*	LC	-	-	-		X
Malvaceae	*Sida rhombifolia**	-	-	-	-	X	X
Malvaceae	*Sterculia quadrifida*	LC	-	-	-		X
Meliaceae	*Melia azedarach*	LC	-	-	-	X	X
Meliaceae	*Owenia venosa*	LC	-	-	-		X
Menispermaceae	*Hypserpa decumbens*	LC	-	-	-	X	X

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Menyanthaceae	*Nymphoides indica*	LC	-	-	-		X
Mimosaceae	*Acacia amblygona*	LC	-	-	-	X	
Mimosaceae	*Acacia bakeri*	LC	-	-	-		X
Mimosaceae	*Acacia complanata*	LC	-	-	-	X	X
Mimosaceae	*Acacia disparrima*	LC	-	-	-	X	X
Mimosaceae	*Acacia falcata*	LC	-	-	-	X	X
Mimosaceae	*Acacia fimbriata*	LC	-	-	-	X	X
Mimosaceae	*Acacia leiocalyx*	LC	-	-	-	X	X
Mimosaceae	*Acacia leiocalyx subsp. herveyensis*	LC	-	-	-	X	X
Mimosaceae	*Acacia maidenii*	LC	-	-	-	X	X
Mimosaceae	*Acacia melanoxylon*	LC	-	-	-	X	
Mimosaceae	*Acacia oshanesii*	LC	-	-	-	X	X
Mimosaceae	*Acacia penninervis var. penninervis*	LC	-	-	-	X	
Mimosaceae	*Acacia ulicifolia*	LC	-	-	-	X	
Mimosaceae	*Leucaena leucocephala subsp. leucocephala**	-	-	-	-	X	X
Monimiaceae	*Wilkiea macrophylla*	LC	-	-	-		X
Moraceae	*Ficus coronata*	LC	-	-	-	X	X
Moraceae	*Ficus macrophylla forma macrophylla*	LC	-	-	-	X	X
Moraceae	*Ficus obliqua*	LC	-	-	-	X	X
Moraceae	*Ficus opposita*	LC	-	-	-		X
Moraceae	*Ficus watkinsiana*	LC	-	-	-	X	
Moraceae	*Maclura cochinchinensis*	LC	-	-	-	X	X
Moraceae	*Streblus brunonianus*	LC	-	-	-	X	X
Moraceae	*Trophis scandens subsp. scandens*	LC	-	-	-	X	X
Myrsinaceae	*Embelia australiana*	LC	-	-	-	X	X
Myrsinaceae	*Myrsine angusta*	LC	-	-	-		X
Myrsinaceae	*Myrsine variabilis*	LC	-	-	-	X	X
Myrtaceae	*Acmena smithii*	LC	-	-	-	X	X
Myrtaceae	*Angophora leiocarpa*	LC	-	-	-	X	X
Myrtaceae	*Angophora subvelutina*	LC	-	-	-	X	X
Myrtaceae	*Archirhodomyrtus beckleri*	LC	-	-	-	X	
Myrtaceae	*Backhousia myrtifolia*	LC	-	-	-	X	X
Myrtaceae	*Corymbia citriodora*	LC	-	-	-	X	
Myrtaceae	*Corymbia citriodora subsp. variegata*	LC	-	-	-	X	X
Myrtaceae	*Corymbia intermedia*	LC	-	-	-	X	X
Myrtaceae	*Corymbia tessellaris*	LC	-	-	-	X	X
Myrtaceae	*Corymbia torelliana*	LC	-	-	-	X	X
Myrtaceae	*Corymbia trachyphloia subsp. trachyphloia*	LC	-	-	-	X	
Myrtaceae	*Eucalyptus acmenoides*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus cloeziana*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus crebra*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus exserta*	LC	-	-	-	X	
Myrtaceae	*Eucalyptus fibrosa subsp. fibrosa*	LC	-	-	-	X	X

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Myrtaceae	*Eucalyptus grandis*	LC				X	X
Myrtaceae	*Eucalyptus longirostrata*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus microcorys*	LC	-	-	-	X	
Myrtaceae	*Eucalyptus moluccana*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus propinqua*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus racemosa subsp. racemosa*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus siderophloia*	LC	-	-	-	X	X
Myrtaceae	*Eucalyptus tereticornis subsp. tereticornis*	LC	-	-	-	X	X
Myrtaceae	*Gossia bidwillii*	LC	-	-	-		X
Myrtaceae	*Leptospermum polygalifolium*	LC	-	-	-	X	X
Myrtaceae	*Lophostemon confertus*	LC	-	-	-	X	X
Myrtaceae	*Lophostemon suaveolens*	LC	-	-	-	X	X
Myrtaceae	*Melaleuca salicina*	LC	-	-	-	X	X
Myrtaceae	*Melaleuca styphelioides*	LC	-	-	-	X	
Myrtaceae	*Melaleuca viminalis*	LC	-	-	-	X	
Myrtaceae	*Pilidiostigma rhytispermum*	LC	-	-	-	X	X
Myrtaceae	*Rhodamnia dumicola*	LC	-	-	-		X
Myrtaceae	*Rhodamnia rubescens*	LC	-	-	-	X	
Myrtaceae	*Rhodomyrtus psidioides*	LC	-	-	-	X	X
Myrtaceae	*Syncarpia glomulifera subsp. glomulifera*	LC	-	-	-	X	X
Myrtaceae	*Syzygium australe*	LC	-	-	-	X	
Myrtaceae	*Syzygium oleosum*	LC	-	-	-	X	
Myrtaceae	*Tristaniopsis laurina*	LC	-	-	-	X	X
Myrtaceae	*Waterhousea floribunda*	LC	-	-	-	X	X
Myrtaceae	*Xanthostemon oppositifolius* (planted specimen)	V	V	-	-	X	
Ochnaceae	*Ochna serrulata**		-	-	-	X	X
Oleaceae	*Jasminum simplicifolium*	LC	-	-	-	X	X
Oleaceae	*Ligustrum lucidum**	-	-	*3	-	X	X
Oleaceae	*Ligustrum sinense**	-	-	*3	-	X	X
Oleaceae	*Notelaea longifolia*	LC	-	-	-	X	X
Oleaceae	*Olea paniculata*	LC	-	-	-	X	
Onagraceae	*Ludwigia octovalvis*	LC	-	-	-	X	
Onagraceae	*Oenothera lindheimeri**	-	-	-	-	X	
Oxalidaceae	*Oxalis corniculata**	-	-	-	-	X	X
Oxalidaceae	*Oxalis exilis*	LC	-	-	-		X
Passifloraceae	*Passiflora aurantia*	LC	-	-	-	X	X
Passifloraceae	*Passiflora edulis**	-	-	-	-	X	
Passifloraceae	*Passiflora foetida**	-	-	-	-	X	X
Passifloraceae	*Passiflora suberosa**	-	-	-	-	X	X
Passifloraceae	*Passiflora subpeltata**	-	-	-	-	X	
Petiveriaceae	*Rivina humilis**	-	-	-	-	X	X
Phyllanthaceae	*Breynia oblongifolia*	LC	-	-	-	X	X
Phyllanthaceae	*Bridelia exaltata*	LC	-	-	-		X
Phyllanthaceae	*Glochidion ferdinandi*	LC	-	-	-	X	X
Phyllanthaceae	*Glochidion sumatranum*	LC	-	-	-	X	X

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Phyllanthaceae	*Phyllanthus fuernrohrii*	LC	-	-	-	X	X
Phyllanthaceae	*Phyllanthus gunnii*	LC	-	-	-		X
Phyllanthaceae	*Phyllanthus microcladus*	LC	-	-	-	X	X
Phyllanthaceae	*Phyllanthus similis*	LC	-	-	-	X	X
Phyllanthaceae	*Phyllanthus virgatus*	LC	-	-	-	X	X
Picrodendraceae	*Petalostigma pubescens*	LC	-	-	-		X
Picrodendraceae	*Petalostigma triloculare*	LC	-	-	-	X	X
Pittosporaceae	*Pittosporum multiflorum*	LC	-	-	-	X	X
Pittosporaceae	*Pittosporum revolutum*	LC	-	-	-	X	X
Plantaginaceae	*Scoparia dulcis**	-	-	-	-	X	
Plantaginaceae	*Veronica plebeia*	LC	-	-	-		X
Polygalaceae	*Polygala triflora*	LC	-	-	-		X
Polygalaceae	*Polygala virgata**	-	-	-	-		X
Polygonaceae	*Persicaria decipiens*	LC	-	-	-	X	
Polygonaceae	*Persicaria orientalis*	LC	-	-	-		X
Polygonaceae	*Persicaria strigosa*	LC	-	-	-	X	
Polygonaceae	*Muehlenbeckia gracillima*	LC	-	-	-	X	
Proteaceae	*Banksia integrifolia*	LC	-	-	-	X	X
Proteaceae	*Grevillea baileyana*	LC	-	-	-	X	
Proteaceae	*Grevillea hilliana*	LC	-	-	-		X
Proteaceae	*Grevillea robusta*	LC	-	-	-	X	X
Proteaceae	*Stenocarpus sinuatus*	LC	-	-	-	X	X
Putranjivaceae	*Drypetes deplanchei*	LC	-	-	-		X
Rhamnaceae	*Alphitonia excelsa*	LC	-	-	-	X	X
Ripogonaceae	*Ripogonum discolor*	LC	-	-	-	X	X
Rosaceae	*Rubus moluccanus*	LC	-	-	-	X	
Rosaceae	*Rubus parvifolius*	LC	-	-	-	X	X
Rubiaceae	*Atractocarpus chartaceus*	LC	-	-	-	X	X
Rubiaceae	*Coelospermum paniculatum*	LC	-	-	-		X
Rubiaceae	*Cyclophyllum longipetalum*	LC	-	-	-	X	X
Rubiaceae	*Cyclophyllum coprosmoides*	LC	-	-	-	X	
Rubiaceae	*Everistia vacciniifolia var. nervosa*	LC	-	-	-	X	X
Rubiaceae	*Morinda jasminoides*	LC	-	-	-	X	X
Rubiaceae	*Pavetta australiensis*	LC	-	-	-	X	X
Rubiaceae	*Pomax umbellata*	LC	-	-	-	X	X
Rubiaceae	*Psychotria daphnoides*	LC	-	-	-	X	X
Rubiaceae	*Psychotria loniceroides*	LC	-	-	-		X
Rubiaceae	*Psydrax odorata*	LC	-	-	-	X	X
Rubiaceae	*Richardia brasiliensis**	-	-	-	-	X	X
Rubiaceae	*Triflorensia cameronii*	LC	-	-	-		X
Rutaceae	*Acronychia laevis*	LC	-	-	-	X	X
Rutaceae	*Acronychia oblongifolia*	LC	-	-	-	X	X
Rutaceae	*Acronychia pauciflora*	LC	-	-	-		X
Rutaceae	*Citrus australis*	LC	-	-	-		X
Rutaceae	*Citrus limon**	-	-	-	-	X	
Rutaceae	*Flindersia australis*	LC	-	-	-	X	X
Rutaceae	*Flindersia bennettiana*	LC	-	-	-	X	X
Rutaceae	*Flindersia collina*	LC	-	-	-		X
Rutaceae	*Flindersia schottiana*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Rutaceae	*Flindersia xanthoxyla*	LC	-	-	-		X
Rutaceae	*Melicope hayesii*	LC	-	-	-	X	X
Rutaceae	*Melicope micrococca*	LC	-	-	-		X
Rutaceae	*Pentaceras australe*	LC	-	-	-		X
Rutaceae	*Sarcomelicope simplicifolia*	LC	-	-	-		X
Rutaceae	*Zieria minutiflora subsp. minutiflora*	LC	-	-	-	X	X
Rutaceae	*Zieria smithii*	LC	-	-	-	X	X
Sapindaceae	*Alectryon connatus*	LC	-	-	-	X	X
Sapindaceae	*Alectryon reticulatus*	LC	-	-	-		X
Sapindaceae	*Cupaniopsis parvifolia*	LC	-	-	-	X	X
Sapindaceae	*Cupaniopsis serrata*	LC	-	-	-		X
Sapindaceae	*Dodonaea triquetra*	LC	-	-	-	X	X
Sapindaceae	*Elattostachys bidwillii*	LC	-	-	-		X
Sapindaceae	*Guioa acutifolia*	LC	-	-	-		X
Sapindaceae	*Guioa semiglauca*	LC	-	-	-	X	X
Sapindaceae	*Harpullia hillii*	LC	-	-	-	X	
Sapindaceae	*Jagera pseudorhus var. pseudorhus*	LC	-	-	-	X	X
Sapindaceae	*Mischocarpus australis*	LC	-	-	-	X	X
Sapindaceae	*Toechima tenax*	LC	-	-	-		X
Sapotaceae	*Planchonella cotinifolia*	LC	-	-	-		X
Sapotaceae	*Planchonella queenslandica*	LC	-	-	-		X
Sapotaceae	*Planchonella pohlmaniana*	LC	-	-	-		X
Scrophulariaceae	*Artanema fimbriatum*	LC	-	-	-	X	X
Scrophulariaceae	*Eremophila debilis*	LC	-	-	-	X	X
Scrophulariaceae	*Myoporum acuminatum*	LC	-	-	-	X	
Solanaceae	*Solanum densevestitum*	LC	-	-	-	X	
Solanaceae	*Solanum gympiense*	LC	-	-	-	X	X
Solanaceae	*Solanum mauritianum**	-	-	-	-	X	X
Solanaceae	*Solanum nigrum**	-	-	-	-	X	X
Solanaceae	*Solanum seaforthianum**	-	-	-	-	X	X
Solanaceae	*Solanum stelligerum**	-	-	-	-		X
Solanaceae	*Solanum torvum**	-	-	-	-	X	X
Sterculiaceae	*Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198)	LC	-	-	-		X
Sterculiaceae	*Brachychiton discolor*	LC	-	-	-		X
Sterculiaceae	*Brachychiton populneus*	LC	-	-	-	X	X
Sterculiaceae	*Sterculia quadrifida*	LC	-	-	-	X	X
Thymelaeaceae	*Wikstroemia indica*	LC	-	-	-	X	
Thymelaeaceae	*Pimelia linifolia*	LC	-	-	-	X	X
Ulmaceae	*Aphananthe philippinensis*	LC	-	-	-	X	X
Ulmaceae	*Celtis sinensis**	-	-	*3	-	X	X
Ulmaceae	*Trema tomentosa var. aspera*	LC	-	-	-	X	X
Verbenaceae	*Duranta erecta**	-	-	-	-	X	X
Verbenaceae	*Lantana camara**	-	-	*3	X	X	X
Verbenaceae	*Lantana montevidensis**	-	-	*3	-	X	X
Verbenaceae	*Verbena bonariensis**	-	-	-	-	X	X
Violaceae	*Hybanthus stellarioides*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Violaceae	*Viola banksii*	LC	-	-	-		X
Violaceae	*Viola hederacea*	LC	-	-	-	X	X
Vitaceae	*Cayratia clematidea*	LC	-	-	-	X	X
Vitaceae	*Cissus antarctica*	LC	-	-	-	X	X
Vitaceae	*Clematicissus opaca*	LC	-	-	-	X	X
Myoporaceae	*Myoporum acuminatum*	LC	-	-	-	X	
Primulaceae	*Myrsine angusta*	LC	-	-	-	X	X
Lower dicots							
Aristolochiaceae	*Aristolochia elegans**	-	-	-	-	X	
Aristolochiaceae	*Aristolochia meridionalis*	LC	-	-	-		X
Lauraceae	*Cassytha filiformis*	LC	-	-	-	X	X
Lauraceae	*Cassytha pubescens*	LC	-	-	-		X
Lauraceae	*Cinnamomum camphora**	-	-	*3	-	X	X
Lauraceae	*Cryptocarya bidwillii*	LC	-	-	-		X
Lauraceae	*Cryptocarya laevigata*	LC	-	-	-		X
Lauraceae	*Cryptocarya sclerophylla*	LC	-	-	-		X
Lauraceae	*Cryptocarya* sp. 'Worlds End Pocket'	LC	-	-	-		X
Lauraceae	*Cryptocarya triplinervis*	LC	-	-	-	X	X
Lauraceae	*Endiandra discolor*	LC	-	-	-	X	X
Lauraceae	*Endiandra muelleri*	LC	-	-	-	X	X
Lauraceae	*Endiandra virens*	LC	-	-	-	X	
Menispermaceae	*Pleogyne australis*	LC	-	-	-		X
Menispermaceae	*Sarcopetalum harveyanum*	LC	-	-	-	X	X
Menispermaceae	*Stephania japonica var. discolor*	LC	-	-	-	X	X
Menispermaceae	*Tinospora smilacina*	LC	-	-	-	X	
Nymphaeaceae	*Nymphaea capensis*	-	-	-	-		X
Piperaceae	*Peperomia blanda var. floribunda*	LC	-	-	-	X	
Monocots							
Anthericaceae	*Laxmannia gracilis*	LC	-	-	-	X	X
Araceae	*Gymnostachys anceps*	LC	-	-	-	X	X
Arecaceae	*Livistona decora*	LC	-	-	-	X	X
Asparagaceae	*Asparagus aethiopicus**	-	-	*3	X	X	
Asparagaceae	*Asparagus africanus**	-	-	*3	X	X	
Asparagaceae	*Asparagus plumosus**	-	-	*3	X	X	X
Commelinaceae	*Aneilema acuminatum*	LC	-	-	-	X	X
Commelinaceae	*Commelina diffusa*	LC	-	-	-		X
Commelinaceae	*Commelina ensifolia*	LC	-	-	-		X
Commelinaceae	*Pollia macrophylla*	LC	-	-	-	X	
Commelinaceae	*Murdannia graminea*	LC	-	-	-	X	X
Cyperaceae	*Abildgaardia ovata*	LC	-	-	-	X	X
Cyperaceae	*Carex appressa*	LC	-	-	-		X
Cyperaceae	*Cyperus gracilis*	LC	-	-	-	X	X
Cyperaceae	*Cyperus lhotskyanus*	LC	-	-	-		X
Cyperaceae	*Cyperus polystachyos*	LC	-	-	-	X	X
Cyperaceae	*Eleocharis plana*	LC	-	-	-		X
Cyperaceae	*Fimbristylis dichotoma*	LC	-	-	-	X	X
Cyperaceae	*Gahnia aspera*	LC	-	-	-	X	X
Cyperaceae	*Lepidosperma laterale*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Cyperaceae	*Lepironia articulata*	LC	-	-	-		X
Dioscoreaceae	*Dioscorea transversa*	LC	-	-	-	X	X
Hemerocallidaceae	*Dianella caerulea var. vannata*	LC	-	-	-	X	X
Hemerocallidaceae	*Dianella revoluta*	LC	-	-	-	X	X
Hemerocallidaceae	*Geitonoplesium cymosum*	LC	-	-	-	X	X
Juncaceae	*Juncus continuus*	LC	-	-	-	X	X
Laxmanniaceae	*Cordyline rubra*	LC	-	-	-	X	X
Laxmanniaceae	*Eustrephus latifolius*	LC	-	-	-	X	X
Laxmanniaceae	*Lomandra laxa*	LC	-	-	-	X	X
Laxmanniaceae	*Lomandra longifolia*	LC	-	-	-	X	X
Laxmanniaceae	*Lomandra multiflora*	LC	-	-	-		X
Laxmanniaceae	*Thysanotus tuberosus*	LC	-	-	-	X	
Orchidaceae	*Cymbidium canaliculatum*	LC	-	-	-		X
Orchidaceae	*Cymbidium madidum*	LC	-	-	-	X	
Orchidaceae	*Cymbidium suave*	LC	-	-	-	X	X
Orchidaceae	*Dendrobium teretifolium*	LC	-	-	-		X
Orchidaceae	*Dendrobium tetragonum*	LC	-	-	-		X
Orchidaceae	*Dockrillia linguiformis*	LC	-	-	-		X
Orchidaceae	*Geodorum densiflorum*	LC	-	-	-		X
Poaceae	*Aristida gracilipes*	LC	-	-	-	X	X
Poaceae	*Aristida vagans*	LC	-	-	-	X	X
Poaceae	*Axonopus compressus**	-	-	-	-	X	X
Poaceae	*Bothriochloa bladhii*	LC	-	-	-	X	
Poaceae	*Bothriochloa decipiens var. decipiens*	LC	-	-	-	X	X
Poaceae	*Capillipedium spicigerum*	LC	-	-	-	X	X
Poaceae	*Chloris divaricata var. divaricata*	LC	-	-	-	X	
Poaceae	*Chloris gayana**	-	-	-	-	X	X
Poaceae	*Cymbopogon refractus*	LC	-	-	-	X	X
Poaceae	*Cynodon dactylon var. dactylon**	-	-	-	-	X	X
Poaceae	*Digitaria ciliaris**	-	-	-	-	X	
Poaceae	*Digitaria ramularis*	LC	-	-	-	X	X
Poaceae	*Entolasia stricta*	LC	-	-	-	X	X
Poaceae	*Eragrostis curvula**	-	-	-	-	X	
Poaceae	*Eragrostis elongata*	LC	-	-	-	X	X
Poaceae	*Eragrostis spartinoides*	LC	-	-	-	X	
Poaceae	*Eragrostis tenuifolia*	LC	-	-	-	X	
Poaceae	*Eriochloa pseudoacrotricha*	LC	-	-	-	X	
Poaceae	*Imperata cylindrica*	LC	-	-	-	X	X
Poaceae	*Megathyrsus maximus**	-	-	-	-	X	X
Poaceae	*Melinis minutiflora**	-	-	-	-	X	X
Poaceae	*Melinis repens**	-	-	-	-	X	X
Poaceae	*Oplismenus aemulus*	LC	-	-	-	X	X
Poaceae	*Oplismenus hirtellus subsp. imbecillis*	LC	-	-	-	X	X
Poaceae	*Ottochloa gracillima*	LC	-	-	-	X	X
Poaceae	*Panicum effusum*	LC	-	-	-	X	X
Poaceae	*Panicum maximum var. trichoglume*	LC	-	-	-	X	X

Family	Scientific name	Status				Survey	
		NC Act	EPBC Act	LP Act	WoNS	2015	2016
Poaceae	*Panicum queenslandicum*	LC	-	-	-	X	
Poaceae	*Paspalidium distans*	LC	-	-	-	X	X
Poaceae	*Paspalidium gracile*	LC	-	-	-	X	
Poaceae	*Paspalum conjugatum**	-	-	-	-	X	
Poaceae	*Paspalum dilatatum**	-	-	-	-	X	
Poaceae	*Paspalum mandiocanum**	-	-	-	-	X	X
Poaceae	*Paspalum notatum**	-	-	-	-	X	X
Poaceae	*Paspalum scrobiculatum*	LC	-	-	-	X	X
Poaceae	*Paspalum urvillei**	-	-	-	-	X	
Poaceae	*Setaria sphacelata**	-	-	-	-	X	X
Poaceae	*Sporobolus fertilis**	-	-	*2	-	X	X
Poaceae	*Themeda triandra*	LC	-	-	-	X	X
Ripogonaceae	*Ripogonum album*	LC	-	-	-	X	X
Ripogonaceae	*Ripogonum brevifolium*	LC	-	-	-		X
Smilacaceae	*Smilax australis*	LC	-	-	-	X	X
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	LC	-	-	-	X	X
Xanthorrhoeaceae	*Xanthorrhoea latifolia*	LC	-	-	-	X	X
Xanthorrhoeaceae	*Xanthorrhoea macronema*	LC	-	-	-	X	

E = Endangered
V = Vulnerable
LC = Least Concern
*****= naturalised species, exotic or not native to south-east QLD
***2**=Declared Class 2 pest plant under the *Land Protection (Pest and Stock Route Management) Act* (*LP Act)*
***3**=Declared Class 3 pest plant under the *LP Act*
WONS = Weed of National Significance
+ = species identification confirmed through submission of specimen to Queensland Herbarium

APPENDIX B

Marsdenia coronata habitat photos and similar species photos

Photo 1. *Marsdenia coronata* habitat, Meander 1, RE 12.11.5e.

Photo 2. *Marsdenia coronata* habitat, Meander 2, RE 12.11.5e.

Photo 3. *Marsdenia coronata* habitat, Meander 3, RE 12.11.5e.

Photo 3. *Marsdenia coronata* habitat, Meander 5, RE 12.11.5e.

Photo 5. *Marsdenia coronata* habitat, Meander 6, RE 12.9-10.4.

Photo 6. *Marsdenia coronata* habitat, Meander 14, RE 12.11.5e.

Photo 7. *Marsdenia coronata* habitat, Meander 18, RE 12.11.3, upper hillslope.

Photo 8. *Marsdenia coronata* habitat, Meander 18, RE 12.11.3, lower hillslope gully.

Photo 9. *Marsdenia coronata* seedling.

Photo 10. *Marsdenia lloydii* seedling.

Photo 11. *Parsonsia lanceolata* seedling.

Photo 12. *Secamone elliptica* seedling.

APPENDIX C

Threatened Ecological Community Assessment

Appendix C: Assessment summary for a patch of notophyll vine forest vegetation against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community

An approximately 1 ha patch of Regional Ecosystem 12.11.10 (notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics) in the south of the Stage D1 portion of the study area was assessed against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community during a 1.5 hour traverse of the patch by two ecologists on 25/02/2016. The results of this assessment are summarised in **Tables C.1** to **C.3** below.

Table C.1. Notophyll vine forest patch vegetation community details.

Vegetation layer	Height (m)	Dominant species
Assessment site coordinates: 26.241975 S 152.706652 E		
Emergent	35 m	*Araucaria cunninghamii* (d) *Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198) *Pseudoweinmannia lachnocarpa*
Tree1	22 m	*Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198) (d) *Brachychiton discolour* *Planchonella pohlmaniana* *Vitex lignum-vitae*
Tree2	12 m	*Dissiliaria baloghioides* (d) *Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198) *Acacia bakeri* *Polyalthia nitidissima*
Shrub1	3 m	*Dissiliaria baloghioides* *Acronychia pauciflora* *Gossia bidwillii* *Pentaceras australe*
Ground	0.5 m	*Asplenium attenuatum* *Dissiliaria baloghioides* *Arachniodes aristata* Leaf litter (90% cover)

Table C.2. Assessment summary against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community.

TEC criterion	Assessment	Meets criterion?
Key diagnostic characteristics		
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions.	Patch occurs in the South Eastern Queensland bioregion	Yes
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments	Occurs on land zone 11 (soils derived from metamorphic rocks).	Yes
The ecological community generally occurs at an altitude less than 300 m above sea level.	Occurs at an altitude of 100 m	Yes

TEC criterion	Assessment	Meets criterion?
The ecological community typically occurs in areas with high annual rainfall (>1300mm).	Occurs in an area with approximately 1,100 mm mean annual rainfall.	Marginal
The ecological community is typically more than 2 km inland from the coast.	Occurs 36 km inland from the coast.	Yes
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	Occurs as a tall closed forest with multiple tree layers (see **Table C.1**).	Yes
Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A).	The patch has high species richness (at least 96 native species), including 38 species from Appendix A (see **Table C.3**).	Yes
Condition thresholds		
Patch Type (evidence of remnant vegetation & regeneration status)	Natural remnant evident by the persistence of mature residual trees from Appendix B. AND	Yes
Patch Size (excludes buffer zone)	≥ 0.1 ha AND	Yes, 1 ha.
Canopy Cover (over entire patch)	Emergent/canopy/subcanopy cover is ≥ 70% AND	Yes, ≥ 90%
Species Richness (over entire patch)	Contains ≥ 40 native woody species from Appendix A AND	No, contains 38 species from Appendix A (see **Table C.3**).
Percent of total vegetation cover that is native (use sample plot)	≥70% of vegetation is native	Yes

Table C.3. Notophyll vine forest patch flora species list.

Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Mimosaceae	*Acacia bakeri*	LC	-	-	-	X
Rutaceae	*Acronychia laevis*	LC	-	-	-	
Rutaceae	*Acronychia pauciflora*	LC	-	-	-	
Euphorbiaceae	*Actephila lindleyi*	LC	-	-	-	X
Euphorbiaceae	*Alchornea ilicifolia*	LC	-	-	-	
Sapindaceae	*Alectryon reticulatus*	LC	-	-	-	
Rhamnaceae	*Alphitonia excelsa*	LC	-	-	-	X
Apocynaceae	*Alyxia ruscifolia*	LC	-	-	-	
Ulmaceae	*Aphananthe philippinensis*	LC	-	-	-	X
Dryopteridaceae	*Arachniodes aristata*	LC	-	-	-	
Araucariaceae	*Araucaria cunninghamii*	LC	-	-	-	X
Sterculiaceae	*Argyrodendron* sp. (Kin Kin W.D.Francis AQ81198)	LC	-	-	-	

Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Tectariaceae	*Arthropteris tenella*	LC	-	-	-	
Aspleniaceae	*Asplenium attenuatum*	LC	-	-	-	
Aspleniaceae	*Asplenium australasicum*	LC	-	-	-	X
Rubiaceae	*Atractocarpus chartaceus*	LC	-	-	-	X
Sterculiaceae	*Brachychiton discolor*	LC	-	-	-	
Phyllanthaceae	*Breynia oblongifolia*	LC	-	-	-	X
Phyllanthaceae	*Bridelia exaltata*	LC	-	-	-	X
Arecaceae	*Calamus muelleri*	LC	-	-	-	X
Capparaceae	*Capparis arborea*	LC	-	-	-	X
Capparaceae	*Capparis sarmentosa*	LC	-	-	-	
Caesalpiniaceae	*Cassia tomentella*	LC	-	-	-	
Vitaceae	*Cissus antarctica*	LC	-	-	-	X
Rutaceae	*Citrus australis*	LC	-	-	-	
Euphorbiaceae	*Cleistanthus cunninghamii*	LC	-	-	-	X
Lamiaceae	*Clerodendrum floribundum*	LC	-	-	-	X
Laxmanniaceae	*Cordyline rubra*	LC	-	-	-	X
Euphorbiaceae	*Croton insularis*	LC	-	-	-	
Euphorbiaceae	*Croton stigmatosus*	LC	-	-	-	
Lauraceae	*Cryptocarya laevigata*	LC	-	-	-	
Lauraceae	*Cryptocarya sclerophylla*	LC	-	-	-	
Lauraceae	*Cryptocarya* sp. 'Worlds End Pocket'	LC	-	-	-	
Lauraceae	*Cryptocarya triplinervis*	LC	-	-	-	
Sapindaceae	*Cupaniopsis serrata*	LC	-	-	-	X
Rubiaceae	*Cyclophyllum longipetalum*	LC	-	-	-	
Orchidaceae	*Dendrobium teretifolium*	LC	-	-	-	
Orchidaceae	*Dendrobium tetragonum*	LC	-	-	-	
Fabaceae	*Derris involuta*	LC	-	-	-	
Dioscoreaceae	*Dioscorea transversa*	LC	-	-	-	X
Ebenaceae	*Diospyros fasciculosa*	LC	-	-	-	
Ebenaceae	*Diospyros geminata*	LC	-	-	-	
Euphorbiaceae	*Dissiliaria baloghioides*	LC	-	-	-	
Blechnaceae	*Doodia aspera*	LC	-	-	-	
Putranjivaceae	*Drypetes deplanchei*	LC	-	-	-	
Erythroxylaceae	*Erythroxylum* sp. Splityard Creek (L.Pedley 5360)	LC	-	-	-	
Rutaceae	*Flindersia australis*	LC	-	-	-	X
Rutaceae	*Flindersia bennettiana*	LC	-	-	-	
Rutaceae	*Flindersia xanthoxyla*	LC	-	-	-	X
Hemerocallidaceae	*Geitonoplesium cymosum*	LC	-	-	-	X
Myrtaceae	*Gossia bidwillii*	LC	-	-	-	X
Proteaceae	*Grevillea hilliana*	LC	-	-	-	X
Proteaceae	*Grevillea robusta*	LC	-	-	-	X
Sapindaceae	*Guioa semiglauca*	LC	-	-	-	X
Acanthaceae	*Harnieria hygrophiloides*	LC	-	-	-	
Sapindaceae	*Jagera pseudorhus* var. *pseudorhus*	LC	-	-	-	X
Oleaceae	*Jasminum simplicifolium*	LC	-	-	-	
Verbenaceae	*Lantana camara**	-	-	*3	X	
Myrtaceae	*Lophostemon confertus*	LC	-	-	-	X

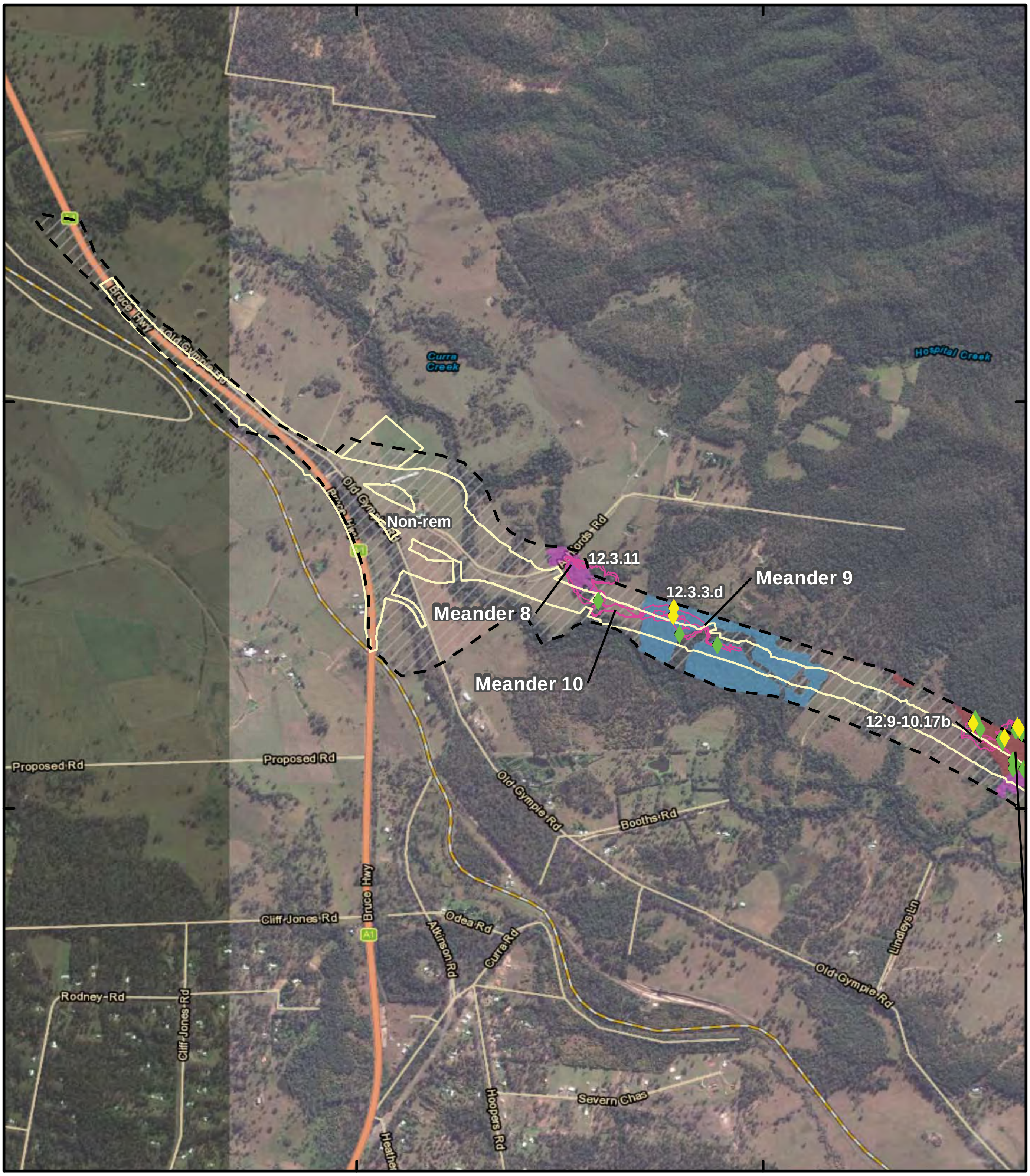
Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Euphorbiaceae	*Mallotus philippensis*	LC	-	-	-	X
Apocynaceae	*Marsdenia microlepis*	LC	-	-	-	
Rutaceae	*Melicope micrococca*	LC	-	-	-	X
Annonaceae	*Melodorum leichhardtii*	LC	-	-	-	
Myrsinaceae	*Myrsine variabilis*	LC	-	-	-	
Oleaceae	*Notelaea longifolia*	LC	-	-	-	X
Meliaceae	*Owenia venosa*	LC	-	-	-	
Bignoniaceae	*Pandorea jasminoides*	LC	-	-	-	
Apocynaceae	*Parsonsia paulforsteri*	LC	-	-	-	
Apocynaceae	*Parsonsia velutina*	LC	-	-	-	
Pteridaceae	*Pellaea paradoxa*	LC	-	-	-	
Rutaceae	*Pentaceras australe*	LC	-	-	-	X
Pittosporaceae	*Pittosporum multiflorum*	LC	-	-	-	X
Pittosporaceae	*Pittosporum revolutum*	LC	-	-	-	X
Sapotaceae	*Planchonella cotinifolia*	LC	-	-	-	
Sapotaceae	*Planchonella pohlmaniana*	LC	-	-	-	
Sapotaceae	*Planchonella queenslandica*	LC	-	-	-	
Polypodiaceae	*Platycerium superbum*	LC	-	-	-	X
Menispermaceae	*Pleogyne australis*	LC	-	-	-	
Annonaceae	*Polyalthia nitidissima*	LC	-	-	-	
Araliaceae	*Polyscias elegans*	LC	-	-	-	X
Cunoniaceae	*Pseudoweinmannia lachnocarpa*	LC	-	-	-	
Rubiaceae	*Psychotria daphnoides*	LC	-	-	-	
Rubiaceae	*Psychotria loniceroides*	LC	-	-	-	
Rubiaceae	*Psydrax odorata*	LC	-	-	-	
Myrtaceae	*Rhodamnia dumicola*	LC	-	-	-	
Ripogonaceae	*Ripogonum brevifolium*	LC	-	-	-	
Petiveriaceae	*Rivina humilis**	-	-	-	-	
Rutaceae	*Sarcomelicope simplicifolia*	LC	-	-	-	X
Smilacaceae	*Smilax australis*	LC	-	-	-	X
Proteaceae	*Stenocarpus sinuatus*	LC	-	-	-	
Malvaceae	*Sterculia quadrifida*	LC	-	-	-	
Loganiaceae	*Strychnos axillaris*	LC	-	-	-	
Apocynaceae	*Tabernaemontana pandacaqui*	LC	-	-	-	X
Sapindaceae	*Toechima tenax*	LC	-	-	-	
Rubiaceae	*Triflorensia cameronii*	LC	-	-	-	X
Moraceae	*Trophis scandens* subsp. *scandens*	LC	-	-	-	
Lamiaceae	*Vitex lignum-vitae*	LC	-	-	-	
Monimiaceae	*Wilkiea macrophylla*	LC	-	-	-	

E = Endangered
V = Vulnerable
LC = Least Concern
*****= naturalised species, exotic or not native to south-east QLD
***2**=Declared Class 2 pest plant under the *Land Protection (Pest and Stock Route Management) Act* (*LP Act)*
***3**=Declared Class 3 pest plant under the *LP Act*
WONS = Weed of National Significance

APPENDIX D

Locations of key habitat features recorded opportunistically

Latitude	Longitude	Habitat feature
-26.065168	152.611508	Hollow-bearing log
-26.235585	152.702819	Hollow-bearing tree
-26.235679	152.702933	Hollow-bearing tree
-26.235771	152.703041	Hollow-bearing tree
-26.23613	152.703297	Hollow-bearing tree
-26.116859	152.650513	Hollow-bearing tree
-26.058168	152.593237	Hollow-bearing tree
-26.059547	152.596577	Hollow-bearing tree
-26.059974	152.598114	Hollow-bearing tree
-26.065283	152.61162	Hollow-bearing tree
-26.065187	152.611278	Hollow-bearing tree
-26.063578	152.610609	Hollow-bearing tree
-26.063468	152.61052	Hollow-bearing tree
-26.063498	152.610359	Hollow-bearing tree
-26.063952	152.609819	Hollow-bearing tree
-26.063012	152.608712	Hollow-bearing tree
-26.063423	152.608899	Hollow-bearing tree
-26.064703	152.610253	Hollow-bearing tree
-26.06485	152.610351	Hollow-bearing tree
-26.065044	152.610247	Hollow-bearing tree
-26.065047	152.61069	Hollow-bearing tree
-26.071287	152.622912	Hollow-bearing tree
-26.219366	152.702758	Hollow-bearing tree
-26.063839	152.609746	Hollow-bearing tree
-26.05879	152.596309	Hollow-bearing log
-26.058457	152.596347	Hollow-bearing log
-26.064882	152.610934	Hollow-bearing log
-26.063407	152.610525	Hollow-bearing log
-26.063321	152.610435	Hollow-bearing log
-26.063787	152.609912	Hollow-bearing log
-26.063178	152.608616	Hollow-bearing log
-26.070724	152.620987	Hollow-bearing log
-26.211615	152.702689	Log pile
-26.213059	152.702336	Log pile
-26.216877	152.702326	Brush-turkey nest mound
-26.242013	152.704896	Brush-turkey nest mound
-26.242115	152.705398	Black-breasted Button-quail (platelets)
-26.241975	152.706652	TEC assessment site



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

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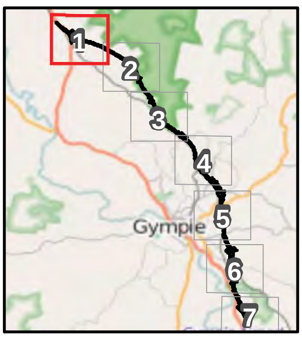

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	**1 (1 of 7) Appendix D**
Title:	Location of other key habitat features recorded opportunistically
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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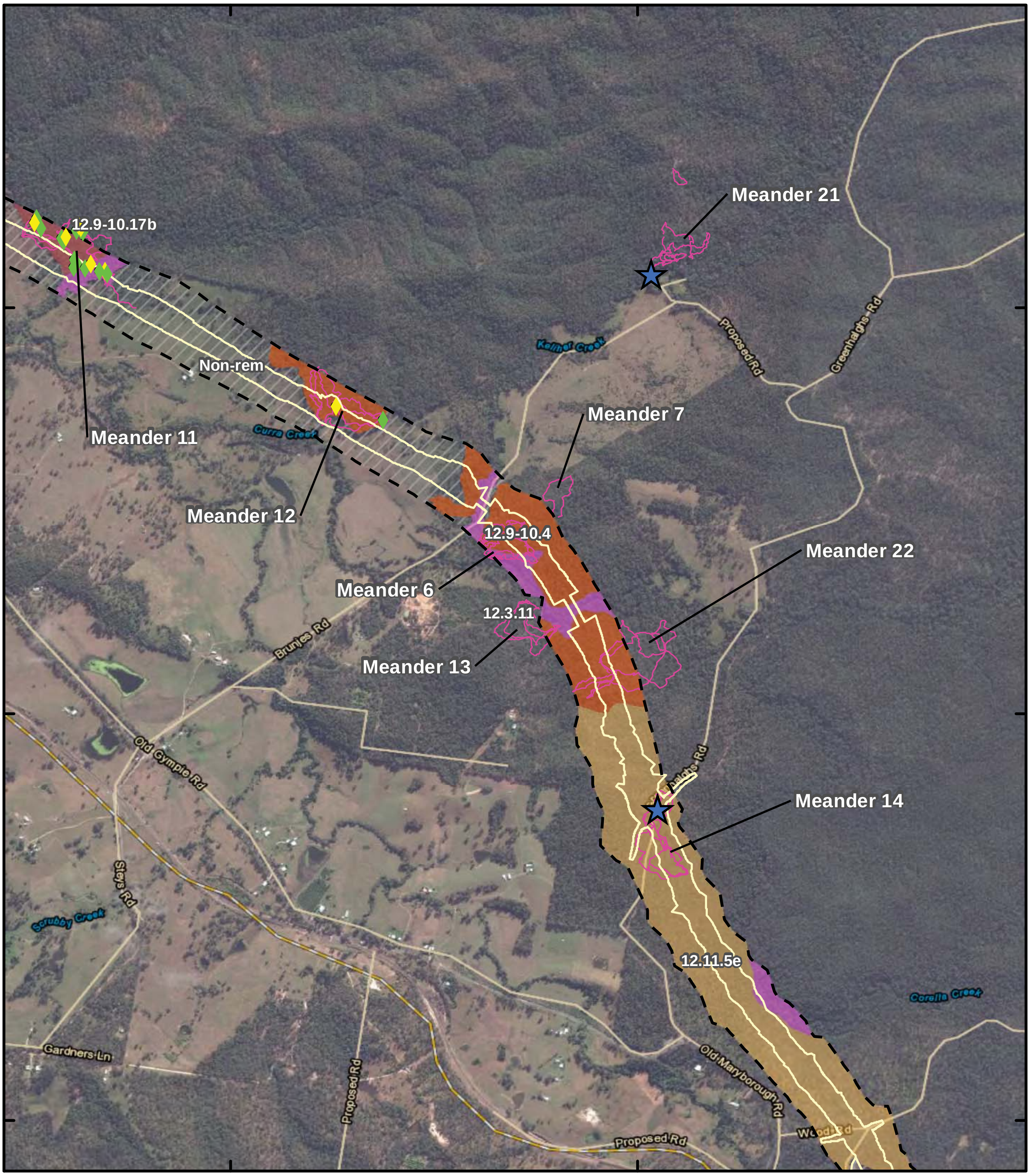
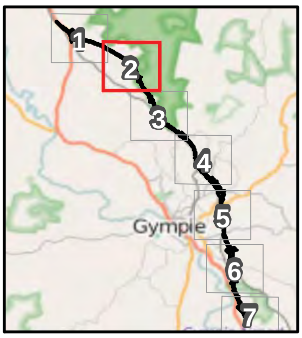


Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers



LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	**1 (2 of 7) Appendix D**
Title:	Location of other key habitat features recorded opportunistically
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

BAAM
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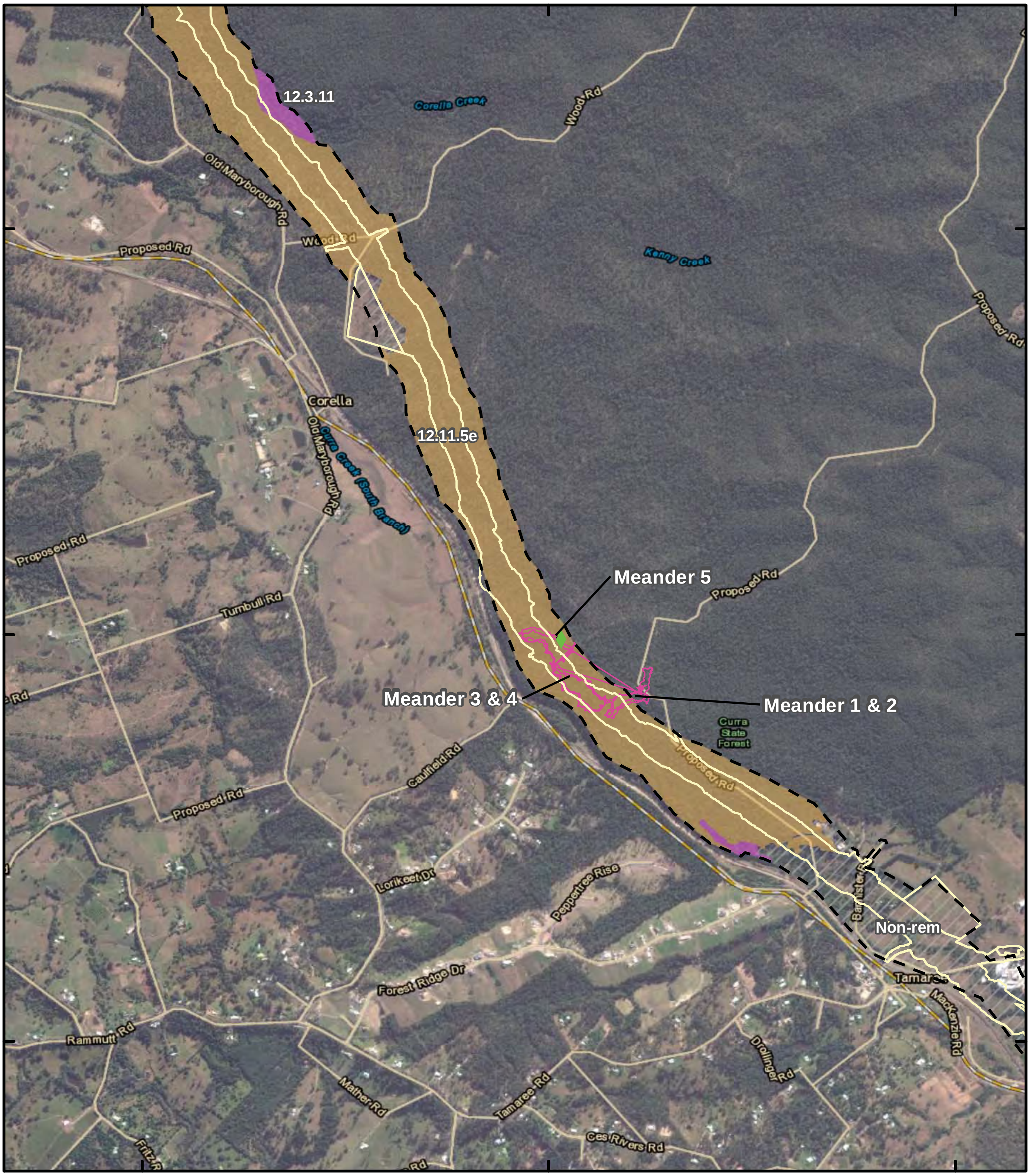
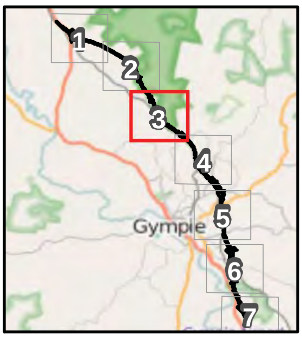


Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers



LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	**1 (3 of 7) Appendix D**
Title:	Location of other key habitat features recorded opportunistically
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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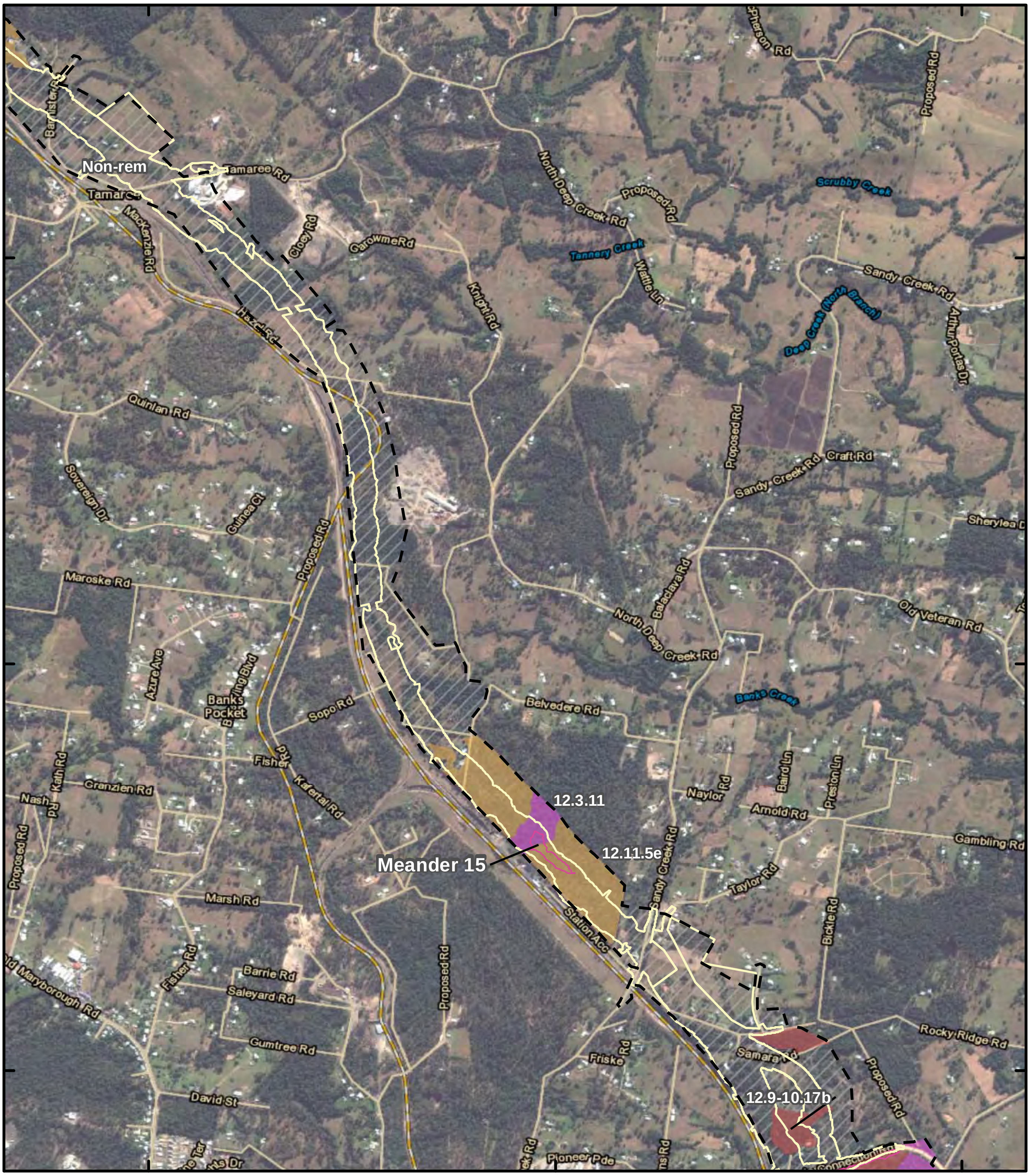

Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

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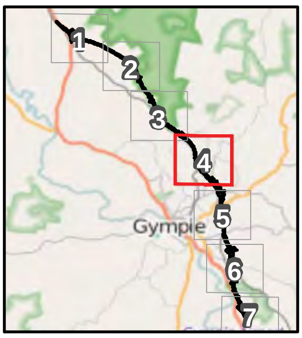

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site

- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG   Reviewed by: PL   Date: 4/04/2016

Figure:	1 (4 of 7) Appendix D
Title:	Location of other key habitat features recorded opportunistically
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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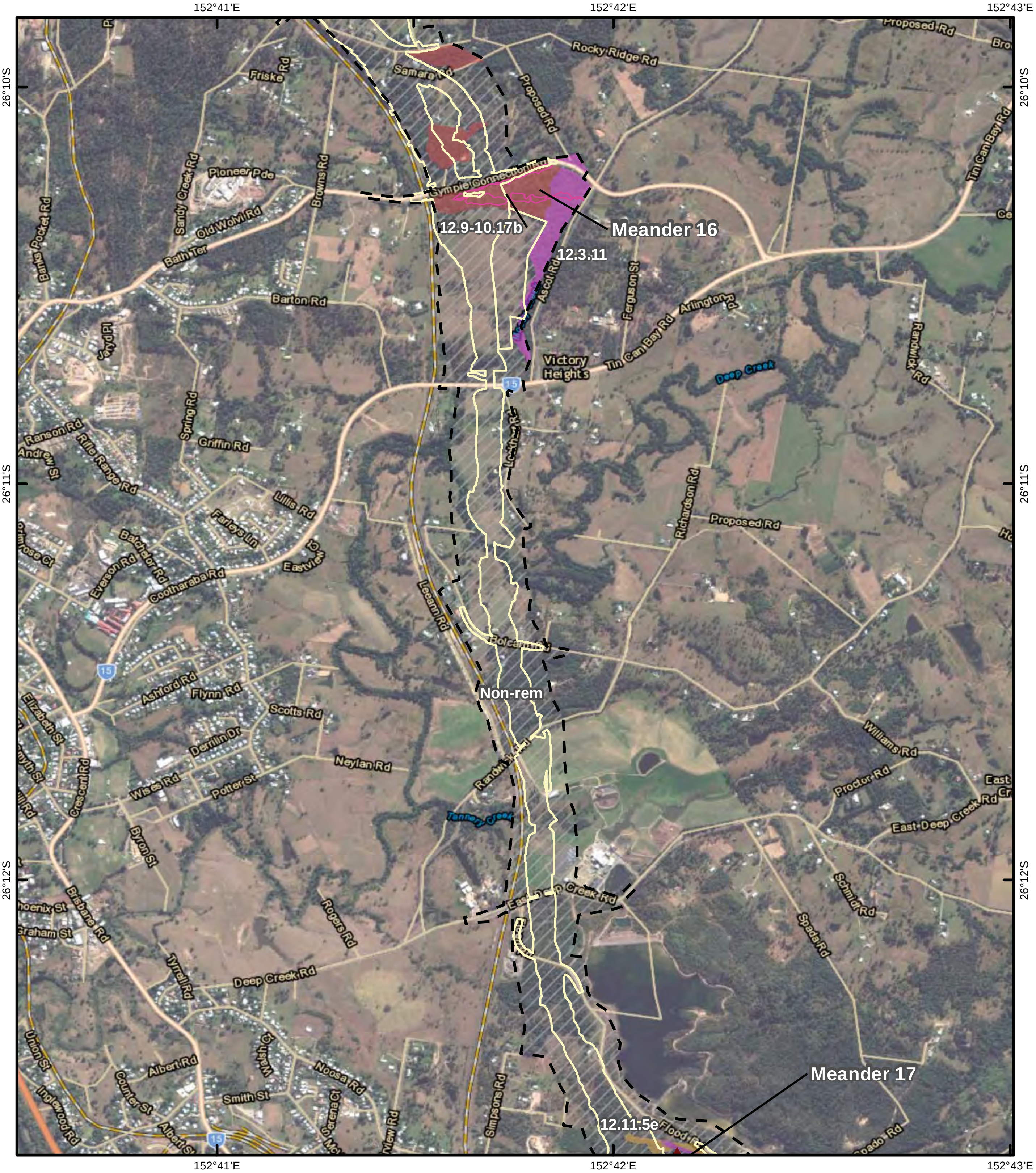
ECOLOGICAL CONSULTANTS

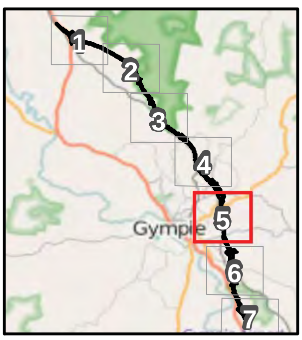


Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers



LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	**1 (5 of 7) Appendix D**
Title:	Location of other key habitat features recorded opportunistically
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

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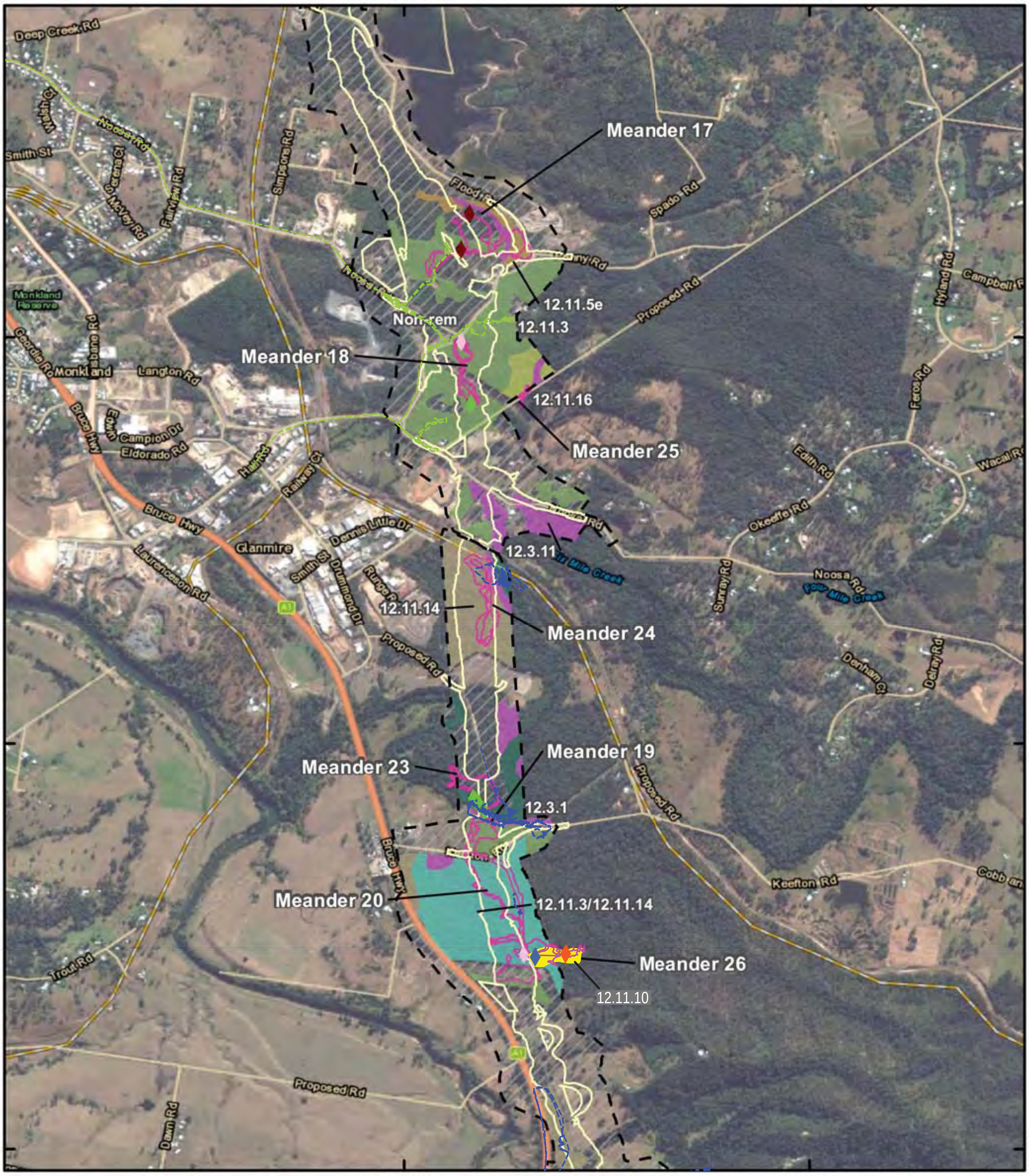


Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

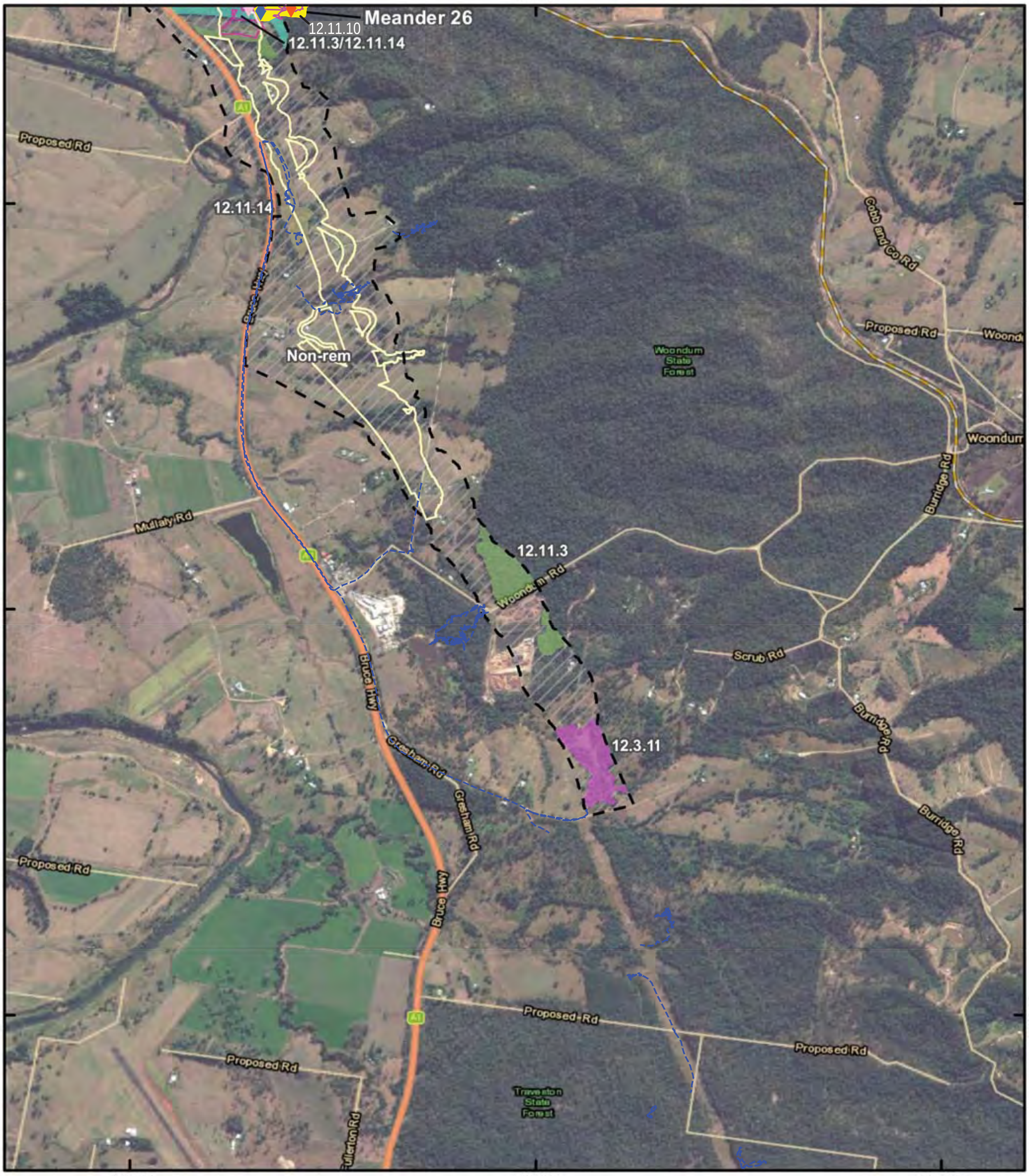
Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem
- 12.11.10

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	1 (6 of 7) Appendix D
Title:	Location of other key habitat features recorded opportunistically
Project:	Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)
Client:	Advisian on behalf of QLD Dept. of Transport and Main Roads

BAAM ECOLOGICAL CONSULTANTS



Notes: imagery sourced from ArcGIS Online (c) 2016

Coordinate System: GCS GDA 1994
Datum: GDA 1994
Units: Degree

1:25,590 at A4

0 0.125 0.25 0.5 0.75 1 Kilometers

LEGEND

- Brush-turkey nest
- Hollow log
- Hollow tree
- Log pile
- Platelets
- TEC assessment site
- *Macrozamia* ALA record
- Study Area
- Project Footprint
- Field Track (2011)
- Field Track (2015)
- Field Track (2016)

Regional Ecosystem

- 12.11.14
- 12.11.16
- 12.11.3
- 12.11.3/12.11.14
- 12.11.5e
- 12.3.1
- 12.3.11
- 12.3.3.d
- 12.3.7
- 12.9-10.17b
- 12.9-10.4
- Non-rem
- 12.11.10

Drawn By: MG Reviewed by: PL Date: 4/04/2016

Figure:	**1 (7 of 7) Appendix D**
Title:	**Location of other key habitat features recorded opportunistically**
Project:	**Detailed Terrestrial Flora Surveys, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)**
Client:	**Advisian on behalf of QLD Dept. of Transport and Main Roads**

BAAM ECOLOGICAL CONSULTANTS

Addendum 1: Summary of survey effort in the Section D study area (2011 to 2016) and details of the Threatened Ecological Community (TEC) assessment of a patch of RE 12.3.1 conducted in 2011.

Flora surveys in the Section D study area that have contributed to the assessment of the occurrence of threatened flora species in this report include the following:

- A flora field survey undertaken over six days from the 5th to the 10th of December 2011 by two ecologists in the Section C study area, which included the southern portion of the current Section D study area (i.e. the portion south of the North Coast railway line). This survey is reported in BAAM (2012), and included completion of 13 secondary and 63 quaternary site surveys following the methodology of Neldner *et al.* (2012) as part of the process of ground-truthing Regional Ecosystems, as well as continuous searches for conservation significant species while traversing the study area over the survey period. The locations of the survey sites from this survey within the current Section D study area are shown in Appendix 7-B of Jacobs (2015), and reflect the mapped survey points south of the North Coast railway line.
- A flora field survey undertaken over six days from the 2nd to the 7th of March 2015 by two ecologists covering the portion of the Section D study area north of the North Coast railway line. This survey is reported in Jacobs (2015) and included completion of 12 secondary, one tertiary and 45 quaternary site surveys as part of the process of ground-truthing Regional Ecosystems, as well as continuous searches for conservation significant species while traversing the study area over the survey period. The locations of the survey sites from this survey are shown in Appendix 7-B of Jacobs (2015), and reflect the mapped survey points north of the North Coast railway line.
- Two sets of protected plant surveys undertaken following the methodology of EHP (2014) conducted by one ecologist at specific geotechnical investigation sites within the Section D study area over the periods 6th to 7th of March 2015 and 5th to 7th of May 2015. These surveys are reported in BAAM (2015 a,b).
- A targeted threatened flora species survey undertaken over four days from the 22nd to 25th February 2016 by two ecologists covering the Section D study area, which is reported on in the current report.

The December 2011 survey identified a narrow riparian patch of RE 12.3.1 (Gallery rainforest (notophyll vine forest) on alluvial plains) along Six Mile Creek. This patch was assessed against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community. The results of this assessment, reproduced from BAAM (2012) and associated data not presented in the BAAM (2012) report are summarised in **Tables A.1** to **A.3** below. The patch was in a relatively degraded condition, largely due to a substantial invasion of Cat's Claw Creeper (*Macfadyena unguis-cati**) (see photo in **Table A1.1** below) and did not meet the condition threshold of ≥ 40 native woody species from Appendix A of the listing advice.

Table A1.1. Gallery rainforest patch vegetation community details.

Vegetation layer	Height (m)	Dominant species
Assessment site coordinates: -26.236312 S 152.704185 E (site S08); -26.226200 S 152.704037 (site S11)		
Emergent		None
Tree1	16-24 m	*Waterhousea floribunda* (d) *Castanospermum australe* *Lophostemon suaveolens*

Tree2	8-17 m	*Cryptocarya triplinervis* *Aphananthe philippinensis* *Streblus brunonianus*
Shrub1	3-6 m	*Atractocarpus chartaceus* *Phyllanthus microcladus*
Ground	0-1 m	*Macfadyena unguis-cati** (d) *Oplismenus* spp. *Lomandra hystrix*

Photo of RE 12.3.1 on Six Mile Creek showing dense ground and vine cover of *Macfadyena unguis-cati** weed.

Table A1.2. Assessment summary against the key diagnostic characteristics and condition thresholds of the *Lowland Rainforest of Subtropical Australia* threatened ecological community.

TEC criterion	**Assessment**	**Meets criterion?**
Key diagnostic characteristics		
Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions.	Patch occurs in the South Eastern Queensland bioregion	Yes
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments	Occurs on land zone 11 (soils derived from metamorphic rocks).	Yes

TEC criterion	**Assessment**	**Meets criterion?**
The ecological community generally occurs at an altitude less than 300 m above sea level.	Occurs at an altitude of 100 m	Yes
The ecological community typically occurs in areas with high annual rainfall (>1300mm).	Occurs in an area with approximately 1,100 mm mean annual rainfall.	Marginal
The ecological community is typically more than 2 km inland from the coast.	Occurs 36 km inland from the coast.	Yes
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	Occurs as a tall closed forest with multiple tree layers (see **Table A1.1**).	Yes
Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A).	The patch has relatively low species richness, including only 38 species from Appendix A (see **Table A1.3**).	Yes
Condition thresholds		
Patch Type (evidence of remnant vegetation & regeneration status)	Natural remnant evident by the persistence of mature residual trees from Appendix B. AND	Yes
Patch Size (excludes buffer zone)	≥ 0.1 ha AND	Yes, ≥ 0.1 ha.
Canopy Cover (over entire patch)	Emergent/canopy/subcanopy cover is ≥ 70% AND	Yes, ≥ 70%
Species Richness (over entire patch)	Contains ≥ 40 native woody species from Appendix A AND	No, contains only 21 species from Appendix A (see **Table A1.3**).
Percent of total vegetation cover that is native (use sample plot)	≥70% of vegetation is native	Yes

Table A1.3. Gallery rainforest patch flora species list.

Family	**Scientific name**	**Status**				**Appendix A species**
		NC Act	**EPBC Act**	**LP Act**	**WoNS**	
Mimosaceae	*Acacia bakeri*	LC	-	-	-	X
Rutaceae	*Acronychia oblongifolia*	LC	-	-	-	
Adiantaceae	*Adiantum diaphanum*	LC	-	-	-	
Adiantaceae	*Adiantum hispidulum*	LC	-	-	-	
Asteraceae	*Ageratum houstonianum**	-	-	-	-	
Euphorbiaceae	*Alchornea ilicifolia*	LC	-	-	-	
Commelinaceae	*Aneilema biflorum*	LC	-	-	-	
Ulmaceae	*Aphananthe philippinensis*	LC	-	-	-	X
Sterculiaceae	*Argyrodendron trifoliatum*	LC	-	-	-	X

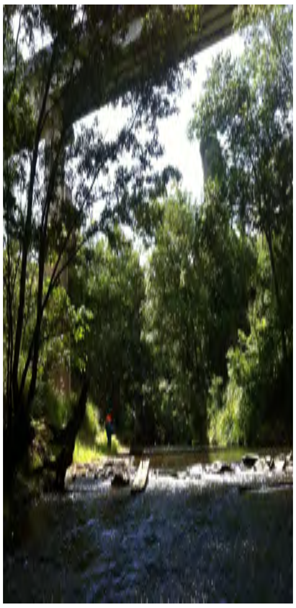
Family	Scientific name	Status				Appendix A species
		NC Act	EPBC Act	LP Act	WoNS	
Sapindaceae	*Arytera foveolata*	LC	-	-	-	
Rubiaceae	*Atractocarpus chartaceus*	LC	-	-	-	X
Burseraceae	*Canarium australasicum*	LC	-	-	-	
Cyperaceae	*Carex appressa*	LC	-	-	-	
Fabaceae	*Castanospermum australe*	LC	-	-	-	X
Ulmaceae	*Celtis sinensis**	-	-	*3	-	
Asteraceae	*Centipeda minima subsp. minima*	LC	-	-	-	
Euphorbiaceae	*Cleistanthus cunninghamii*	LC	-	-	-	X
Asteraceae	*Conyza bonariensis**		-	-	-	
Asteraceae	*Crassocephalum crepidioides**		-	-	-	
Lauraceae	*Cryptocarya glaucescens*	LC	-	-	-	
Lauraceae	*Cryptocarya obovata*	LC	-	-	-	X
Lauraceae	*Cryptocarya triplinervis*	LC	-	-	-	
Sapindaceae	*Cupaniopsis parvifolia*	LC	-	-	-	
Cyperaceae	*Cyperus tetraphyllus*	LC	-	-	-	
Thelypteridaceae	*Christella hispidula*	LC	-	-	-	
Blechnaceae	*Doodia caudata*	LC	-	-	-	
Elaeocarpaceae	*Elaeocarpus obovatus*	LC	-	-	-	
Sapindaceae	*Elattostachys bidwillii*	LC	-	-	-	
Myrsinaceae	*Embelia australiana*	LC	-	-	-	
Lauraceae	*Endiandra discolor*	LC	-	-	-	
Lauraceae	*Endiandra muelleri* subsp. *muelleri*	LC	-	-	-	
Apiaceae	*Eryngium expansum*	LC	-	-	-	
Moraceae	*Ficus coronata*	LC	-	-	-	X
Moraceae	*Ficus fraseri*	LC	-	-	-	X
Flagellariaceae	*Flagellaria indica*	LC	-	-	-	
Hemerocallidaceae	*Geitonoplesium cymosum*	LC	-	-	-	X
Phyllanthaceae	*Glochidion ferdinandi*	LC	-	-	-	X
Dennstaedtiaceae	*Hypolepis muelleri*	LC	-	-	-	
Oleaceae	*Ligustrum sinense**	-	-	*3	-	
Laxmanniaceae	*Lomandra hystrix*	LC	-	-	-	
Myrtaceae	*Lophostemon suaveolens*	LC	-	-	-	
Lygodiaceae	*Lygodium japonicum**	LC	-	-	-	
Bignoniaceae	*Macfadyena unguis-cati**	-	-	*3	-	
Euphorbiaceae	*Mallotus claoxyloides*	LC	-	-	-	
Myrtaceae	*Melaleuca saligna*	LC	-	-	-	
Apocynaceae	*Melodinus australis*	LC	-	-	-	X
Sapindaceae	*Mischocarpus australis*	LC	-	-	-	
Rubiaceae	*Morinda umbellata*	LC	-	-	-	X
Ochnaceae	*Ochna serrulata**		-	-	-	
Poaceae	*Oplismenus aemulus*	LC	-	-	-	
Poaceae	*Oplismenus imbecillis*	LC	-	-	-	X
Poaceae	*Oplismenus undulatifolius*	LC	-	-	-	
Apocynaceae	*Parsonsia straminea*	LC	-	-	-	X
Phyllanthaceae	*Phyllanthus microcladus*	LC	-	-	-	X
Pittosporaceae	*Pittosporum revolutum*	LC	-	-	-	X
Menispermaceae	*Pleogyne australis*	LC	-	-	-	
Acanthaceae	*Pseuderanthemum variabile*	LC	-	-	-	

Family	**Scientific name**	**Status**				**Appendix A species**
		NC Act	**EPBC Act**	**LP Act**	**WoNS**	
Rubiaceae	*Psychotria daphnoides*	LC	-	-	-	
Myrtaceae	*Rhodomyrtus psidioides*	LC	-	-	-	
Ripogonaceae	*Ripogonum discolor*	LC	-	-	-	
Menispermaceae	Sarcopetalum harveyanum	LC	-	-	-	
Caesalpiniaceae	*Senna pendula**		-	-	-	
Smilacaceae	*Smilax australis*	LC	-	-	-	X
Solanaceae	*Solanum nigrum**		-	-	-	
Solanaceae	*Solanum seaforthianum**		-	-	-	
Moraceae	*Streblus brunonianus*	LC	-	-	-	X
Apocynaceae	*Tabernaemontana pandacaqui*	LC	-	-	-	X
Poaceae	*Themeda triandra*	LC	-	-	-	
Commelinaceae	*Tradescantia fluminensis**		-	-	-	
Moraceae	*Trophis scandens*	LC	-	-	-	
Violaceae	*Viola hederacea*	LC	-	-	-	
Campanulaceae	*Wahlenbergia gracilis*	LC	-	-	-	
Myrtaceae	*Waterhousea floribunda*	LC	-	-	-	X

E = Endangered
V = Vulnerable
LC = Least Concern
*****= naturalised species, exotic or not native to south-east QLD
***2**=Declared Class 2 pest plant under the *Land Protection (Pest and Stock Route Management) Act* (*LP Act)*
***3**=Declared Class 3 pest plant under the *LP Act*
WONS = Weed of National Significance

Appendix M – *Aquatic Ecology Technical Report, Bruce Highway Cooroy to Curra (Section D: Woondum to Curra)* (GHD, 2016a)







Department of Transport and Main Roads

Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Aquatic Ecology Technical Report

August 2016

Executive summary

The Department of Transport and Main Roads (TMR) is currently progressing the Bruce Highway – Cooroy to Curra (Section D: Woondum to Curra) (Section D project) through the detailed design phase. The Section D project involves the realignment of 26 km of the Bruce Highway between Keefton Road and the township of Curra and includes a bypass of Gympie. The construction of the Section D project will involve a number of waterway crossings and waterway diversions within major and minor tributaries of the Mary River.

Desktop assessments and preliminary field investigations identified that the waterways potentially impacted by the Section D project support a range of aquatic ecological values including aquatic species of State and/or Commonwealth significance. Specifically, the following six conservation significant species have the potential to occur within the Section D project footprint:

- Mary River turtle (*Elusor macrurus*) – endangered (*Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Nature Conservation Act 1992* (NC Act))
- White-throated snapping turtle (*Elseya albagula*) – critically endangered (EPBC Act) and endangered (NC Act)
- Mary River cod (*Maccullochella mariensis*) – endangered (EPBC Act)
- Australian lungfish (*Neoceratodus forsteri*) – vulnerable (EPBC Act)
- Platypus (*Ornithorynchus anatinus*) – special least concern (NC Act)
- Queensland lace plant (*Aponogeton elongates*) – near threatened (NC Act).

Due to the potential and likely impact upon waterways during the construction of the project, a detailed aquatic ecology assessment was deemed necessary to gain a baseline understanding of the waterways and inform the ecological statutory requirements for the project. GHD was commissioned by TMR to undertake a detailed aquatic assessment of the waterways within the Section D project footprint. The detailed aquatic assessment involved aquatic habitat assessments, aquatic flora and fauna surveys and channel morphology surveys.

Aquatic habitat assessments were undertaken to identify whether habitat features present in each of the waterways are likely to support aquatic species of conservation significance, and determine the current level of disturbance within the waterway in its broader catchment. The aquatic habitat assessment survey involved a combination of desktop assessments, detailed habitat assessments, AUSRIVAS habitat assessments and *in situ* water quality sampling.

Aquatic flora and fauna surveys were conducted to identify the presence or absence of conservation significant aquatic species within the Section D project footprint, and describe the diversity of the fish community at waterways in which insufficient information was available. The aquatic fauna and flora surveys involved a combination of desktop assessments; general fish community surveys and targeted flora and fauna surveys for conservation significant species.

General fish community surveys, involving backpack electrofishing, were conducted at four sites to fill spatial gaps in fish community knowledge within the Section D project footprint (i.e. Tannery Creek Downstream, Corella Creek, Unnamed Creek #1 (Lot 889 on CP864404), and Unnamed Creek #2(Lot 889 on CP864404)). The targeted fauna and flora surveys included a range of survey techniques and focused on waterways in which conservation significant species were considered likely to occur (i.e. Six Mile Creek, Deep Creek and Curra Creek). Survey methodology was developed with regard to Commonwealth and State guidelines and included backpack electrofishing, fyke netting, bait trapping, turtle cathedral trapping, dusk platypus surveys, meander surveys and opportunistic sightings.

The aquatic habitat assessments identified that the majority of waterways within the Section D project footprint were ephemeral and generally in moderate to poor condition. Much of the land in the catchment has been deforested and converted to grazing or cropping land. Cattle damage to banks and gully erosion was common at many of the sites. A layer of silt on the substrate was a common occurrence which is indicative of high levels of erosion and sedimentation throughout the catchment. Although riparian vegetation along the banks of the creeks was often dense, it often supported a high diversity and abundance of introduced exotic species. Water quality monitoring indicates that waterways within the Section D project footprint were generally characterised by moderate to high turbidity and low dissolved oxygen levels when compared to the relevant water quality objectives. Waterway barriers were observed at almost all sites monitored consisting of bed level crossings, road crossings and pipe culverts. These structures form a barrier to aquatic fauna movement under normal flow conditions but quickly ‘drown out’ following substantial rainfall.

The detailed aquatic habitat assessments recorded habitat conditions suitable for conservation significant fish, turtles and platypus in all three major creek systems. Six Mile Creek was characterised by pool, run and riffle sequences with a high abundance of in-stream habitat features and intact riparian zone. Six Mile Creek has good connectivity to the Mary River and was determined to have the best habitat condition of all sites assessed. Areas of Deep Creek contained deep pools and high abundance of in-stream habitat features including overhanging vegetation and shade. Curra Creek is an anabranching system with backwaters and lagoons. Key habitat features observed included: deep pools, high abundance of large woody debris and macrophytes. Degradation from land use practises, combined with reduced with connectivity (natural and as a result of waterway barriers) make it less likely that conservation significant species will occur in the sections of Deep Creek and Curra Creek within the Section D project footprint.

The targeted fauna surveys confirmed the presence of the Mary River cod (*Maccullochella mariensis*), within Six Mile Creek and the white-throated snapping turtle (*Elseya albagula*), within Curra Creek. Six Mile Creek is considered habitat critical to the survival of the Mary River cod as the creek is necessary for activities such as foraging, breeding, maintaining genetic diversity and for the long-term maintenance of the species. The results of the habitat assessments and targeted surveys, combined with knowledge of species’ distributions and previous recorded refined the likelihood of occurrence assessment ratings for each conservation significant species predicted to occur within the Section D project footprint. Results of the assessment are detailed in the table below.

Species	Refined likelihood of occurrence			
	Six Mile Creek	Deep Creek	Curra Creek	Minor waterways (AUSRIVAS assessment sites)
Mary River turtle (*Elusor macrurus*)	**Likely to occur** (foraging)	**Potential to occur** (foraging)	**Potential to occur** (foraging)	**Unlikely to occur**
White-throated snapping turtle (*Elseya albagula*)	**Likely to occur** (foraging and low value breeding)	**Potential to occur** (foraging and low value breeding)	**Known to occur** (foraging and low value breeding)	**Unlikely to occur**
Mary River cod (*Maccullochella mariensis*)	**Known to occur** (foraging and breeding)	**Potential to occur** (foraging and breeding)	**Potential to occur** (foraging and breeding)	**Unlikely to occur**
Australian lungfish (*Neoceratodus forsteri*)	**Potential to occur** (foraging)	**Potential to occur** (foraging)	**Potential to occur** (foraging and breeding)	**Unlikely to occur**
Platypus (*Ornithorhynchus anatinus*)	**Potential to occur** (foraging and breeding)	**Known to occur** (foraging and breeding)	**Likely to occur** (foraging and breeding)	**Unlikely to occur**
Queensland lace plant (*Aponogeton elongatus*)	**Unlikely to occur**	**Unlikely to occur**	**Likely to occur**	**Known to occur**

Due to the known and/or likely occurrence of conservation significant species within the Section D project footprint, an assessment of potential impacts associated with project construction and operation, should be undertaken for each species. The assessment should include management actions proposed to avoid or minimise potential direct and indirect impacts to species and their habitat. Assessment of the significance of impacts will be required in accordance with the Department of the Environment and Energy (DEE) significant impact criteria. The results of the significant impact assessment will inform the requirement for referral of the Section D project under the EPBC Act. Given Six Mile Creek supports a number of conservation significant species and is habitat critical to the survival of the species, referral of the Section D project works is likely to be triggered at this location.

Potential breeding habitat for the Mary River cod, Australian lungfish and platypus was confirmed present within the Section D project footprint. A species management program (SMP) should be prepared for these species in accordance with the NC Act. The SMP will detail the management requirements of the project for the protection of the species.

Queensland Department of Agriculture and Fisheries (DAF) *Queensland waterways for waterway barrier works* spatial layer has identified many of the waterways within the Section D project footprint, including Six Mile Creek, Deep Creek and Curra Creek, are important waterways for fish passage. As such, the presence of artificial barriers has the potential to have a major risk of impact on fish movement . The fish community within the Mary River is dominated by potamodromous species, though diadromous species were recorded as present. Upstream and downstream migration within the freshwater environment is an important aspect of the life cycle for many species with movement strongly cued to hydrology. Two of the potadromous species confirmed present within the Section D footprint (i.e. spangled perch (*Leiopotherapon unicolor*) and Mary River cod), undertake particularly long distance migrations within the freshwater environment. Five species confirmed present within the Section D footprint are known to migrate between marine and freshwater environments (i.e. diadromous species). The design of temporary and permanent structures for the Section D project must therefore consider potential impacts on fish movement and avoid increase cumulative impacts on fauna movement.

A morphological survey was undertaken to acquire quantitative and descriptive data on the key physical features along 11 watercourse reaches in close proximity to the Section D project footprint crossing locations. This information will be used to identify potential habitat features for conservation significant species, and to assist in the development of the detailed design for any diversion works. In general, the watercourse reaches surveyed are characterised by low to moderate sinuosity channels with a relatively low width to depth ratio (i.e. relatively narrow and deep channels). Most reaches are set in partly confined valley settings such that a significant length of the channel runs adjacent to the bedrock valley margin. Reaches where the valley margin has limited influence on the channel are Deep Creek, Curra Creek (north), Unnamed Watercourse (Lot 1717 on M37818) and the upstream section of Tamaree Creek. Most reaches are single channel systems with the exception of the Curra Creek (north) and the Unnamed Watercourse (Lot 1717 on M37818) reaches which exhibit secondary channels (anabranches).

The systems are dominated by fine grained sediments (typically fine sand, silt and mud) and generally do not exhibit bed forms typical of gravel and cobble bed river systems such as riffles and bars. Banks are generally steep with well-vegetated convex upper profiles while lower bank profiles are often near vertical and un-vegetated with the change in profile from the upper bank marked by undercutting. The presence and extent of undercutting varies from reach to reach, but is usually located along the outside bank of pool features. In some instances, such as along Deep Creek, the presence of undercutting is the result of the ponding of water at a consistent level upstream of weir structures. Bench features are typically irregular and poorly defined. The more pronounced benches are generally associated with bends in the channel, where higher rates of channel migration have resulted in a wider overall bankfull channel width.

Most reaches are relatively laterally and vertically stable, with evidence of bank erosion typically limited to sections of channel where erosion is generally expected (i.e. outside bank on bends). Reaches with a relatively high level of lateral or vertical instability due to anthropogenic influences are limited to the reach of Moody Creek (north), where four headcuts where identified, and the middle reach of Tamaree Creek, where an existing diversion is experiencing erosion along a section of the right bank. In addition, the reach of Moody Creek (south) exhibits evidence of past channel incision and some localised sections of increased levels of bank erosion.

The results of the morphology assessment can be used to guide the design of any creek diversions required as part of the proposed Section D of the Cooroy to Curra Bruce Highway Upgrade. Key features of the existing creek systems recommended for inclusion in the design form of any diversions include:

- A channel of low to moderate sinuosity and low width to depth ratio (typically 6 to 8).
- Average longitudinal grades in the order of 0.003 to 0.005 m/m. This grade range is based on all creeks with the exception of Six Mile Creek and Curra Creek. Based on the current business case design, it is not expected that these two creeks will be diverted.
- Long pools (30 to 50 m long and up to 8 m wide) with low flow depths in the order of 1 metre separated by shorter sections of vegetated pool crossing (10 to 30 m). In the event any diversion is constructed in bedrock, pool crossing features are unlikely to be viable as their construction would involve placing fill material within the excavated channel and the fill will most likely be eroded out during high flow events. Hence, it would be considered appropriate to incorporate bedrock step type features as the main grade controls through the diversion.
- Along pools, provide convex upper bank profiles with typical grades between 1 in 3 and 1 in 4 and near vertical lower bank profiles to a height equivalent to the level of ponding in pools during low flows. Typically, lower bank profiles display gentler grades at pool crossings and on the inside bank of bends.
- Vegetation to promote bank stability, particularly *Lomandra longifolia* in combination with deeper rooted endemic riparian tree species. Consideration should also be given to replication the structure of nature vegetation canopy layers with respect to position on the bank.
- Floodplains or areas to permit overbank flows to spread and dissipate beyond the channel at a similar flow stage to the bankfull channel capacity of the existing creek system.
- Large woody debris pieces and multi log jams in pools with at least one large log per 10 metres of pool length.

Ultimately the morphology represented in any diversion will be influenced by other factors including geotechnical and topographic conditions along the proposed diversion alignment as well as the necessity to minimise any adverse flood inundation impacts. As a result, it is likely that there will be a trade-off between mimicking the existing morphology of the local creek with considerations to geotechnical, channel stability and hydraulic requirements.

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1. Introduction

1.1 Project overview

The Department of Transport and Main Roads (TMR) is currently progressing the Bruce Highway – Cooroy to Curra (Section D: Traveston to Woondum) (Section D project) towards detailed design. The Section D project involves the realignment of 26 km of the Bruce Highway between Keefton Road and the township of Curra and includes a bypass of Gympie (Figure 1-1). The Section D project forms part of a 61 km upgrade of the Bruce Highway between the townships of Cooroy and Curra and is the final stage of works. The Bruce Highway Upgrade is one of Queensland State Government's highest priority road projects aiming to provide an effective transport link as part of the National highway network and improved safety and flood immunity for all infrastructure users. The key elements of the Section D project include the following infrastructure:

- Approximately 26 kilometres of four lane highway with a posted speed limit of 110 km/h and directional separation from Woondum Interchange to Curra
- Integration with the Woondum Interchange at the northern extremity of the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) project and major interchanges at Penny Road, Gympie Connection Road and Curra
- Bridge structures over major waterways
- Major crossing structures at several local roads and the North Coast Railway
- Several connections and alterations to the existing local road network
- Acquisition of a corridor to ultimately accommodate a six lane divided carriageway
- Acquisition of approximately 13 hectares of Woondum State Forest and 91 hectares of Curra State Forest, which will be converted to road tenure.

The 'Section D project footprint' is referred to throughout this report and is based on the proposed alignment as of January 2015 completed to preliminary design standard as part of the Options Analysis and Business Case phase of the project. The construction of the Section D project will involve a number of waterway crossings and waterway diversions within major and minor tributaries of the Mary River. Due to the potential and likely impact upon these waterways during the construction of the project a detailed aquatic ecology and geomorphology assessment of these waterways was deemed necessary to gain a baseline understanding of the waterways and inform the ecological statutory requirements for the project. A detailed understanding of the environmental values that have the potential to be impacted by the Section D project has been identified within the Review of Environmental Factors (REF) (Business Case) (Jacobs 2016) as critical to successfully obtaining relevant statutory approvals within the required timeframes.

1.2 Background

The Section D project is primarily located within the lower Mary River drainage sub-basin, with the initial 6 km of the alignment within the upper Mary River drainage sub-basin (Figure 1-2). There are 17 waterways along the length of the alignment, ranging from small ephemeral first order streams to fifth order tributaries of the Mary River (Figure 1-2). The Mary River itself has a total length of approximately 300 km, extending from the Booroobin in the Sunshine Coast Hinterland and discharging into the Great Sandy Strait Ramsar wetland, approximately 142 km downstream from the Section D project (Department of Environment and Heritage Protection (EHP) 2016).

Desktop assessments and preliminary field investigations have identified that the waterways potentially impacted by the Section D project support a range of aquatic ecological values including aquatic species of State and/or Commonwealth significance. The Queensland Department of Agriculture and Fisheries (DAF) has also identified the Mary River and its major tributaries, including Six Mile Creek, Deep Creek and Curra Creek within the Section D project footprint, as important waterways for fish passage. These waterways are mapped as posing either high or major risk to fish passage where a waterway barrier is placed along these waterways (*Queensland Waterways for Waterway Barrier Works* spatial layer).

Additional information on the aquatic ecological values potentially present within the Section D project footprint is required to provide a baseline understanding of the conservation significant species likely to be present, assist in the development of detailed design and inform Section D project approvals. As such, GHD was commissioned by TMR to undertake a detailed aquatic ecology and geomorphological assessment of the waterways within the Section D project footprint. The detailed aquatic assessment involved three main survey components:

- Aquatic habitat assessments
- Aquatic flora and fauna surveys
- Channel morphology surveys.

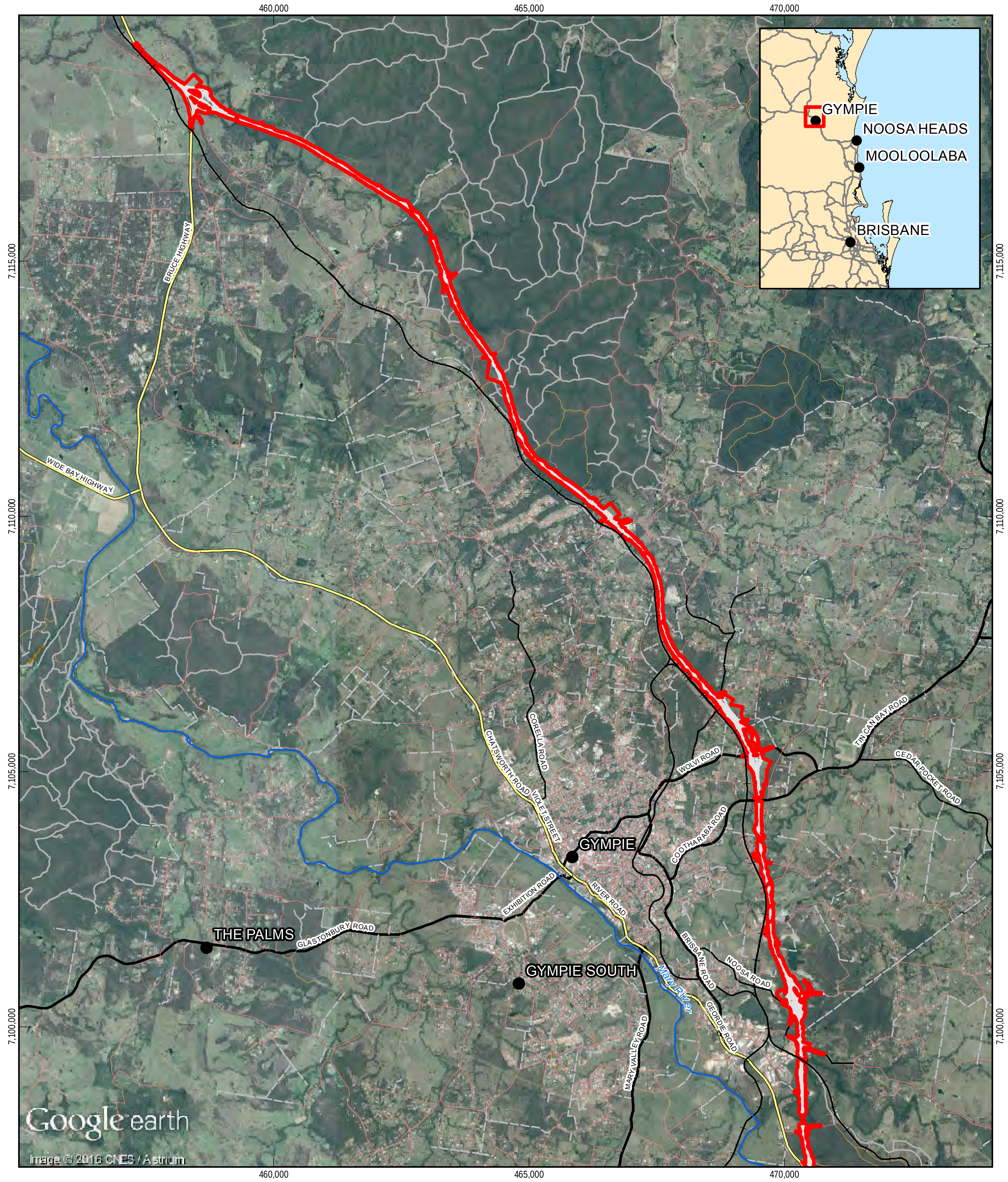
These surveys were conducted as separate survey events with the location and timing of each survey component determined by the specific aims and objectives of each survey. Each survey component was designed, executed and reported on in accordance with all State and Commonwealth requirements, including those of the

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Nature Conservation Act 1992* (NC Act)
- *Fisheries Act 1994* (Fisheries Act)
- *Water Act 2000* (Water Act).

1.3 Study area

The study area for the aquatic assessments encompassed the 17 waterways present along the length of the Section D project footprint. The specific survey locations for each survey component have been determined based on the objectives of each survey. In general, the aquatic habitat assessments were conducted within each waterway intersected by the alignment to describe habitat conditions and existing levels of disturbance. The aquatic flora and fauna surveys targeted waterways with suitable habitat conditions for conservation significant species and other sites for each which insufficient knowledge of the existing fish community existed. Channel morphology surveys targeted those waterways for which waterway diversion works are required to be undertaken.

An overview of the specific survey site locations for each survey component is provided in Appendix A with additional detail provided in the survey methodology section for each of the aquatic habitat assessments (Section 3.4), aquatic flora and fauna assessments (Section 4.4) and geomorphology assessment (Section 6.4).



LEGEND

Town	Street/Local Road	Major Watercourse
Railway	Private or Restricted Road	Proposed Alignment
Highway	4WD and Track	Project Footprint
Secondary Road	Unconstructed Road	
Local Connector Road	Bikeway/Walkway	

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size A4

0 0.5 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29710
Revision	0
Date	11 Aug 2016

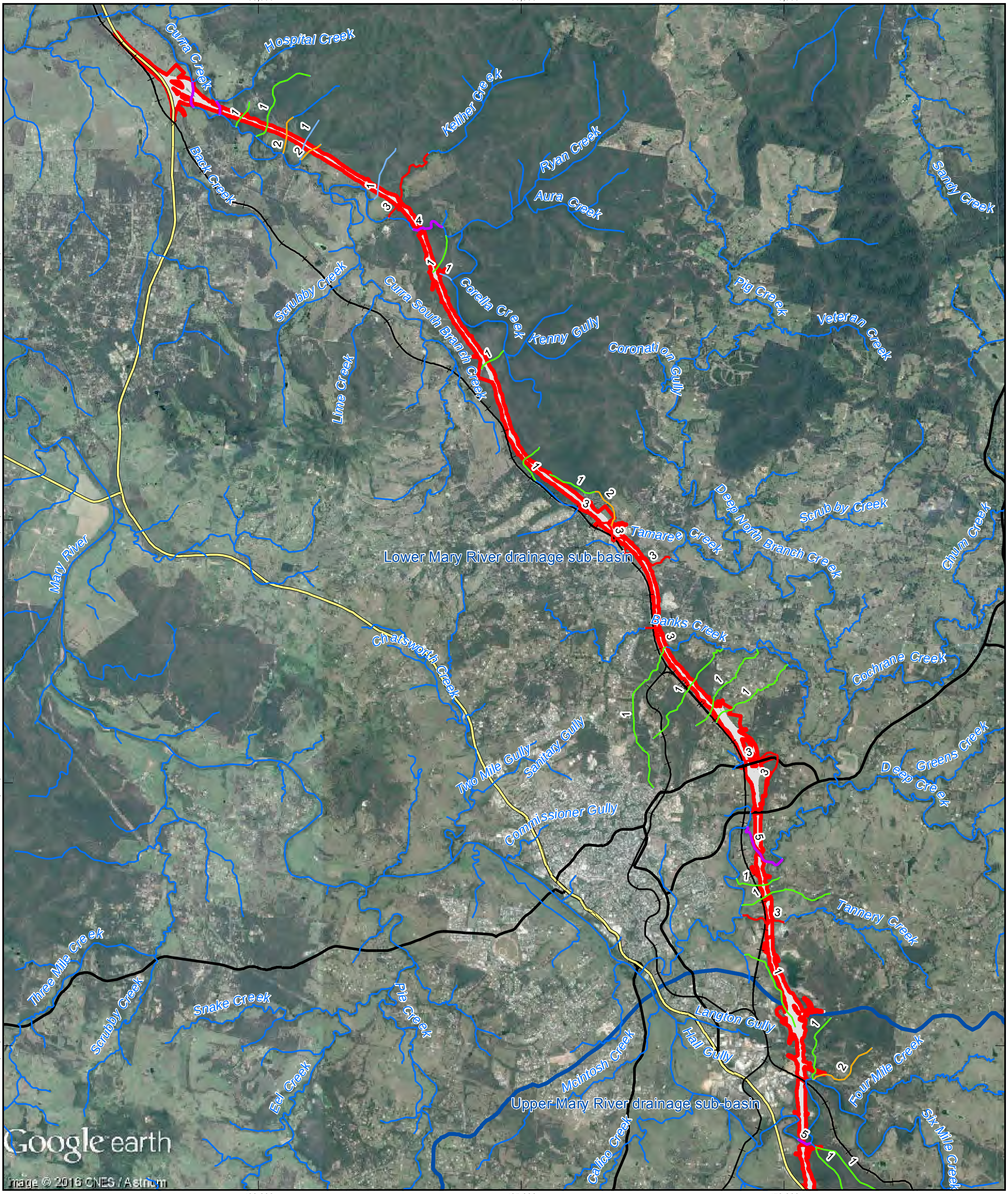
Study area and regional context

Figure 1-1

145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

G:\41\29710\GIS\Maps\MXD\4129710_010_Rev0.mxd

Data source: GA: Town (2007); TMR: Proposed Alignment, Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GE: Imagery extracted 4/03/2016. Created by: RB



LEGEND

- Railway
- Highway
- Secondary Road
- Proposed Alignment
- Stream Order

Water Way Barrier Works Risk of Impact

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

- Sub Catchment
- Project Footprint

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size A4

0 0.5 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

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Waterways present along the length of Section D project footprint

Figure 1-2

145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

G:\41\29710\GIS\Maps\MXD\4129710_011_Rev0.mxd

Data source: DAF: WWBW (2013); TMR: Project Footprint, Proposed Alignment (2016); DNRM: Stream Order (2010), Sub Catchment (2012), Railway (2014), Road (2016); GE: Imagery extracted 4/03/2016. Created by: RB

1.4 Previous investigations

As mentioned in Section 1.1, an understanding of the environmental values that have the potential to be impacted by the Section D project was provided by Jacobs (2015) as part of their aquatic ecology work undertaken for the REF (Business Case).

Aquatic habitat condition, aquatic plants, aquatic macroinvertebrates, fish and macrocrustaceans, turtles and platypus surveys were conducted in March 2015 at sites where the proposed project footprint crossed or was likely to directly affect major waterbodies. Eleven crossings were surveyed, from 100 metres upstream of the proposed project footprint to 100 metres downstream of the proposed project alignment. The survey sites comprised of Curra Creek North, Curra Creek Overflow, Keliher Creek, Upper Curra Creek, Tamaree Creek (at three locations), Banks Creek, Deep Creek and Six Mile Creek.

Where relevant, data from the REF study was used in this report to support more recent data collected and to provide a more holistic assessment of the project.

1.5 Purpose of this report

The purpose of this technical report is to present the findings of the aquatic ecology surveys undertaken for the Section D project and complement the work undertaken previously by Jacobs (2015). Background information on the conservation significant species that have potential to occur within the Section D project footprint is discussed in Section 2. The three survey components are then presented in separate sections (Sections 3, 4 and 6) within this document, each section includes the following details:

- Aims and objectives
- Survey locations
- Survey timing
- Methodology
- Results and discussion.

The report is concluded with a likelihood of occurrence assessment for conservation significant species (Section 5) and general summary and recommendations (Section 7).

1.6 Disclaimer

This report has been prepared by GHD for TMR and may only be used and relied on by TMR for the purpose agreed between GHD and the TMR as set out in Section 1.5 of this report.

GHD otherwise disclaims responsibility to any person other than TMR arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD as described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Species background

2.1 Overview

Desktop assessments and preliminary field investigations have identified that the waterways potentially impacted by the Section D project support a range of aquatic ecological values including aquatic species of State and/or Commonwealth significance. Specifically, the following six conservation significant species were either assessed as known to occur or likely to occur within the Section D project footprint during the previous investigations undertaken during the Options Analysis and Business Case phase of the project (Jacobs, 2016):

- Mary River turtle (*Elusor macrurus*)
- White-throated snapping turtle (*Elseya albagula*)
- Mary River cod (*Maccullochella mariensis*)
- Australian lungfish (*Neoceratodus forsteri*)
- Platypus (*Ornithorynchus anatinus*)
- Queensland lace plant (*Aponogeton elongates*).

As the above species were determined as either known to occur or likely to occur during the Options Analysis and Business Case phase of the project, these species have been targeted during this aquatic survey. The conservation status and preliminary likelihood of occurrence ratings for each species as per the REF are detailed in Table 2-1. A description of each species' ecology, as relevant to this aquatic assessment, and the Section D project, is provided in Sections 2.2 – 2.7.

Table 2-1 Conservation significant species predicted to occur within the study area as determined in the Review of Environmental Factors (Jacobs, 2016)

Species name	Common name	Conservation status		Likelihood of occurrence*
		EPBC Act	NC Act	
Elusor macrurus	Mary River turtle	Endangered	Endangered	Likely
Elseya albagula	White-throated snapping turtle	Critically endangered	Endangered	Unlikely
Maccullochella mariensis	Mary River cod	Endangered	-	Known
Neoceratodus forsteri	Australian lungfish	Vulnerable	-	Potential
Ornithorhynchus anatinus	Platypus	-	Special least concern	Known
Aponogeton elongatus	Queensland lace plant	-	Near threatened	Potential

* Based on a preliminary likelihood of occurrence assessment (Jacobs 2016)

2.2 Mary River turtle (*Elusor macrurus*)

The Mary River turtle is listed as endangered under the EPBC Act and the NC Act. The Mary River turtle is endemic to the Mary River where it primarily occurs in the mainstream of the Mary River and major tributaries, including Tinnana Creek, Yabba Creek and Obi Obi Creek (Limpus 2008).

The Mary River turtle generally inhabits well-oxygenated pools associated with riffle zones. Habitat pools vary in depth from one to six metres and generally have a sand or gravel bottom, steep sides and an abundance of submerged shelter in the form of fallen logs, boulders, undercut banks and aquatic vegetation. Very little information is known about the habitat requirements of hatchling turtles; however, rocky outcrops are thought to be of importance (Flakus 2002).

Nesting of the Mary River turtle is primarily restricted to alluvial sand/loam banks that occur in depositional areas. These banks generally form at the river's edge and extend back into the immediate riparian zone; however, islands are also known to occur in places. There is insufficient evidence available on species specific nesting requirements to accurately describe optimal nesting bank conditions; however, banks are generally large, steep and sparsely vegetated. Eggs are laid between two metres and 50 m away from the waters' edge and are an average of 2.3 m above water level (Flakus 2002; Flakus and Connell 2008). Nesting occurs from October to December and females are thought to return to the same nesting banks each year. The majority of aggregated nesting occurs at traditional nesting banks immediately upstream from Tiaro. Limited turtle nesting has been observed outside this area.

The home range of the Mary River turtle is small with daily movements averaging 200 m. During the breeding season, female turtles may make average daily movements of around 2 km, however, migrations of up to 7 km have been recorded (Flakus 2002). Male turtles are also known to increase movement during the breeding season. During flooding events, the Mary River turtle moves upstream against the current into small creeks, backwaters or eddies. When the water flow subsides, the turtles move back to the same pool from which they originated (Flakus 2002). Movement over land is only known to occur between adjacent pools.

Adult Mary River turtles are primarily herbivorous with aquatic plants making up the majority of their diet. Aquatic insect larvae and buds, seeds and fruit from terrestrial plants are also consumed. The diet of hatchling and juvenile turtles consists of aquatic insect larvae, freshwater sponges and aquatic plants (Cann and Leger 1994, Flakus 2002).

The Mary River turtle has the ability to respire aquatically with hatchlings obtaining up to 50 % of their total oxygen requirements from the water (Clark 2008). Aquatic respiration is achieved via diffusion over the skin or by active ventilation of the cloacal bursae. Being able to supplement aerial oxygen stores with aquatic oxygen allows this turtle species to significantly increase dive duration and reduce surfacing frequency. Hatchling Mary River turtles are able to remain submerged underwater for over 2.5 days without surfacing for air. Benefits of increased dive duration include more time for foraging (particularly in riffles), reduced predator exposure and decreased energetic costs of surfacing.

Illegal poaching during the 1960's and 1970's and high nest predation by feral dogs, foxes and goannas, has result in a 90 % reduction in Mary River turtle nesting in the last 50 years (Flakus and Connell 2008). The long term, pervasive and intense egg loss from predation and cattle trampling of nests has been identified as a critical threat to the species (Limpus 2008). Other threatening processes include:

- Removal of riparian vegetation preventing recruitment of important instream structure and microhabitat into the aquatic environment
- Degradation of water quality as a result of extensive land clearing, heavy grazing and sand mining
- Decreasing habitat suitability as a result of increased siltation and filling of deep pool habitats
- Degradation in nesting habitat suitability as a result of sand mining and proliferation of weed species

- Loss and degradation of habitat, restriction of movement and injury and mortality from instream infrastructure (i.e. dams and weirs) (DEE 2016a).

2.3 White-throated snapping turtle (*Elseya albagula*)

The white-throated snapping turtle is listed as critically endangered under the EPBC Act and endangered under the NC Act. The species is endemic to the Fitzroy, Burnett and Mary River catchments. Within the Mary River catchment, the white-throated snapping turtle occurs from the Mary River Barrage near Tiaro up to Kenilworth in the upper catchment. Individuals have been recorded in main tributaries with permanent water including Tinana Creek, Wide Bay Creek, Obi Obi Creek and Yabba Creek (Limpus 2008).

The white-throated snapping turtle primarily inhabits permanent flowing reaches of streams with a sand/gravel substrate and an abundance of refugia (i.e. rock crevices, submerged logs, macrophytes beds) (Hamann et al. 2007). The white-throated snapping turtle is not thought to occur within farm dams, ephemeral swamplands or brackish waters, but does occur in impounded pools at lower densities (Limpus et al. 2011; Hamann et al. 2007). During the day, the white-throated snapping turtle is generally found in deep pools (>6 m) either up- or downstream from a riffle zone, whereas at night the turtle moves into the shallow riffle zones (Gordos et al. 2007; Hamann et al. 2007).

The home range of the white-throated snapping turtle is generally less than 500 m and is usually restricted to the one pool. The turtle is, however, known to move large distances (10 – 55 km) in association with dispersal, courtship and nesting and repositioning following flood displacement. Movement over land is generally only known to occur between adjacent pools (Limpus et al. 2011; Hamann et al. 2007).

Juvenile white-throated snapping turtles are carnivorous, while adult turtles are primarily herbivorous, feeding on fruit and leaves of riparian vegetation and aquatic macrophytes (Rogers 2000; Armstrong and Booth 2005). The white-throated snapping turtle can respire aquatically, with turtles obtaining approximately 40-60 per cent of their oxygen requirements from the water (Mathie and Franklin 2006; Clark et al. 2008).

The white-throated snapping turtle is thought to aggregate nesting at traditional nesting sites. Nesting aggregations have been recorded near Tiaro, the junction with Munna Creek, Gunalda, upstream from Traveston and along Obi Obi Creek (Limpus 2008). Nesting usually occurs on alluvial sand/loam banks that are deposited by floodwaters. Nesting can however, occur in a variety of substrates ranging from sand to dark clay and grassed loam slopes. Nests are generally laid on the front face and top of steep slopes, are an average of 16.6 m from the water's edge (Limpus et al. 2011). The white-throated snapping turtle nests from autumn through to early spring (peak activity between May and July) with hatching generally occurring in early summer (December- January) after an embryonic diapause over the winter months (Hamann et al. 2007). Once they reach sexual maturity (15-20 years) female turtles are thought to breed annually (Hamann et al. 2007).

The key threatening process to the white-throated snapping turtle is the lack of recruitment into the population (TSSC 2014). Predation of nests by foxes, goannas, feral cats, and water rats is extremely high, with close to 100 per cent of clutches predated each season (Limpus et al. 2011; Hamann et al. 2007). The high mortality of eggs has led to little to no recruitment of hatchlings into the population over the last decade. The population of white-throated snapping turtle in the Mary River is now primarily comprised of adult individuals with only 0.9 per cent of adults recruited into the breeding population each year (Hamann et al. 2007). The protection of turtle nests and the artificial incubation of eggs have been key recovery actions for the species (TSSC 2014).

Other threatening processes include:

- Stocking of top end predator fish into impoundments and recreational fishing
- Dense aquatic weeds restricting access to nesting areas
- Extended drought resulting in poor water quality
- Loss and degradation of habitat, restriction of movement and injury and mortality from instream infrastructure (i.e. dams and weirs) (TSSC 2014).

2.4 Mary River cod (*Maccullochella mariensis*)

The Mary River cod is listed as endangered under the EPBC Act. Historically, Mary River cod were distributed throughout the Mary, Brisbane-Stanley, Albert-Logan and Coomera River systems (Wagner and Jackson 1993). Now, this species is restricted to the Mary River catchment and it is estimated the species now occurs in less than 30 % of its original range (Simpson and Jackson 1996).

There are three areas within the Mary River system where cod are relatively abundant. These are Tinana-Coondoo Creek upstream from Tinana Barrage, Six Mile Creek downstream from Lake Macdonald, and upper Obi Obi Creek. These natural sub-populations are isolated from one another by impoundments and the main river channel (Simpson and Jackson 1996).

Six Mile Creek provides one of the best refuges for cod in the Mary River catchment (Simpson and Jackson 1996). The range of Mary River cod in Six Mile Creek extends from the confluence with the Mary River, to Lake Macdonald (Six Mile Creek Dam), in which the species is stocked. The total stream length in this reach is approximately 40 km, less than half of which comprises large pool habitats that are likely to provide permanent habitat for cod (Simpson 1994). Based on this data and electrofishing surveys, the cod population in this creek system has been previously estimated at around 250 individuals (personal communication, J. Koehn).

Mary River cod occur in a variety of habitat types within the Mary River catchment, from high gradient, rocky, upland streams, to large, slow-flowing pools in lowland areas. Deep slow moving pools with abundant instream timber and heavy shading by overhanging vegetation are the preferred habitat. Areas of open water were usually avoided (Simpson and Jackson 1996).

The Mary River cod is largely territorial and occupies a particular home range between 70 metres and one kilometre in length for up to several years (Simpson and Mapleston 2002). Large scale movement in excess of 30 km either upstream or downstream can occur during high flow events (Simpson and Jackson 1996).

The Mary River cod are ambush predators and adults mainly consume fish (DEE 2016b). Submerged logs and branches (snags) are used as cover from which to ambush prey, as resting sites, and as nesting sites (DEE 2016b). The cod are often found within metres of woody debris structures (Simpson and Mapleston 2002). Spawning occurs during spring when water temperatures reach above 20 degrees Celsius (Harris and Rowland 1996). Hollow logs are thought to be used as spawning sites (Simpson and Mapleston 2002).

The key threatening processes to the Mary River cod include:

- Excessive siltation and in filling of pools as a result of land clearing and grazing
- Reduction in abundance of instream woody debris as a result of riparian vegetation clearing
- Restriction of movement
- Competition with non-indigenous fish species
- Overfishing during the late 1800's and early 1900's
- Water quality degradation and pollution
- Impoundments causing restriction of movement, degradation of water quality, loss of instream woody debris
- Susceptibility to disease, loss of genetic variability and inbreeding as a result of small isolated populations (DEE 2016b; Simpson and Jackson 1996).

2.5 Australian lungfish (*Neoceratodus forsteri*)

The Australian lungfish is listed as vulnerable under the EPBC Act. The species is restricted to South-Eastern Queensland, with its natural distribution being the Mary, Burnett and possibly Brisbane and North Pine Rivers. Australian lungfish have also been introduced to other rivers and dams including the Condamine and Coomera Rivers and the Enoggera Reservoir (DEE 2016).

Within the Mary River catchment, the lungfish occurs from the Mary River Barrage near Tiaro, up to Conondale in the upper catchment. Individuals have been recorded in large tributaries including Tinana Creek, Coondoo Creek, Wide Bay Creek, Obi Obi Creek, Munna Creek and Yabba Creek (Kind 2002).

The Australian lungfish inhabits permanent vegetated pools that are still or slow-following. Dense macrophyte beds, submerged riparian vegetation, woody debris and submerged rocks are particularly important habitat features (Kind 2002). They shelter in complex, shaded habitat. The species avoids open water, and very seldom uses rocky habitat and eroded banks, which are uncommon in the Mary River (DEE 2016c). Adult lungfish generally occupy depths between 2-3 metres (Brooks and Kind 2002).

Australian lungfish spawn at night between August and December, with peak activity in late October. Spawning occurs amongst aquatic macrophytes with *Vallisneria gigantea* the most commonly used species. The Australian lungfish is a benthic omnivore which primarily forages at night (DEE 2016c). The species is largely sedentary but can make annual movements to and from spawning ground (Kind 2002).

Key threatening processes to the lungfish include:

- Long-lived species with low juvenile survival
- Recreational fishing
- Introduced fish species
- Loss of riparian habitat
- Instream infrastructure (i.e. dams and weirs) causing decline in water quality, inundation of breeding habitat, disruption of movement and injury and/or motility (DEE 2016c).

2.6 Platypus (*Ornithorynchus anatinus*)

The platypus is listed as special least concern wildlife under the NC Act. Special least concern wildlife are those species considered as having inherent value and potential importance for the maintenance of ecosystem processes. Special least concern fauna are also considered a source of genetic information integral to an understanding of the evolution of the Australian biota and a genetic resource of potential benefit to society. These species are also considered culturally significant.

Platypus are found in eastern Australia from far north Queensland to Tasmania. In Queensland, the species inhabits rivers east of the Great Dividing Range, and some western-flowing streams (EHP 2011). Platypus habitat includes freshwater creeks, slow-moving rivers, lakes joined by rivers, and built water storages such as farm dams. Preferred habitat for the species is defined as areas that have steep, well vegetated banks (Grant and Temple-Smith 1998). Platypus occupy a wide range of aquatic habitats, are tolerant of degraded systems, and show notable adaptability (Grant and Temple-Smith 1998). Burrows are built in river banks, just above water level and often among a tangle of tree roots (EHP 2011).

Platypus mostly live alone, but can share a water body with several other individuals. Platypus show fidelity to home ranges with daily foraging movements of several kilometres. Platypus eat small aquatic invertebrates such as insect larvae, freshwater shrimps, and crayfish. The species detects electrical currents in the water with its bill and this is used to find prey. Dawn and dusk are periods of increased activity (EHP 2011). Platypus can remain submerged underwater for up to 10 minutes (EHP 2011).

In Queensland, platypus mate in August. After mating, the female increases consumption of food and builds a nesting burrow. Nursing burrows can be up to 30 m long. The female platypus blocks herself into the burrow with dirt to protect herself from floodwater and predators. After laying two soft-shelled eggs, the female curls up to incubate the eggs by holding them to her stomach with her tail. Incubation for the 17 mm eggs takes about 1-2 weeks. Tiny young are born naked, blind and with undeveloped limbs. The young stay in the burrow for weaning, while the mother leaves to forage. After about five weeks, the mother spends more time away from her young. At four months, the young venture out of the burrow and are fully grown by the time they are a year old (EHP 2011).

Platypus were hunted for their fur early last century. This practice has since ceased and the species is now legally protected under the NC Act. The key threatening processes to platypus include:

- Pollution to waterways
- Increased algal growths
- Siltation and destruction of riparian vegetation which put platypus burrows under increasing pressure
- Predators including snakes, water rats, goannas, foxes, and crocodiles.

2.7 Queensland lace plant (*Aponogeton elongates*)

The Queensland lace plant is listed as near threatened under the NC Act. This species is an aquatic perennial with oblong leaves and a tuberous root (Leiper et al. 2008). The species inhabits still and flowing permanent creeks and backwaters. Muddy sediment is a key habitat feature of the Queensland lace plant. Flowering occurs from October to March, however a previous record of the species from Mary River catchment was identified in December. The Queensland lace is generally submerged but can also be floating (Leiper et al. 2008).

3. Aquatic habitat assessments

3.1 Aims and objectives

The aim of the aquatic habitat assessments was to identify whether habitat features present in each of the waterways are likely to support aquatic species of conservation significance, and determine the current level of disturbance within the waterway in its broader catchment.

The specific objectives of the study were to:

- Provide a documented recorded of the distribution and abundance of aquatic habitat features known to be utilised by threatened species in waterways where they were likely to occur based on the results of past studies (i.e. Six Mile Creek, Deep Creek and Curra Creek)
- Utilise the above results to refine the likelihood of occurrence for conservation significant species in these three waterways based on habitat suitability and to identify potential sampling locations to carry out targeted aquatic fauna surveys
- Characterise aquatic habitat conditions (including water quality) in these and other waterways intersected by the Section D project footprint based on a standardised set of assessment criteria (AUSRIVAS habitat assessment) at locations upstream and downstream of crossing points
- Use the above information to infer general catchment condition in each of the waterways assessed.

3.2 Survey locations

3.2.1 Detailed habitat assessments

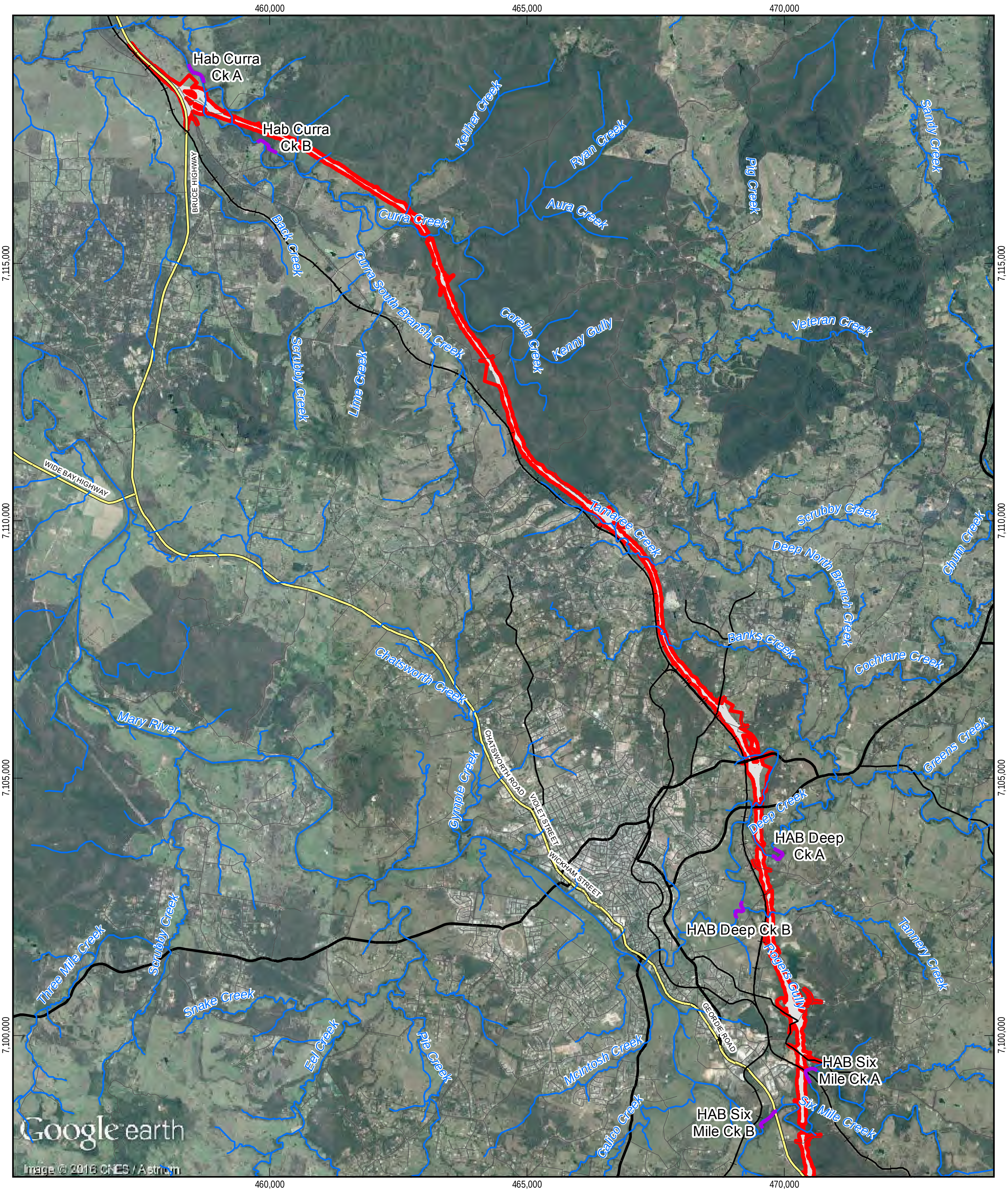
Detailed habitat assessment surveys were undertaken in those waterways in which conservation significant species were considered likely to occur based on a preliminary likelihood of occurrence assessment (Jacobs 2016). On this basis, detailed habitat assessments were carried out at Six Mile Creek, Deep Creek and Curra Creek.

The detailed habitat assessment involved a longitudinal survey of two 500 m reaches in each of the waterways, one upstream and one downstream of the Section D project footprint. Based on a desktop assessment of habitats using aerial imagery, provisional assessment reach extents were nominated prior to sampling. The criteria used to identify the location of these assessment reaches included the following:

- Suitable access
- The presence of key habitat features such as pools, riffles and sand bars
- Locations other than those that overlap with waterway crossing ROW, which had already been assessed based on AUSRIVAS habitat surveys (Jacobs 2016) and those that were to be characterised as part of the geomorphology assessment (refer to Section 5).

With respect to the latter, it was determined that sufficient habitat description data would be available based on the combination of these two data sets to determine the likelihood of the nominated conservation significant species occurring within the Section D project footprint. Further, construction activities have the potential to impact downstream populations through sediment mobilisation and upstream populations through reduced stream connectivity. Hence, an assessment of the habitat conditions upstream and downstream of the Section D project footprint is required to determine direct and indirect impacts on conservation significant species inhabiting these waters.

The location of detailed habitat assessment reaches that were surveyed are shown in Figure 3-1.



LEGEND

- Survey Line
- Railway
- Highway
- Secondary Road
- Local Connector Road
- Street/Local Road
- Proposed Alignment
- Watercourse
- Project Footprint

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Location of detailed habitat assessment survey reaches

Figure 3.1

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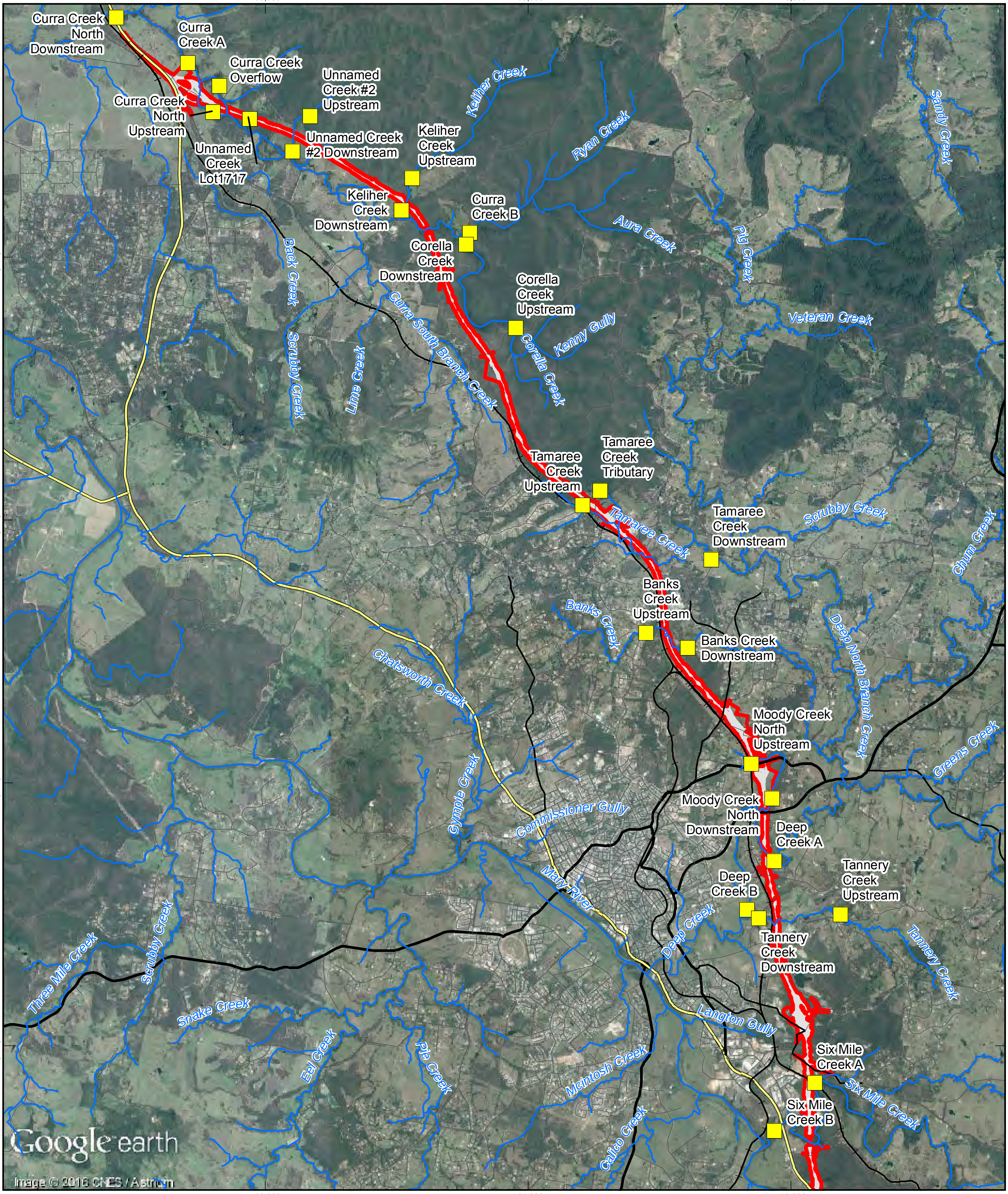
Data source: TMR: Proposed Alignment, Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Survey Line (2016); GE: Imagery extracted 4/03/2016. Created by: RB



LEGEND

- Survey Sites
- Railway
- Highway
- Secondary Road
- Local Connector Road
- Street/Local Road
- Proposed Alignment
- Watercourse
- Project Footprint

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Location of Survey Sites

Figure 3.2

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Data source: GHD: Survey Sites (2016); DNRM: Railway, Watercourse (2014), Road (2016); TMR: Project Footprint, Proposed Alignment (2016); GE: Imagery extracted 4/03/2016. Created by: RB

3.2.2 AUSRIVAS habitat assessment

AUSRIVAS habitat assessments were undertaken within the alignment corridor of many of the waterways within the study area as part of the REF study carried out by Jacobs (2015). The locations of these surveys sites are presented in Table 1 of Appendix 8-C of the REF (Jacobs, 2016). As such, the approach for this study was to utilise and build on this existing information by carrying out additional AUSRIVAS habitat assessments at locations upstream and downstream of the alignment corridor to provide a broader catchment-level understanding of existing condition and pressures.

As such, Queensland AUSRIVAS habitat assessments for this study were, where possible, conducted both upstream and downstream of the each of the 17 proposed crossing locations along the length of the Section D project footprint. Assessments were conducted over a maximum reach length of 300 m per site. Where there were multiple crossing sites proposed on the one system (e.g. Moody Creek North and Moody Creek South), habitat assessment sites were positioned upstream and downstream of both crossing points simultaneously.

The location of the AUSRIVAS assessment sites are shown on Figure 3-2 as survey sites.

3.3 Survey timing

The aquatic habitat assessment survey was undertaken in the post-wet season (10-20 March 2016) (refer Table 4-1). This timing was chosen to coincide with a time when many of the target species are more active (and therefore more likely to be observed), while at the same time avoiding the impacts of high wet seasonal flows on survey results, sampling logistics and the safety of the field team. It also avoided key breeding times for conservation significant species.

Survey timing coincided with some rainfall (7.6 mm, Bureau of Meteorology Gympie station 40093) over the week preceding the survey commencement with occasional rain throughout the field survey event (total of 43.6 mm, most of which was from the last day). Maximum temperature of 34.4°C was recorded during the field survey period.

3.4 Methodology

The aquatic habitat assessment survey involved the following survey techniques:

- Desktop assessment – to review existing information available and inform survey design
- Detailed habitat assessment – to identify and map key habitat features that relate to conservation significant species
- Queensland AUSRIVAS habitat assessment – to describe general habitat type and condition
- *In situ* water quality sampling – to characterise the physico-chemical water quality properties at the time of survey.

Each of these survey techniques are discussed in the following sections.

3.4.1 Desktop assessment

In order to develop an understanding of the existing aquatic environment and inform survey design, background information was reviewed from the following sources:

- DAF Queensland Waterways for Waterway Barrier Works spatial data layer, to identify the risk of impact from waterway barrier works on fish movement and fish communities
- Publically available scientific reports on the Mary River catchment
- Existing technical reports prepared for the project including:
  - Cooroy to Curra (Section D: Traveston to Woondum), Review of Environmental Factors (Business Case), Chapter 8 Aquatic Ecology (Jacobs 2016).

3.4.2 Detailed habitat assessment

Detailed habitat assessments were conducted at two locations (upsteam and downstream) over a length of approximately one kilometre of stream (total) per system in each of the following systems: Six Mile Creek, Deep Creek and Curra Creek (refer to Figure 3-1). The assessment included:

- Identification of key habitat features for conservation significant species. Such features included:
  - Pool habitat >0.8 m average depth
  - Riffle habitat
  - Run/glide habitat
  - Backwater
  - Sand bars
  - Submerged macrophyte vegetation (particularly *Vallisneria* beds)
  - Large woody debris
  - Undercut banks
  - Rock/boulder outcrops
  - Tree root habitat
  - Rock outcrops and boulders
  - Overhanging vegetation
  - Sediment deposition.
- GPS location of potential breeding places (e.g. potential turtle nesting areas, platypus burrows)
- Location of any opportunistic observations of key flora and fauna species
- Location of any man-made or natural barriers
- Georeferenced data and photographs – data collected during the detailed habitat assessments were captured using a tablet-based data collector such that data entries for key habitat features and potential breeding sites could be geo-linked. Photos of key features were taken using a geo-linked camera.

A list of fields and attributes collected during the detailed habitat assessments is provided in Appendix B. The results of the detailed habitat assessments are presented in Section 3.6.1 and 3.6.2.

3.4.3 AUSRIVAS habitat assessment

Queensland AUSRIVAS habitat assessment surveys were undertaken upstream and downstream of waterway crossings within the Section D project (refer to Figure 3-2 for survey site locations). At each habitat assessment site, a Queensland AUSRIVAS habitat assessment field sheet was completed and a habitat bioassessment score to be calculated as per Department of Natural Resources and Mines (DNRM) 2001. The habitat categories assessed and the category score ranges are provided in Figure 3-3. The general habitat characteristics of each site were also recorded. The results of the AUSRIVAS habitat assessments are presented in Section 3.6.1 and 3.6.2.

Habitat Category	Category Score Range			
	Excellent	Good	Moderate	Poor
Bottom substrate / available cover	16–20	11–15	6–10	0–5
Embeddedness	16–20	11–15	6–10	0–5
Velocity / depth category	16–20	11–15	6–10	0–5
Channel alteration	12–15	8–11	4–7	0–3
Bottom scouring & deposition	12–15	8–11	4–7	0–3
Pool / riffle, run / bend ratio	12–15	8–11	4–7	0–3
Bank stability	9–10	6–8	3–5	0–2
Bank vegetative stability	9–10	6–8	3–5	0–2
Streamside cover	9–10	6–8	3–5	0–2
Total Habitat Bioassessment Score for the Site	**111–135**	**75–110**	**39–74**	**0–38**

Source: adapted from (DNRM 2001)

Figure 3-3 Habitat assessment rating criteria

3.4.4 *In situ* water quality

In situ water quality readings were taken within the detailed habitat reaches and at each AUSRIVAS habitat assessment site to characterise physico-chemical water quality properties. A YSI multiprobe calibrated to the manufacturer's specifications prior to use was used to measure temperature (^{o}C), turbidity (NTU), dissolved oxygen (DO; mg/L and % saturation), pH and electrical conductivity (µS/cm). Readings were taken at the surface (10-50 cm depth).

Results for each site were compared against the following relevant guideline ranges:

- *Environmental Protection (Water) Policy 2009 Mary River environmental values and water quality objectives Basin No. 138, including all tributaries of the Mary River* (Department of Environment and Resource Management (DERM) 2010)
- *Queensland Water Quality Guidelines – southern coastal zone (80th percentile)* (EHP 2013).

The results of the *in situ* water quality assessment are presented in Section 3.6.3.

3.5 Scope and limitations

It should be noted that results presented in this report reflect site conditions at the time of sampling and these may change through time.

3.6 Results and discussion

3.6.1 Habitat features and suitability for conservation significant species

Six Mile Creek

The habitat characteristics of Six Mile Creek were consistent with a waterway that is in relatively good condition. Surrounding catchment modification (mostly related to agricultural practices such as land clearing and introduction of exotic vegetation) is evident within the creek, but has not impacted habitats significantly. The availability of habitat features, coupled with its proximity to the confluence with the Mary River, make Six Mile Creek the most likely of the three assessed waterways to support conservation significant species.

The Six Mile Creek upstream reach (refer HAB Six Mile Creek A in Figure 3-1) featured a combination of pool, glide and riffle habitat (Plate 3-1). This included pool habitat > 0.8 m average depth. The bank profile was moderate and the bank substrate dominated by clay and sand. Consolidated steep banks were present and considered to be suitable for platypus burrowing. Tree roots and large woody debris clusters were abundant along the banks and within the channel (Plate 3-2), providing suitable foraging habitat for platypuses. Many of the exposed sections of tree roots were associated with undercut banks, which were suitable resting and sheltering locations for Mary River cod, Australian lungfish, Mary River turtles and white-throated snapping turtles. Sandy substrate potentially suitable for turtle nesting was also found at the site, but cattle damage to those areas was evident. A layer of silt on the substrate was indicative of erosion within the catchment, and was easily suspended in the water column. Although a silt layer was found within the pools of both reaches of Six Mile Creek, high velocity flows, which periodically scour and remove fine sediment from the creek, preclude Six Mile Creek from being preferred habitat for the Queensland lace plant. The reach was shaded by a combination of native and exotic tree species covered in a dense layer of invasive climbing plants. The understorey was made up of invasive creepers and ferns. Due to the high levels of shading, habitat suitability for macrophytes, including the Queensland lace plant, was low and no plants were observed.

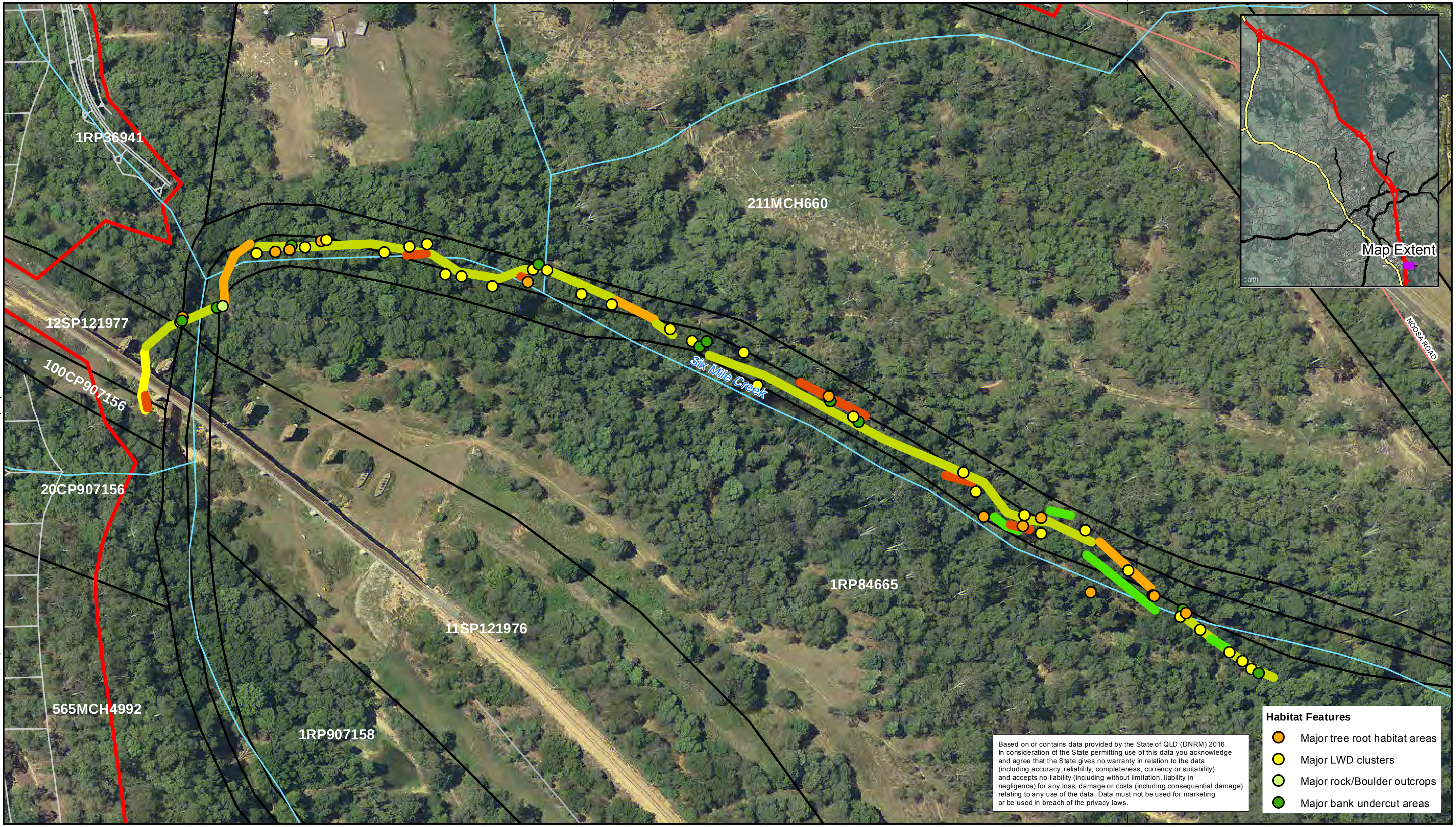
Downstream, the channel featured abundant large woody debris and bank undercuts, providing suitable shelter and resting habitat for adult Australian lungfish, Mary River Cod, white-throated snapping turtles and Mary River turtles. Riffle, run and pool sequences were found within the reach that are likely to support a healthy macroinvertebrate community and allow connectivity for fish, turtles and platypuses. Macrophyte cover was limited, which means that this reach is less likely to be used for breeding by Australian lungfish, or as habitat for juveniles of the species. Platypuses are likely to occur within the creek to forage in large pools and within woody debris clusters, but less likely to burrow into banks due to a lack of consolidation. Sandy banks, potentially suitable for turtle nesting, were present, but cattle damage to those areas was evident. Although large trees lined the banks of Six Mile Creek along the downstream reach, the creek only received a moderate amount of shade as there was little overhanging vegetation.

Detailed habitat assessment mapping outputs for the Six Mile Creek upstream and downstream assessment reaches are shown in Figure 3-4 and Figure 3-5, respectively.

Plate 3-1 Riffle within Six Mile Creek

Plate 3-2 Large woody debris within Six Mile Creek

Plate 3-3 Exposed roots and undercut banks along Six Mile Creek



Paper Size A4

0 12.5 25 50 75

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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LEGEND

Habitat Features

- Backwater
- Pool >0.8 m average depth
- Riffle habitat
- Run/Glide habitat
- Sand-gravel bar
- Minor watercourse
- Local connector road
- Private or restricted road
- Proposed Alignment
- Project footprint
- Cadastre

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Habitat features within Six Mile Creek (A) upstream reach

Figure 3.4

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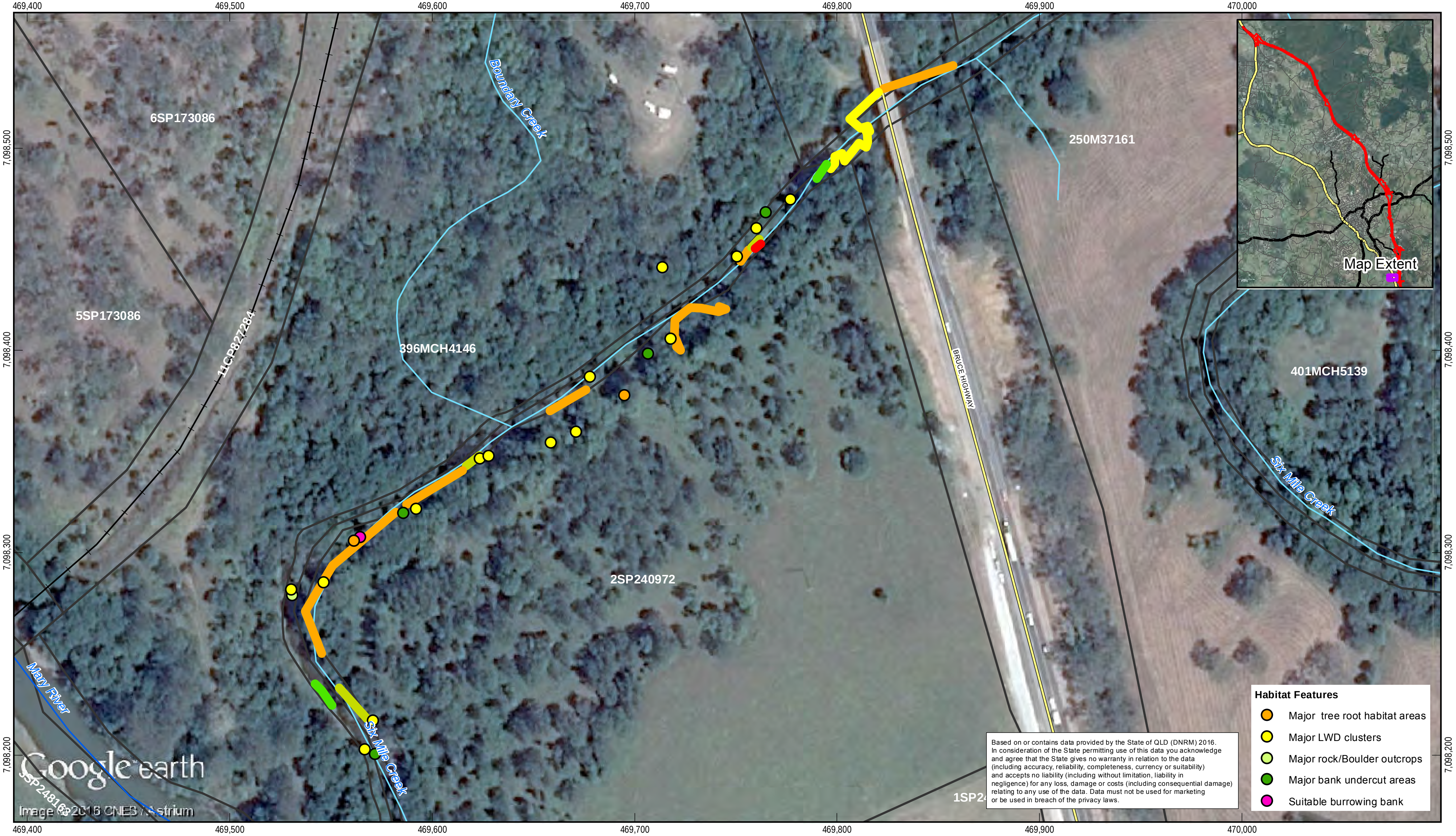
Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Cadastre, Road (2016); GHD: Habitat Features (2016); TMR: Imagery (2016). Created by: RB



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Habitat Features

- Backwater
- Pool >0.8 m average depth
- Riffle habitat
- Run/Glide habitat
- Sand-gravel bar
- Major watercourse
- Minor watercourse
- Railway
- Highway
- Cadastre

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Habitat features within Six Mile Creek (B) upstream reach

Figure 3.5

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145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Cadastre, Road (2016); GHD: Habitat Features (2016); GE: Imagery extracted 4/03/2016. Created by: RB

Deep Creek

Deep Creek was heavily influenced by local land use practices and the habitats within the creek reflected these impacts. Vegetation consisted of trees and shrubs, but also included areas cleared to the water's edge, which were actively eroding and contained gullies. A large portion of the riparian zone was dominated by weed species (including **Cinnamomum camphora* (camphor laurel), **Celtis sinensis* (Chinese elm) and **Macfadyena unguis-cati* (cats claw) denoting that previous clearing of the entire riparian zone had occurred. Reaches of Deep Creek which contain deep pools, a high abundance of large woody debris, overhanging vegetation and shaded habitat upstream provides potentially suitable habitat conditions for the Mary River cod, Australian lungfish, white-throated snapping turtle and Mary River turtle. Platypuses are also likely to occur within the reach to forage and burrow. Although habitat characteristics suitable for the above listed significant species occurred within the assessment reaches, degradation from land use practises, combined with reduced connectivity (natural and as a result of waterway barriers) within the creek make it less likely that these species will occur in sections of the creek that fall within the footprint of construction. Substrates and flow in the assessed reaches of Deep Creek were not found to be suitable for Queensland lace plant.

The upstream reach was dominated by deep pool habitat >0.8 m, as shown in Figure 3-6. It was heavily shaded, and often up to 12 m wide. The reach consisted of two large pools separated by a small weir, which forms a fish barrier under normal flow conditions (Plate 3-4). However, it should be noted that this weir would quickly 'drown out' following substantial rainfall. At this time, this barrier would effectively be removed, thus restoring connectivity and facilitating the passage of fish. The bank profile was steep and the bank substrate dominated by clay, providing suitable platypus burrowing habitat (Plate 3-6). Tree roots and large woody debris were abundant along the edges of the channel, providing resting and shelter for Australian lungfish, as well as foraging locations for platypuses. The lack of sandy substrate and gentle sloping banks are unlikely to provide suitable nesting conditions for the Mary River turtle or white-throated snapping turtle.

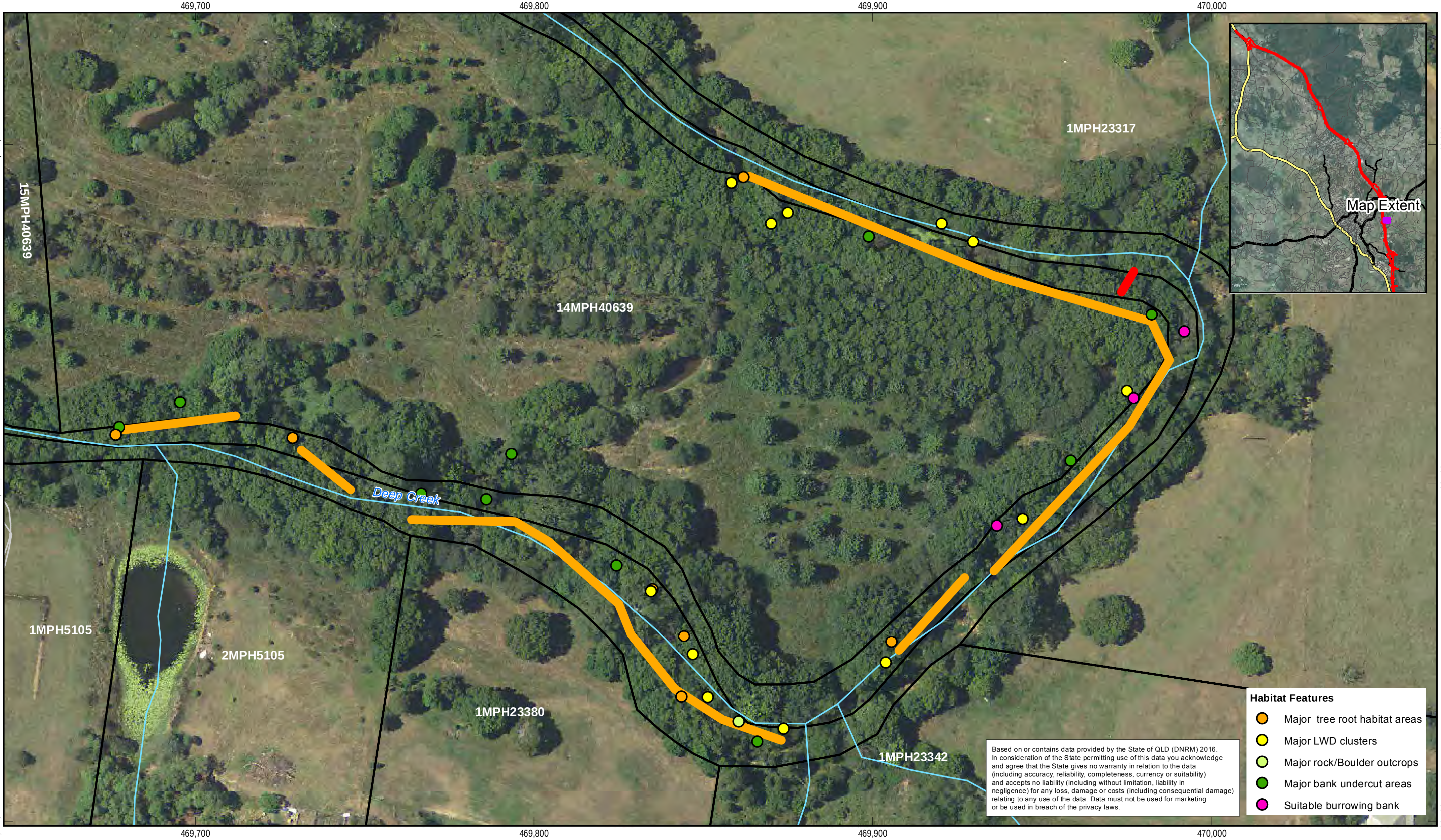
The downstream reach was characterised by pool and run sequences, with sand and cobble substrate dominating the reach. Large clusters of woody debris were present, and in some instances, this woody debris slowed or stopped flow (Plate 3-5). It is possible that where woody debris effectively dammed the creek, that the passage of fish was restricted. However, with increased surface flow, the woody debris would likely be flushed further downstream, or the restriction would be overtopped, thereby re-establishing fish passage. There were some sandy banks found within the transects that may have been suitable for nesting turtles; but evidence of cattle access to the creek at these locations was also observed. Pools >0.8 m in depth were found within the reach, but were much shorter in length than those in the upstream reach. Riparian vegetation was also present, but at a much lower density than upstream, providing little shade along the majority of the reach.

Detailed habitat assessment mapping outputs for the Deep Creek upstream and downstream assessment reaches are shown in Figure 3-6 and Figure 3-7, respectively.

Plate 3-4 Weir constructed within the Deep Creek upstream reach

Plate 3-5 Pool habitat featuring large woody debris limiting fish passage

Plate 3-6 Deep pool and consolidated banks within Deep Creek



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Habitat Features

- Backwater
- Pool >0.8 m average depth
- Minor watercourse
- Cadastre

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Habitat features within Deep Creek (A) upstream reach

Figure 3.6

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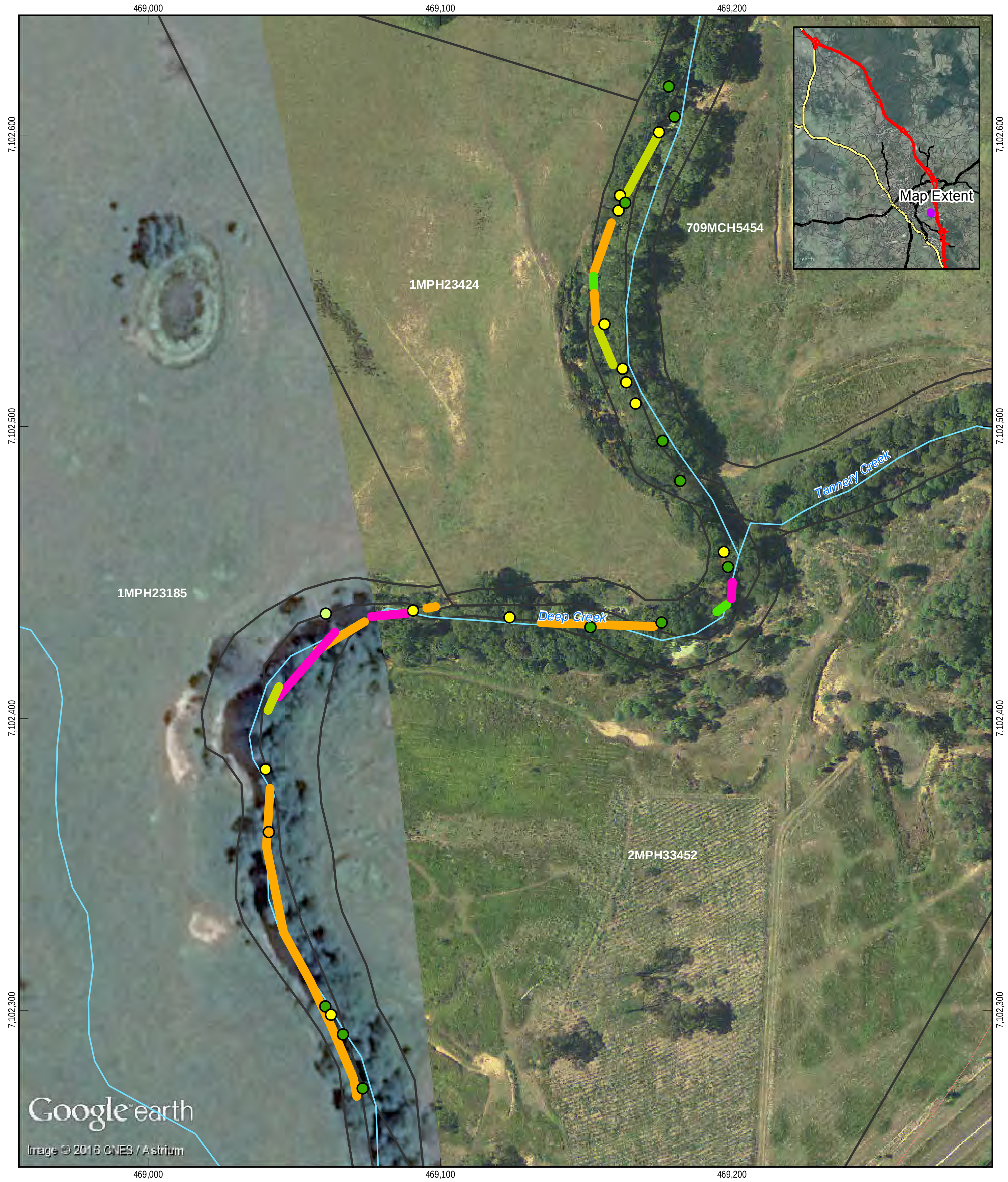

LEGEND

Habitat Features

- Major tree root habitat areas
- Major LWD clusters
- Major rock/Boulder outcrops
- Major bank undercut areas

Habitat Features

- Pool >0.8 m average depth
- Run/Glide habitat
- Sand-gravel bar
- Submerged macrophyte vegetation > 10% cover

- Street/Local road
- Minor watercourse
- Cadastre

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Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Habitat features within Deep Creek (B) downstream reach

Figure 3.7

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Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Cadastre, Road (2016); GHD: Habitat Features (2016); GE: Imagery extracted 4/03/2016; TMR: Imagery (2016). Created by: RB

Curra Creek

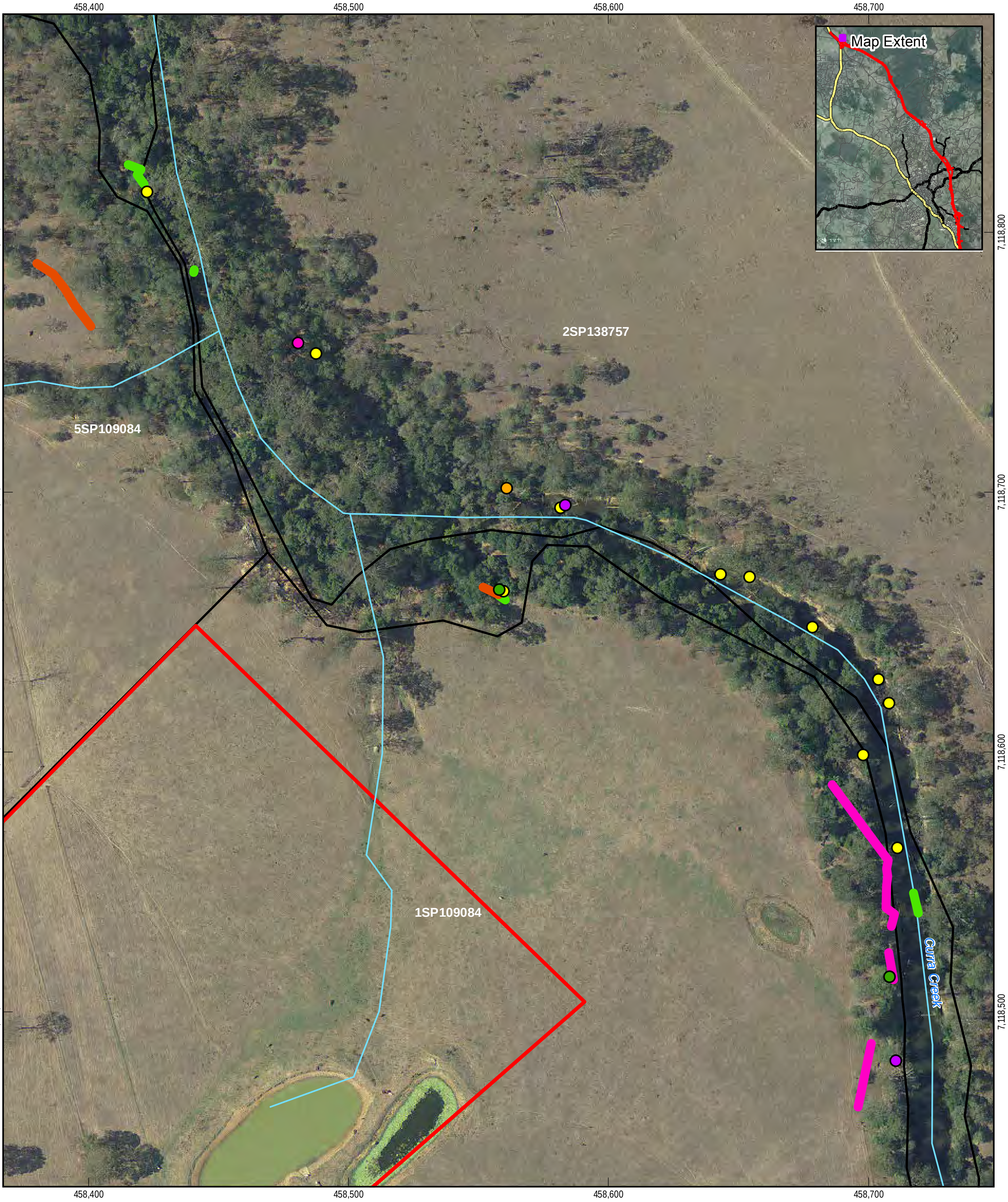
The Curra Creek upstream and downstream reaches were similarly characterised by deep pool habitats (Plate 3-7). This included pool habitat > 0.8 m average depth that extended for the majority of the reaches assessed. The creek was intersected in a number of locations by culverts and road crossings, which would not provide connectivity during low/no flow conditions. These culverts would however, be quickly inundated during medium to large flow events. The system was found to be anabranching and featured backwaters and lagoons as part of its morphology. These areas contained submerged, floating and emergent macrophytes. Although Queensland lace plant was not observed within the surveyed reaches of Curra Creek, backwaters are favourable habitat for this species. Substrate within the creek was a mixture of cobble, sand and soft sediments. Deep pools were dominated by large trees, providing exposed roots and undercut banks for the majority of both reaches. The majority of banks were made up of consolidated material (clay) and some rocky outcrops. No cattle damage was observed. Banks were suitable for platypus burrowing for the majority of the reaches, and number of small sandy banks provide potentially suitable nesting habitat for turtles. Riparian vegetation was dense and consisted of a combination of trees and shrubs creating a dense canopy which cast a large amount of shade. Submerged and floating macrophytes were observed within the main channel of the creek in both reaches (Plate 3-8). Suitable breeding habitat for Australian lungfish (patches of submerged macrophytes) was present; however, the distance of this reach from the Mary River and reduced connectivity between pools in Curra Creek reduce the species' likelihood of occurrence. Large woody debris was abundant throughout Curra Creek providing suitable habitat for the Mary River cod, Mary River turtle and white-throated snapping turtle. A female white-throated snapping turtle was confirmed present within the upstream reach during field surveys. The abundance and distribution of conservation significant fish and turtles within Curra Creek is likely to be reduced by the distance of this reach from the Mary River and reduced connectivity. Platypuses are likely to occur within Curra Creek due to the large amount of available habitat for foraging and shelter.

Detailed habitat assessment mapping outputs for the Curra Creek upstream and downstream assessment reaches are shown in Figure 3-8 and Figure 3-9, respectively.

Plate 3-7 Deep pool habitat common to the majority of both reaches of Curra Creek

Plate 3-8 Floating macrophytes within Curra Creek

Plate 3-9 Piped culvert on Curra Creek causing fish barrier under low flow conditions



LEGEND

Habitat Features

- Major tree root habitat areas
- Major LWD clusters
- Major bank undercut areas
- Overhanging riparian vegetation
- Suitable burrowing bank

Habitat Features

- Backwater
- Sand-gravel bar
- Submerged macrophye vegetation > 10% cover

- Minor watercourse
- Project footprint
- Cadastre

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Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Habitat features within Curra Creek (A) upstream reach

Figure 3.8

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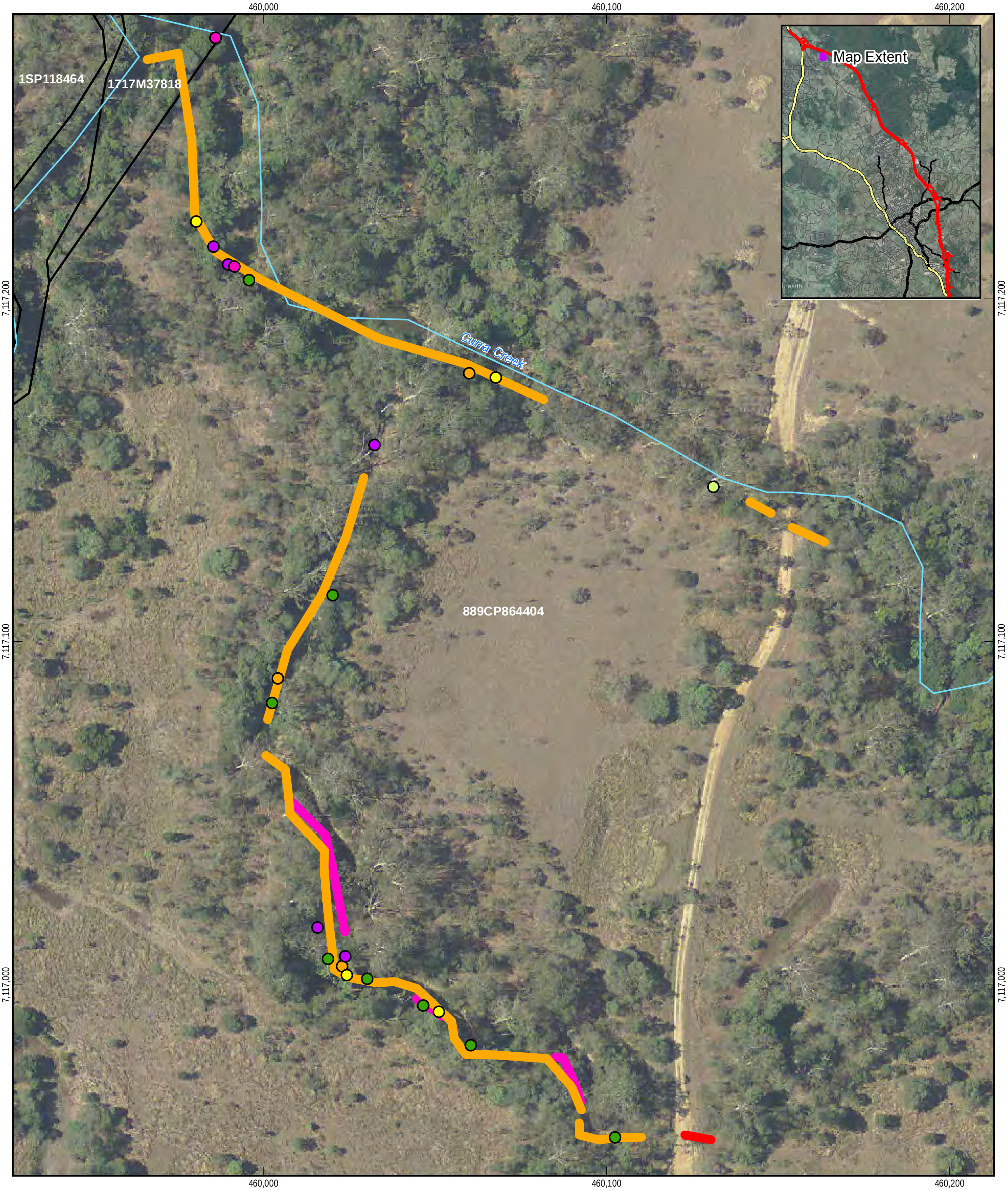
Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Cadastre, Road (2016); GHD: Habitat Features (2016); TMR: Imagery (2016). Created by: RB



LEGEND

Habitat Features

- Major tree root habitat areas
- Major LWD clusters
- Major rock/Boulder outcrops
- Major bank undercut areas
- Overhanging riparian vegetation
- Suitable burrowing bank

Habitat Features

- Backwater
- Pool >0.8 m average depth
- Submerged macrophye vegetation > 10% cover
- Minor watercourse
- Cadastre

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Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Habitat features within Curra Creek (B) downstream reach

Figure 3.9

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G:\41\29710\GIS\Maps\MXD\4129710_009_Rev0.mxd

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road, Cadastre (2016); GHD: Habitat Features (2016); TMR: Imagery (2016). Created by: RB

AUSRIVAS assessment sites

Sites surveyed as part of the AUSRIVAS habitat assessments were ephemeral with the occasional permanent waterhole bound by bedrock or small farm dam built on a waterway (refer to Appendix C for results). The sites were not considered to be potential habitat for any of the conservation significant species related to this study. All sites outside of Curra State Forest were heavily influenced by localised catchment modification such as urbanisation and agriculture. Barriers to fish movement at low flow conditions were observed at almost all sites, usually in the form of culverts and road/rail crossings (refer to Appendix C).

The March 2015 survey also identified a number of waterway barriers in the vicinity of the surveyed sites. The waterway barriers consisted of bed level crossings, road crossings and pipe culverts (Curra Creek North, Curra Creek Overflow, Keliher Creek, Tamaree Creek 1, Banks Creek and Moody Creek). The locations of the barriers are nominated in the REF (Jacobs, 2016). Other waterways were subject to flow modifications. These were in the form of water off-take and ford on Tamaree Creek (crossing 2) and a weir on Deep Creek (Jacobs, 2016).

Two major dams, Cedar Pocket Dam and Six Mile Creek Dam (Lake Macdonald), are located 20 km and 53 km, upstream from the key waterways, Deep Creek and Six Mile Creek, respectively. Both are un-gated dams which spill over when they reach capacity. The Mary River Barrage is located on the Mary River 97 km downstream of the project footprint.

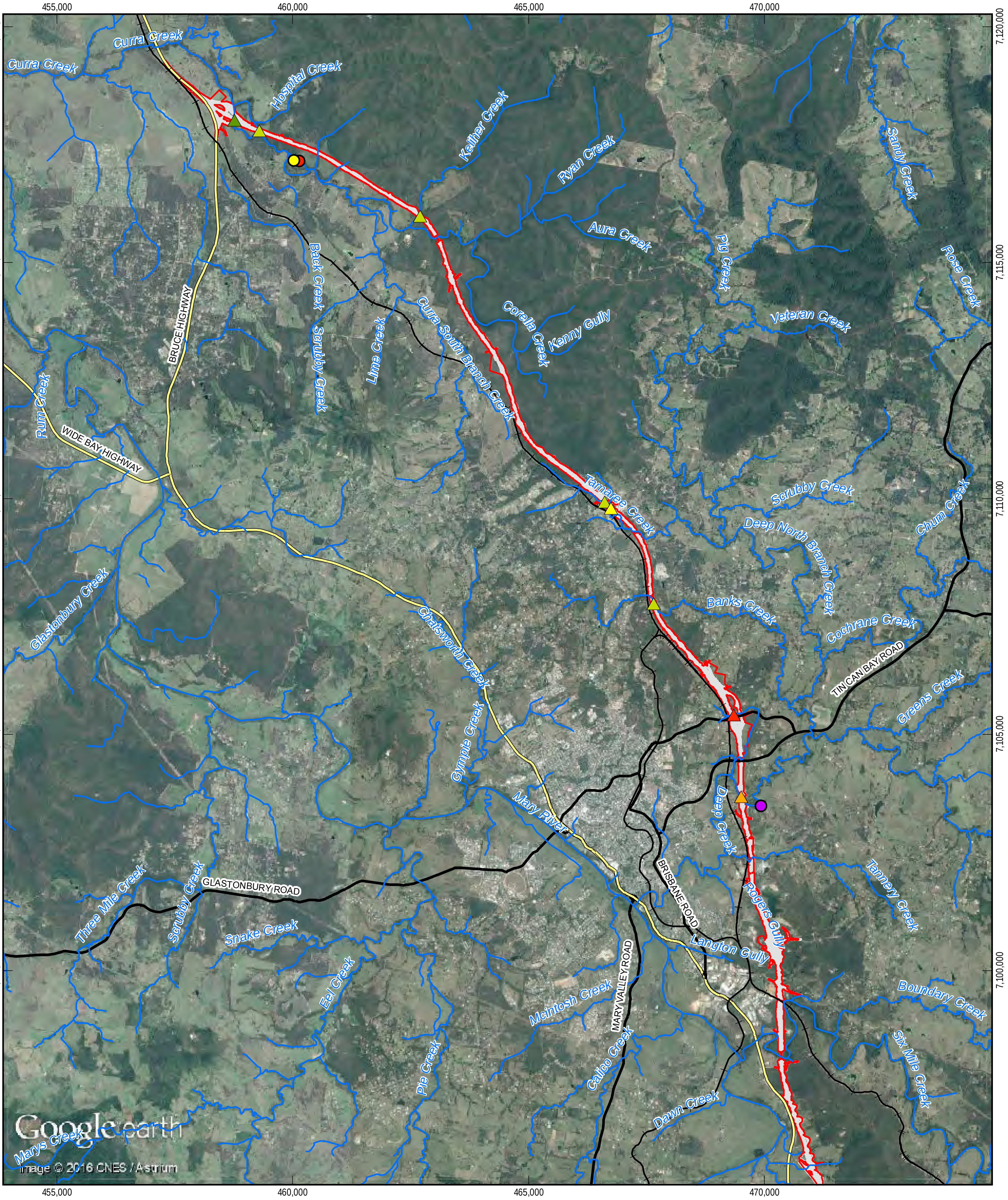
Waterway barriers in the vicinity of the Section D project footprint are illustrated in Figure 3-10.

3.6.2 Habitat conditions

Habitat condition assessment ratings ranged from ‘moderate’ to ‘good’ during the March 2015 survey (Jacobs 2016). Ten of the eleven surveyed sites were rated in Jacobs (2016) as ‘moderate’ (refer to Figure 3-11). These were characterised by a varied substrate composition with a range of in-stream habitat available for aquatic fauna. The riparian zone however was often highly disturbed. Six Mile Creek was associated with the best aquatic habitat condition with a rating of ‘good’. This waterway was characterised by very high substrate diversity with a range of flow and in-stream habitats. The riparian zone was also less disturbed than the other waterways (Jacobs, 2016).

During the March 2016 survey period, habitat condition assessment ratings ranged from ‘poor’ to ‘excellent’ (refer to Appendix D). The waterways associated with the best aquatic habitat condition were Six Mile Creek and Deep Creek, with specific reaches (Corella Creek upstream, Banks Creek downstream and Tamaree Creek downstream) also providing notably good habitat condition. The waterway associated with the poorest condition was Unnamed Creek (Lot 3 on RP165151), which was impacted by factors of low velocity/depth category, low bank stability and low streamside cover. Notable point source (rubbish) and non-point source (grazing) pollution was also recorded within this waterway.

Results of the AUSRIVAS habitat assessment scores and ratings are presented in Appendix D while the overall habitat condition rating (bioassessment score) for each waterway is illustrated in Figure 3-11.



LEGEND

Waterway Barriers

- Bridge and bed level crossing
- Bed level crossing
- Concrete road crossing/total barrier
- Pipe culvert
- Weir
- Low Level causeway
- Pipes/culvert
- Weir
- Highway
- Secondary Road
- Railway
- Proposed Alignment
- Watercourse
- Project footprint

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Paper Size A4

0 0.5 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Waterway barrier in the vicinity of the Section D project footprint

Figure 3.10

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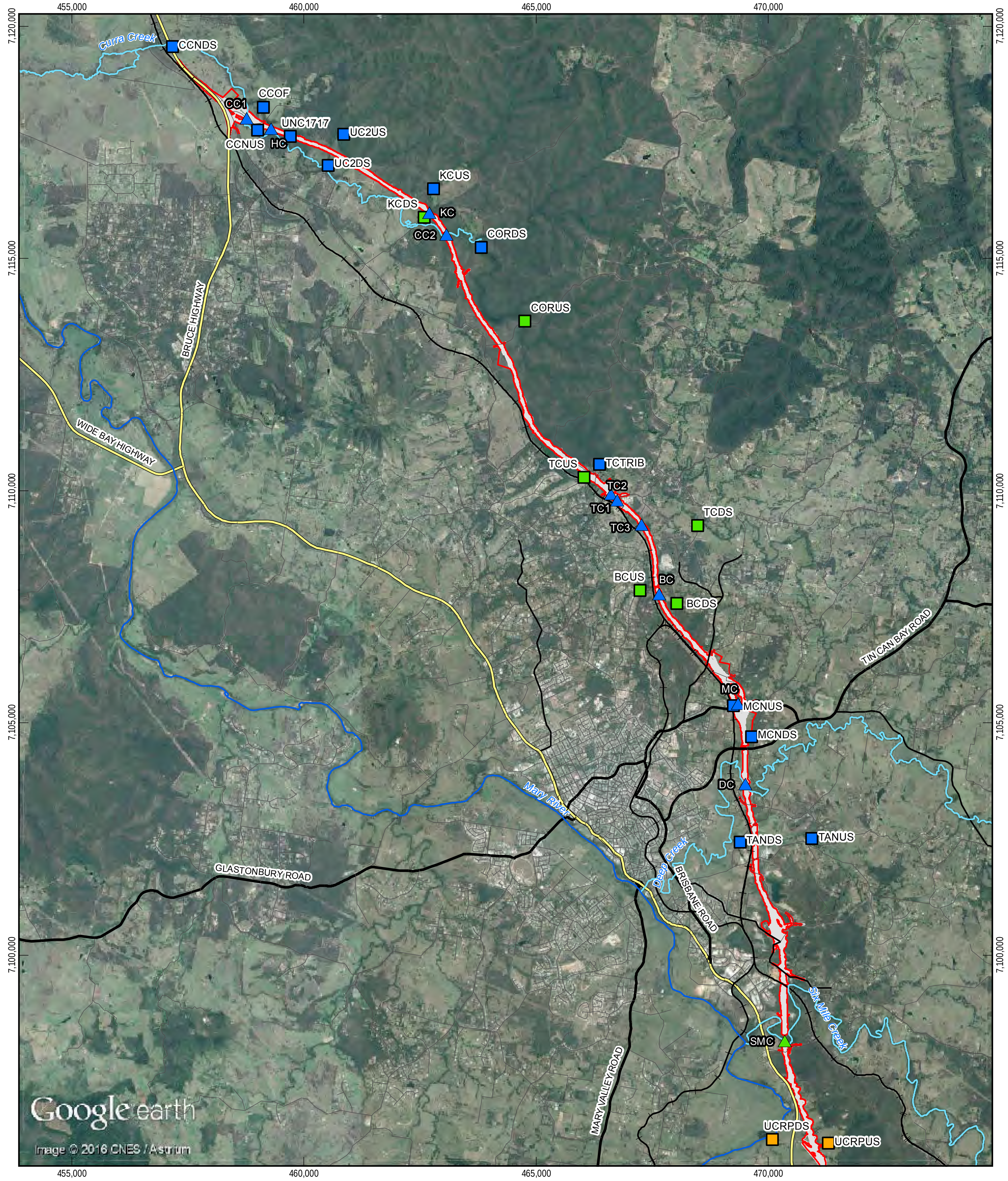
G:\41\29710\GIS\Maps\MXD\4129710_013_Rev0.mxd

Data source: TMR: Project Footprint (2016); GHD: Waterway Barriers (2016); DNRM: Railway, Watercourse (2014), Road (2016); Jacobs: Waterway Barriers (2015); GE: Imagery extracted 16/05/2016. Created by: RB



LEGEND

Bioassessment Score (GHD, 2016)	Bioassessment Score (Jacobs, 2015)		
Good	Good	Highway	Railway
Moderate	Moderate	Secondary Road	Major Watercourse
Poor		Local Connector Road	Minor Watercourse
		Street/Local Road	Proposed Alignment
			Project Footprint

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Paper Size A4
0 0.5 1 2 3 4
Kilometres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Overall habitat condition ratings for waterways within the Section D project footprint

Figure 3.11

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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Data source: TMR: Proposed Alignment, Project Footprint (2016); GHD: Bioassessment Score (2016); DNRM: Railway, Watercourse (2014), Road (2016); Jacobs: Bioassessment Score (2015); GE: Imagery extracted 16/05/2016. Created by: RB

3.6.3 Water quality

Water quality monitoring indicates that waterways were generally characterised by moderate to high turbidity, with six reaches exceeding Water Quality Objectives (WQOs) for these parameters (reaches – Curra Creek North downstream, Curra Creek Overflow, Corella Creek upstream and downstream, Moody Creek North upstream and downstream). Elevated turbidity may correlate to rainfall events experienced during the week of sampling. Water quality results from the March 2016 habitat assessment are provided in Appendix E.

Waterways (particularly those represented by isolated pool habitat) were also typically characterised by low dissolved oxygen levels, with only Moody Creek North upstream and Unnamed Creek Lot 3 on RP16151 downstream reaches falling within recommended WQOs for dissolved oxygen (%). Note that dissolved oxygen readings were taken at varying times of the day, and this parameter undergoes diurnal cycle variation relating to photosynthesis and respiration subjecting readings to variation throughout the day. It should also be noted that the majority of waterways sampled during this survey contained dense vegetation that produced a large amount of shade during most times of the day, reducing the photosynthetic ability of algae to oxygenate the water.

Electrical conductivity was generally recorded within WQOs. Deep Creek A and Tannery Creek upstream were slightly above objectives with conductivity readings of 592 mS/cm and 670 mS/cm, respectively. Unnamed Creek Lot 3 on RP16151 downstream was hypersaline with a conductivity of 1880 mS/cm. This site was primarily dry and supported small isolated pools at the time of survey. These conditions are likely to have resulted in evapo-concentration of salts leading to the observed high levels electrical conductivity.

Recoded pH was typically within the range defined in the WQOs, except for reaches Banks Creek upstream, Unnamed Creek Lot 3 on RP16151 upstream, Curra Creek B, Curra Creek Overflow, Corella Creek upstream and downstream and Keliher Creek upstream and downstream. These sites were all slightly acidic ranging in pH from 6.13 to 6.49. It is unstood that a long term water quality monitoring program is currently being undertaken for the Section D project and provides further water quality data for each of the waterways sampled during the habitat assessments in 2016.

3.7 Summary

The aquatic habitat assessments within the Section D project footprint recorded habitat conditions suitable for conservation significant fish, turtles and platypus in all three major creek systems. A summary of the key habitat values and disturbance factors of each waterway is provided in Table 3-1, along with the habitat suitability for conservation significant species.

Table 3-1 Summary of aquatic habitat suitability within the Section D project footprint

Waterway	Key habitat values	Key disturbance factors	Foraging habitat suitability	Breeding habitat suitability
Six Mile Creek	Pool, run and riffle sequences, deep pools, large quantities of large woody debris, tree roots and undercut banks, consolidated steep banks with some sandy substrate, connectivity and close proximity to confluence with Mary River	Cattle disturbance to banks, introduced exotic flora species	Mary River cod Mary River turtle White-throated snapping turtle Adult Australian lungfish Platypus	Mary River cod Platypus Low value turtle nesting banks
Deep Creek	Deep pools, high abundance of large woody debris, tree roots, overhanging vegetation and shade, consolidated banks	High levels of riparian vegetation clearing, cattle disturbance to banks, erosion and gullies, high diversity and abundance of introduced exotic flora species, waterway barriers	Mary River cod Mary River turtle White-throated snapping turtle Adult Australian lungfish Platypus	Mary River cod Platypus
Curra Creek	Anabranching system with backwaters and lagoons, deep pools, large woody debris, tree roots and undercut banks, submerged, floating and emergent macrophytes, consolidated banks with some sand, dense riparian vegetation with shade	Erosion and gullies, introduced exotic flora species, waterway barriers	Mary River cod Mary River turtle White-throated snapping turtle Australian lungfish Platypus Queensland lace plant	Mary River cod Low value turtle nesting banks Australian lungfish Platypus
Minor waterways (AUSRIVAS assessment sites)	Generally ephemeral, occasional permanent waterhole	High levels of riparian vegetation clearing, cattle disturbance to banks, introduced exotic flora species, erosion and sedimentation, waterway barriers	Queensland lace plant	

4. Aquatic fauna and flora assessments

4.1 Aims and objectives

The aim of the aquatic flora and fauna surveys was to identify the presence or absence of aquatic species, including opportunistic observations of other species, in the broader catchment of each waterway. The specific objectives of the surveys were to:

- Establish the presence or absence of conservation significant species within the Section D project footprint in order to inform the impact assessment process and development of appropriate management actions
- Describe the diversity of the fish community at waterways in which insufficient information is currently available in order to inform detailed design of waterway crossings and diversions and facilitate waterway barrier works approvals.

4.2 Survey locations

Aquatic habitat assessments were undertaken at the locations presented in Table 4-1.

4.2.1 General fish community surveys

General fish community surveys were conducted at four sites to fill spatial data gaps identified during a review of the REF study (Jacobs 2016) and, ultimately to assist with the waterway barrier works assessment process. Sites sampled included:

- Tannery Creek Downstream
- Corella Creek
- Unnamed Creek #1 (Lot 889 on CP864404)
- Unnamed Creek #2 (Lot 889 on CP864404)

The locations of these survey sites are presented in Table 4-1 and are shown on Figure 3-2.

4.2.2 Targeted flora and fauna surveys

The targeted fauna surveys focused on waterways in which conservation significant fish, turtle species and platypus are considered likely to occur based on data presented in Jacobs (2015). Two targeted species sites were surveyed on each of the following three creeks:

- Six Mile Creek
- Deep Creek
- Curra Creek

The locations of these survey sites are presented in Table 4-1 and shown on Figure 3-1.

Table 4-1 Survey locations and timing for each site (Zone 56, GDA94)

Site code	Site name	Creek	Date sampled	Time	Latitude	Longitude	Easting	Northing
SMCA	Six Mile Creek A	Six Mile Creek	14/03/2016	12:44	-26.22554	152.70416	470454	7099305
SMCB	Six Mile Creek B	Six Mile Creek	12/03/2016	7:30	-26.23384	152.69642	469679	7098384
DCA	Deep Creek A	Deep Creek	12/03/2016	11:30	-26.18748	152.69653	469678	7103518
DCB	Deep Creek B	Deep Creek	12/03/2016	14:40	-26.19581	152.69140	469167	7102594
CCA	Curra Creek A	Curra Creek	11/03/2016	12:10	-26.05015	152.58541	458526	7118696
CCB	Curra Creek B	Curra Creek	14/03/2016	9:31	-26.07948	152.63892	463888	7115465
CCNUS	Curra Creek North Upstream	Curra Creek	11/03/2016	15:00	-26.05865	152.59019	459008	7117756
CCNDS	Curra Creek North Downstream	Curra Creek	17/03/2016	15:00	-26.04238	152.57190	457171	7119553
CCOF	Curra Creek Overflow	Curra Creek	11/03/2016	14:30	-26.05414	152.59143	459129	7118256
CORUS	Corella Creek Upstream	Corella Creek	14/03/2016	10:45	-26.09589	152.64758	464760	7113650
CORDS	Corella Creek Downstream	Corella Creek	14/03/2016	9:45	-26.08152	152.63820	463817	7115238
KCUS	Keliher Creek Upstream	Keliher Creek	14/03/2016	8:45	-26.07009	152.62796	462790	7116501
KCDS	Keliher Creek Downstream	Keliher Creek	11/03/2016	16:00	-26.07564	152.62592	462586	7115886
TANUS	Tannery Creek Upstream	Tannery Creek	13/03/2016	12:30	-26.19664	152.70918	470942	7102505
TANDS	Tannery Creek Downstream	Tannery Creek	13/03/2016	7:20	-26.19728	152.69361	469389	7102432
MCNUS	Moody Creek North Upstream	Moody Creek	10/03/2016	13:05	-26.17077	152.69228	469247	7105365
MCNDS	Moody Creek North Downstream	Moody Creek	10/03/2016	13:50	-26.17678	152.69621	469643	7104703
BCUS	Banks Creek Upstream	Banks Creek	10/03/2016	15:30	-26.19828	152.67226	467241	7107853
BCDS	Banks Creek Downstream	Banks Creek	10/03/2016	14:37	-25.15087	152.68016	468032	7107570
TCUS	Tamaree Creek Upstream	Tamaree Creek	10/03/2016	16:35	-26.12626	152.66025	466035	7110282
TCDS	Tamaree Creek Downstream	Tamaree Creek	13/03/2016	14:20	-26.13573	151.68465	468478	7109247
TCTRIB	Tamaree Creek Tributary	Tamaree Creek	13/03/2016	13:40	-26.12384	152.66360	466370	7110560
UCRPUS	Unnamed Creek Lot 3/RP16151 Upstream	Unnamed Creek RP16151	15/03/2016	8:00	-26.2559	152.71255	471296	7095945
UCRPDS	Unnamed Creek Lot 3/ RP16151 Downstream	Unnamed Creek RP16151	15/03/2016	10:10	-26.25514	152.70050	470091	7096025
UNC1717	Unnamed Creek Lot 1717/M37818)	Unnamed Creek Lot1717	11/03/2016	7:20	-26.05984	152.59714	459703	7117627
UC2US	Unnamed Creek #2 Upstream	Unnamed Creek #2	17/03/2016	8:40	-26.05945	152.60867	460857	7117673
UC2DS	Unnamed Creek #2 Downstream	Unnamed Creek #2	17/03/2016	14:15	-26.06552	152.60529	460523	7117003

4.3 Survey timing

The aquatic fauna and flora surveys were undertaken during two survey events within the post-wet season, as follows:

- 12-18 March 2016 – electrofishing surveys (general fish community survey – four sites, targeted fauna survey – three sites) (refer to Appendix A)
- 4-10 April 2016 – targeted netting and trapping surveys (six sites), targeted electrofishing (one site) (refer to Appendix A).

Electrofishing surveys coincided with weather conditions characterised by a maximum temperature of 31.9° and total of 11.4 mm of rain (BOM Gympie station 40093) recorded during the survey period. Similar weather conditions prevailed during the targeted surveys where a maximum temperature of 31.4°C and total of 3.8 mm of rain were recorded.

4.4 Methodology

The aquatic fauna and flora surveys involved a combination of:

- Desktop assessments – to identify the potential for species of conservation significance to be present within the Section D project footprint
- General fish community surveys – to describe the diversity of the fish community at waterways crossed by the Section D project footprint
- Targeted flora and fauna surveys – establish the likelihood of occurrence of conservation significant species.

Each of these survey techniques are discussed below.

4.4.1 Desktop assessment

In order to develop an understanding of the existing environment, including the potential for species of conservation significance to be present within the Section D project footprint, background information was reviewed from the following sources:

- Department of the Environment and Energy (DEE) Protected Matters Search Tool database, which lists matters of national environmental significance within proximity to the project based on bioclimatic information
- Department of Science, Information Technology and Innovation (DSITI) Wildlife Online database, which lists previously recorded species including those listed as endangered, vulnerable or near threatened under the Queensland NC Act and the Commonwealth EPBC Act
- DNRM Regulated Vegetation Management Mapping Version 8.0, which depicts mapped remnant vegetation communities and areas mapped as essential habitat
- DAF Queensland Waterways for Waterway Barrier Works spatial data layer, to identify the risk of impact from waterway barrier works on fish movement and fish communities
- Publically available scientific reports on the Mary River catchment and relevant species including:
  - Movement patterns and habitat use in the Queensland lungfish *Neoceratodus forsteri* (Krefft 1870; Kind 2002)
  - Ecology of the Mary River turtle, *Elusor macrurus* (Flakus 2002)
  - The Mary River turtle, yesterday, today, tomorrow (Flakus and Connell 2008)

- Commonwealth conservation advice on *Elseya albagula,* white-throated snapping turtle (Threatened Species Scientific Committee (TSSC) 2014)
- Freshwater turtles in the Mary River: Review of biological data for turtles in the Mary River, with emphasis on *Elusor macrurus* and *Elseya albagula* (Limpus 2008)
- An investigation into the habitat preferences and population status of the endangered Mary River cod (*Maccullochella peelii mariensis*) in the Mary River system (Simpson 1994)
- The Mary River cod research and recovery plan (Simpson and Jackson 1996)
- Movements and habitat use by the endangered Australian freshwater Mary River Cod *Maccullochella peelii mariensis* (Simpson and Mapleston 2002)
- Field biology of the platypus (*Ornithorhynchus anatinus*): historical and current perspectives (Grant and Temple-Smith 1998).

• Existing technical reports prepared for the project including:
  - Bruce Highway (Cooroy to Curra) Section D: Keefton Road to Curra, Review of Environmental Factors (Business Case), Chapter 8 Aquatic Ecology (Jacobs 2016).

4.4.2 General fish community surveys

General fish community surveys were undertaken at waterways that were not surveyed as part of the REF (Jacobs 2016). The general fish community surveys at these sites were carried out via backpack electrofishing. Fish species captured as part of the targeted species electrofishing, netting and trapping surveys undertaken in Six Mile Creek, Deep Creek and Curra Creek (refer to Section 4.4.3) also contributed to the results of the general fish community surveys.

Electrofishing

Electrofishing was conducted to target the general fish community as well as the threatened Australian lungfish and Mary River cod (refer to Section 4.4.3). Backpack electrofishing was carried out using a Smith-Root Backpack unit LR24 model. Electrofishing was conducted by an experienced operator according to Australian Code of Electrofishing Practice procedures. A second team member assisted in the collection of stunned fish for identification and measurement. Sampling was carried out within a reach approximately 300 m in length from downstream to upstream. All major habitat types within the 300 m reach were sampled to maximise the diversity of fish captures. Within the 300 m reach, one continuous shot of up to 1200 seconds duration was conducted at each site, dependant on habitat availability and operator safety. Backpack electrofishing was only carried out in shallow wadeable habitats where the risk of drowning was considered low.

All individuals caught were identified using relevant keys and counted. A proportion of the fish catch (up to 20 individuals per species per site) were measured (total length to the nearest millimetre) and any wounds, lesions and deformities recorded, if present. Native fish were released at the site of capture while introduced fish were euthanised and disposed of appropriately and humanely and in accordance with animal ethics and fisheries scientific collection permits (refer to Section 4.4.3 for permit numbers).

4.4.3 Targeted flora and fauna surveys

The targeted flora and fauna surveys were conducted to identify those conservation significant species that have the potential to occur within Section D project footprint (Table 2-1). The survey methodology was developed with regard to the following Commonwealth and State guidelines:

- Survey guidelines for Australia's threatened fish (Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC) (2011a), which is applicable to the Australian lungfish and Mary River cod
- Survey guidelines for Australia's threatened reptiles (DSEWPAC 2011b), which is applicable to the Mary River turtle and white-throated snapping turtle
- Flora survey guidelines for protected plants (EHP 2014) which is applicable for the Queensland lace plant.

Appendix F details the survey guideline requirements for each conservation significant species and the methodologies employed for this commission. Currently, no Commonwealth or State approved survey guidelines exist for the platypus and therefore, the proposed methodology for this species has been developed based on the methodology implemented for the Section C project.

As the conservation significant species predicted to occur within the study area as defined in Section 1.3 are patchily distributed in space and time, a range of survey methods in accordance with relevant guidelines were undertaken to increase the opportunity for detecting the species in the time available. In order to streamline the surveys and provide project efficiencies, survey methods which target multiple conservation significant species were selected preferentially.

The targeted fauna survey methods nominated included the following techniques:

- Backpack electrofishing (refer to Section 4.4.2)
- Fyke netting
- Turtle cathedral trapping
- Snorkelling
- Meander surveys
- Dusk platypus survey
- Opportunistic sightings.

Bait trapping was also undertaken to survey the general fish community at these locations.

A summary of the survey techniques applicable for each target species is provided in Table 4-2.

Aquatic flora and fauna surveys were conducted in accordance with the following permits and approvals:

- GHD Department of Employment, Economic Development and Innovation Scientific Users Registration Certificate (Registration Number 132)
- GHD EHP Scientific Purposes Permit (permit number WISP11392912)
- Animal Reacher Authority issued by the accredited GHD Animal Ethics Committee
- GHD QLD General Fisheries Permit (permit number 171785).

As description of each survey technique is provided below.

Fyke netting

Fyke netting was undertaken to target larger fish species, particularly the Australian lungfish, and facilitate comparison with results from preliminary surveys (Jacobs, 2016). Turtles and platypus were also likely be captured using this method.

Fyke netting was used in slow flowing environments (i.e. pool edges), where the channel was wide enough for nets to be deployed without obstructing more than 50 % of the wetted channel width and, where the water level was just above the entry hoop, but not greater than 1 m deep. At appropriate sites, two double-winged Fyke nets (1.2 m x 0.8 m opening – 6 mm mesh, 10 m wings) were set with the mouth of the net facing downstream and the cod ends tied above the water level to avoid mortality of air breathing species such as turtles (refer to Plate 4-1). Nets were set between 2 pm and 10 pm, and checked regularly for signs of turtle and platypus.

Table 4-2 Summary of aquatic fauna and flora survey methodology nominated and target species

Survey method	Australian lungfish	Mary River cod	Mary River turtle	White-throated snapping turtle	Platypus	General fish community	General turtle community	Queensland lace plant
Electofishing	✓	✓				✓		
Fyke netting	✓	✓	✓	✓		✓	✓	
Turtle cathedral traps			✓	✓			✓	
Snorkelling*	✓	✓	✓	✓		✓	✓	
Dusk pool watches	✓		✓	✓	✓		✓	
Meander survey								✓
Opportunistic observations	✓	✓	✓	✓	✓	✓	✓	✓

*Snorkelling surveys for conservation significant species were attempted at all nominated sites; however, due to high turbidity levels and a visibility less than 30 cm, this survey technique could not be completed.

Plate 4-1 Fkye netting within Six Mile Creek A

Turtle trapping

Turtle cathedral traps were used to target the Mary River turtle and white-throated snapping turtle with other least concern turtle species likely to be captured as well. Cathedral traps consisted of a circular collapsible base with three equally spaced funnel openings. Turtles captured enter the traps via funnel openings in the side of the base, and move through a one-way entrance into the upper chamber. The vertical section of the trap was held in the water column by a series of floats. The end of the upper chamber was also fixed above the water surface to provide an aerial breathing chamber for the captured turtles (refer to Plate 4-2).

Where shallow water prevented the full extension of the cathedral trap, the vertical section of the trap was collapsed together so that only the base chamber and upper aerial chamber remained. Ten cathedral traps baited with beef heart were set at approximately 2 pm and retrieved at approximately 10 pm. Traps were checked twice during this period.

Snorkelling

Snorkelling is the preferred method for surveying Mary River turtle and white-throated snapping turtle (Limpus 2008). Mary River cod and Australian lungfish can also be recorded opportunistically through this method. Two ecologists, suitably trained in the identification of the target species, were proposed to snorkel the length of each survey site targeting the sides and bottom of the waterway. Target species were to be identified visually and digital video footage recorded on an underwater camera. A minimum of two search hours per person was proposed at each survey site.

Plate 4-2 Turtle cathedral trap within Six Mile Creek B

Dusk pool watches

Dusk pool watches were conducted at each site to target air-breathing platypus, Australian lungfish, Mary River turtle and white-throated snapping turtle. Pool watches were undertaken by two ecologists and were thirty minutes in duration.

Meander surveys

Surveys for the Queensland lace plant were conducted in accordance with the flora survey guidelines for protected plants (EHP 2014). Meander surveys were conducted as part of the detailed habitat assessments (refer to Section 3.2.1 and 3.4.2) and during geomorphology assessments (refer to Section 6).

Opportunistic observations

All aquatic flora and fauna species opportunistic observed within the study area during the survey events were recorded.

Bait trapping

Bait trapping was conducted to target the general fish community and facilitate comparison with results from preliminary surveys (Jacobs, 2016). Five commercial concertina 3 mm mesh bait traps were deployed for a minimum of two and maximum of four hours to target smaller cryptic species. Traps were set along the creek edge in slow flowing waters and were baited with dry pelletised cat food. Bait trapping was carried out where there was sufficient habitat and water depth, and currents were slow enough to prevent the traps being swept off the substratum or washed downstream.

Data recording

All species caught were identified using relevant keys and counted. All targeted species specimens captured were photographed and measured (where possible) and details regarding the method of capture and habitat captured from recorded, along with GPS details of the capture location.

4.5 Scope and limitations

A number of waterway reaches were not suitable for electrofishing sampling due to factors such as depth, high flow, lack of appropriate habitat and/or inappropriate conductivity. These included:

- Unnamed Creek #2 Lot 889 on CP864404 (general fish community survey site) – creek was dry at time of sampling
- Unnamed Creek Lot 1717 on M37818 (general fish community survey site) – insufficient habitat available (only a very small pool present) and electrical conductivity was too high for the electrofisher to be effective
- Deep Creek B (threatened fauna site) – creek was too deep and unsafe for backpack electrofishing to be conducted
- Curra Creek B (threatened fauna site) – creek was too deep and unsafe for backpack electrofishing to be conducted.

Snorkelling surveys for conservation significant turtles were attempted at all nominated sites on 4 April 2016; however, due to high turbidity levels and a visibility less than 30 cm, this survey technique could not be completed. As a result, the likelihood of occurrence assessment for turtle species is based on habitat conditions and suitability, and is unlikely to change significantly as a result of additional site work (unless a turtle was sighted)..

Results of the flora and fauna surveys are based on a single sampling event undertaken in March/April 2016. The surveys aimed to identify the presence of conservation significant species within the Section D project footprint and were not designed to determine population abundance or density.

The likelihood of occurrence of species not recorded during the field survey event is based on an assessment of habitat conditions/suitability and information identified during the desktop assessment. Habitat assessment, species profiles and hydrological information has been used to provide an understanding of the seasonal variability in the environment.

4.6 Results and discussion

4.6.1 Fish

Species richness and abundance

The desktop assessment identified a total of 50 fish species have been previously recorded in the freshwater reaches of the Mary River. Of these, 24 species were recorded within the Section D project footprint during the 2015 (Jacobs 2016) and 2016 (this study) field surveys (Table 4-3). Species confirmed present included the endangered Mary River cod (*Maccullochella mariensis*), recorded at Six Mile Creek B (discussed further in Section 5.3.3), and two introduced exotic species: eastern mosquitofish (*Gambusia holbrooki*) and platy (*Xiphophorus maculatus*). The eastern mosquitofish was widely distributed across the study area with the species recorded at 12 of the 19 survey sites. This species was the most abundant species recorded (a combined total of 2840 individuals) during the 2015 and 2016 field surveys, with Deep Creek A supporting the majority of those individuals captured.

All other fish species recorded during the field surveys were common least concern fauna. The most numerically abundant native species included: carp gudgeon (*Hypseleotris sp*; N=550); crimson spotted rainbowfish (*Melanotaenia duboulayi*; N=433); firetail gudgeon (*Hypseleotris galii*; N=487) and empire gudgeon (*Hypseleotris compressa*; N=396). The carp gudgeon and crimson spotted rainbow fish were also the most widely distributed species, being recorded at 13 and 11 sites, respectively (refer to Plate 4-3).

Curra Creek A supported the highest species richness (N=15 species), followed by Deep Creek A (N=12 species), Deep Creek B (N=13 species) and Six Mile Creek B (N=12 species). Curra Creek A and Deep Creek B also recorded the highest abundance of native fish with a total of 603 and 847 individuals captured during the 2016 field surveys, respectively. Survey sites that supported low species richness and/or abundance included Corella Creek, Keliher Creek and Unnamed Creek #2 Lot 889 on CP864404.

Plate 4-3 Fish species recorded during 2016 field surveys

a) freshwater catfish (*Tandanus tandanus*); b) spangled perch (*Leiopotherapon unicolor*); c) crimson-spotted rainbowfish (*Melanotaenia duboulayi*); d) Agassiz's glassfish (*Ambassis agassizii*); e) firetail gudgeon (*Hypseleotris galii*); f) smelt (*Retropinna semoni*).

Movement biology

Fish can be categorised by their movement behaviours as being either migratory or non-migratory. A migratory fish can be further defined as being either diadromous or potamodromous (Figure 4-1), where diadromous fish species migrate between marine and freshwater environments, while potamodromous species migrate wholly within freshwaters. Further complexity exists within diadromous fish species, as this movement biology can be broken down into the following three categories:

- Catadromous behaviour, where fish migrate from freshwater to the marine environment for the purposes of breeding
- Anadromous behaviour, where fish migrate from the marine environment to freshwater for the purposes of breeding
- Amphidromous behaviour, where fish migrate between fresh and marine waters but not for the purposes of breeding.

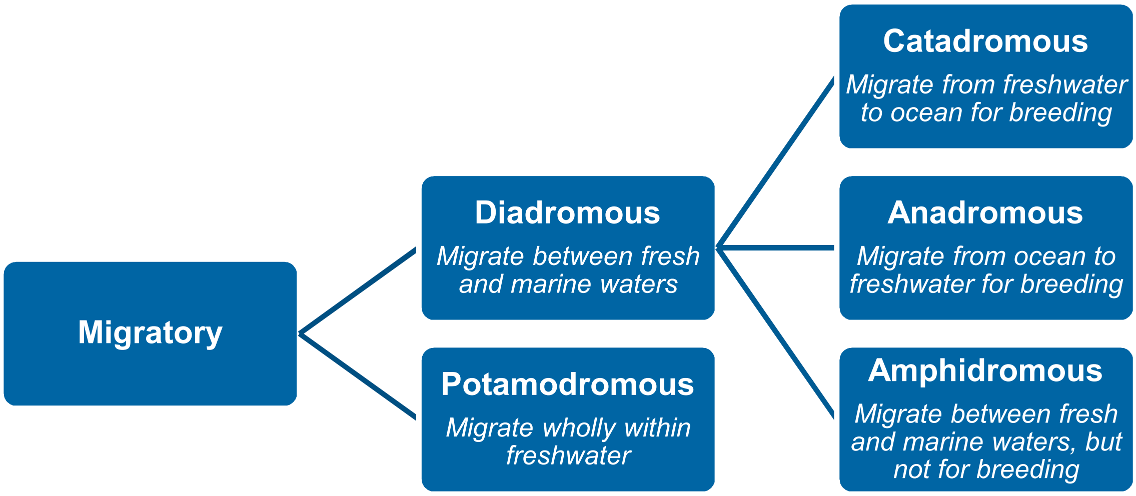


Figure 4-1 Movement biology and categories of migratory fish

The fish community within the Mary River is dominated by potamodromous; however, several diadromous species are known to occur in the catchment. The compiled species list in Table 4-4 indicates that five diadromous species were recorded within the Section D project footprint during field surveys. These species include:

- Australian bass (*Macquaria novemaculeata*)
- Estuary glassfish (*Ambassis marianus*)
- Marbled eel (*Anguillla reinhardtii*)
- Smelt (*Retropinna semoni*)
- Empire gudgeon (*Hypseleotris compressa*).

Many of the potamodromous species recorded during the field surveys are not sedentary and undertake upstream and downstream movements within the freshwater environment (Table 4-4). Fish migration is strongly cued with hydrology with first spring flows and flood flows known to be particularly important movement triggers for many species (Arthington 2012; Renfree and Marsden 2006). Other factors or combinations of environmental factors which stimulate migration include water temperature, day length, food availability, fish biomass and water chemistry (Baron 2006;

Sheaves et al. 2007; Arthington and Balcombe 2011). Of the potamodromous species confirmed present within the Section D project footprint, the spangled perch (*Leiopotherapon unicolor*) and Mary River cod are known to undertake particular long distance migrations (Pusey *et al*. 2004).

Fish passage will be further addressed during the detailed design phase of the project and subsequent design of waterway barriers across the length of the Section D project footprint.

Table 4-3 Fish survey results (2015 and 2016 survey events)

Species	Status	Six Mile Creek A	Six Mile Creek B	Curra Creek A	Curra Creek B	Deep Creek A	Deep Creek B	Tannery Creek D/S	Corella Creek	Unnamed Creek #1	Unnamed Creek #2	Curra Creek North	Keliher Creek	Upper Curra Creek	Tamaree Creek 1	Tamaree Creek 2	Banks Creek	Moody Creek	Deep Creek	Six Mile Creek
Agassiz's glassfish (*Ambassis agassizii*)				67		3	186							9						2
Estuary glassfish (*Ambassis marianus*)												21				13	3	7	27	
Australian bass (*Macquaria novemaculeata*)																			1	
Carp gudgeon (*Hypseleotris sp.*)			4	1		6				1		53	2	200	69	59	35	80	35	5
Crimson spot rainbowfish (*Melanotaenia duboulayi*)		1	7	224	10	2	118					11		27		9			19	5
Eastern rainbow fish (*Melanotaenia splendida subsp. splendida*)			1			3				6										
Empire gudgeon (*Hypseleotris compressa*)		1	26	19	5	10	335													

Species	Status	Six Mile Creek A	Six Mile Creek B	Curra Creek A	Curra Creek B	Deep Creek A	Deep Creek B	Tannery Creek D/S	Corella Creek	Unnamed Creek #1	Unnamed Creek #2	Curra Creek North	Keliher Creek	Upper Curra Creek	Tamaree Creek 1	Tamaree Creek 2	Banks Creek	Moody Creek	Deep Creek	Six Mile Creek
Firetail gudgeon (*Hypseleotris galii*)			5	238	219	7	8	9	1											
Flathead gudgeon (*Philypnodon grandiceps*)			1	3	7	1	20					11		2			1			
Fly-specked hardyhead (*Craterocephalus stercusmuscarum*)				28			54												51	1
Freshwater catfish (*Tandanus tandanus*)				1	1		1					17		2	1	2	19	1	6	
Hyrtle's catfish (*Neosilurus hyrtlii*)																			1	
Marbled eel (*Anguillla reinhardtii*)		5	11			2	3					2		2		3	2	1		
Mary River cod (*Maccullochella mariensis*)	Endangered (EPBC Act)		1																	
Mosquitofish (*Gambusia holbrooki*)	Exotic			579	33	2016	14	107			3	8			24	31	5	19		1
Mouth almighty (*Glossamia aprion*)				5															1	

Species	Status	Six Mile Creek A	Six Mile Creek B	Curra Creek A	Curra Creek B	Deep Creek A	Deep Creek B	Tannery Creek D/S	Corella Creek	Unnamed Creek #1	Unnamed Creek #2	Curra Creek North	Keliher Creek	Upper Curra Creek	Tamaree Creek 1	Tamaree Creek 2	Banks Creek	Moody Creek	Deep Creek	Six Mile Creek
Pacific blue-eye (*Psuedomugil signifer*)		4	2				4	3												6
Platy (*Xiphophorus maculatus*)	Exotic		1	6		2	6	27				2							3	
Purple spotted gudgeon (*Mogurnda adspersa*)												4								
Rendahl's catfish (*Porochilus rendahli*)				9																
Sleepy cod (*Oxyeleotris lineolata*)				2																
Smelt (*Retropinna semoni*)		24	78			8	26			2	3	2							29	15
Spangled perch (*Leiopotherapon unicolor*)				1													4			1
Western carp gudgeon (*Hypseleotris klunzingeri*)			1	5	109	33	92													
Fry										2										

Species	Status	Six Mile Creek A	Six Mile Creek B	Curra Creek A	Curra Creek B	Deep Creek A	Deep Creek B	Tannery Creek D/S	Corella Creek	Unnamed Creek #1	Unnamed Creek #2	Curra Creek North	Keliher Creek	Upper Curra Creek	Tamaree Creek 1	Tamaree Creek 2	Banks Creek	Moody Creek	Deep Creek	Six Mile Creek
Total fish species richness		5	12	15	7	12	13	4	1	4	1	10	1	6	3	6	7	5	10	8
Total fish abundance		35	138	1188	384	2093	867	146	1	11	4	131	2	242	94	117	69	108	173	36
Total abundance native fish species		35	137	603	351	75	847	12	1	11	4	121	2	242	70	86	64	89	170	35

Blue columns: GHD 2016 results; green columns: Jacobs 2016 results

Table 4-4 Movement behaviour of fish species known to occur within the Section D project footprint (Pusey *et al.* 2004)

Species	Conservation status	Movement behaviour
Agassiz's glassfish (*Ambassis agassizii*)		Potamodromous Adults and juveniles move upstream for habitat and dispersal, possibly in response to flooding. A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle.
Estuary glassfish (*Ambassis marianus*)		Facultative amphidromous Estuarine species that may migrate between freshwater and the sea but movement is not required as part of the species' life cycle
Australian bass (*Macquaria novemaculeata*)		Marginally catadromous Adults migrate downstream to spawn in brackish tidal and estuarine waters.
Carp gudgeon (*Hypseleotris sp.*)		Potamodromous - a freshwater species that does not require access to estuarine or marine environment at any stage of life cycle. However large schools undertake upstream dispersal.
Crimson spot rainbowfish (*Melanotaenia duboulayi*)		Potamodromous Although tolerant of elevated salinities, the crimson-spotted rainbow fish is a freshwater species that does not require access to estuarine or marine environments at any stage of life cycle.
Eastern rainbow fish (*Melanotaenia splendida subsp. splendida*)		Potamodromous A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle.
Empire gudgeon (*Hypseleotris compressa*)		Facultatively amphidromous Species may have estuarine larval phase due to passive dispersal downstream. Breeding may occur in freshwater and brackish environments. Large scale upstream and downstream migrations during summer wet season flows.
Firetail gudgeon (*Hypseleotris galii*)		Potamodromous A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle.
Flathead gudgeon (*Philypnodon grandiceps*)		Facultative potamodromous A predominantly freshwater species where access to estuarine or marine environments is not an essential component of the life history. However known to move through brackish and freshwater reaches for unknown reasons.
Fly-specked hardyhead (*Craterocephalus stercusmuscarum*)		Potamodromous Entire life-cycle (including spawning) occurs in freshwater. Undertakes local dispersal and colonisation movements.
Freshwater catfish (*Tandanus tandanus*)		Potamodromous A generally sedentary freshwater species that does not require access to estuarine or marine environments at any stage of life cycle.
Hyrtl's catfish (*Neosilurus hyrtlii*)		Potamodromous Upstream migrations from dry season refugia thought to coincide with spawning.
Marbled eel (*Anguillla reinhardtii*)		Catadromous Passage between freshwater and saltwater habitats an obligatory component of species' life history. Adults migrate to the sea during late summer – autumn for spawning. Also move within the river for habitat and dispersal. Juveniles (elvers) – migrate from the sea to coastal rivers during spring – summer.

Species	Conservation status	Movement behaviour
Mary River cod (*Maccullochella mariensis*)	Endangered (EPBC Act)	Potamodromous This species generally remains within a small home range. Adult cod are known to undertake long-distance movements (>30 km) either upstream or downstream during flood events.
Mosquitofish (*Gambusia holbrooki*)	Exotic	Potamodromous
Mouth almighty (*Glossamia aprion*)		Potamodromous A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle.
Pacific blue-eye (*Psuedomugil signifer*)		Potamodromous Although this species is known to utilise estuarine and marine environments, access to saline habitats is not obligatory for survival.
Platy (*Xiphophorus maculatus*)	Exotic	Potamodromous
Purple spotted gudgeon (*Mogurnda adspersa*)		Potamodromous A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle.
Rendahl's catfish (*Porochilus rendahli*)		Potamodromous Adults migrate downstream to spawn in flooded lowland lagoons. Upstream migration of adults and juveniles coincident with the start of the dry season.
Sleepy cod (*Oxyeleotris lineolata*)		Potamodromous Does not make substantial migrations and does not require access to estuarine or marine environment at any stage of life cycle.
Smelt (*Retropinna semoni*)		Potamodromous and facultative amphidromous Movements between estuaries, brackish lowland rivers and freshwaters do occur but probably not for the purposes of reproduction. Juvenile and sub-adults have been observed moving upstream.
Spangled perch (*Leiopotherapon unicolor*)		Potamodromous Undertakes spawning migrations within the freshwater environment during the wet season. This species may also undertake substantial movements away from dry season habitats as they recede.
Western carp gudgeon (*Hypseleotris klunzingeri*)		Potamodromous A freshwater species that does not require access to estuarine or marine environment at any stage of life cycle. May move upstream to spawn during the wet season.

4.6.2 Reptiles

Six species of freshwater turtle are known to occur within the Mary River catchment. These species include:

- Broad-shelled river turtle (*Chelodina expansa*)
- Eastern snake-necked turtle (*Chelodina longicollis*)
- Krefft's river turtle (*Emydura macquarii krefftii*)
- Saw-shelled turtle (*Wollumbinia latisternum*)
- White-throated snapping turtle (*Elseya albagula*) - critically endangered (EPBC Act) and endangered (NC Act)
- Mary River turtle (*Elusor macrurus*) - endangered (EPBC Act and NC Act)

A total of 19 turtles were captured within the Section D project footprint during the 2015 and 2016 field surveys (Table 4-5; Plate 4-4). Species recorded included the Krefft's river turtle; saw-shelled turtle and white-throated snapping turtle (refer to Section 5.3). Turtles were most abundant at Six Mile Creek B and Curra Creek A. An eastern waterdragon (*Intellagama lesueurii*) was also recorded at Deep Creek A.

Plate 4-4 Krefft's river turtle (*Emydura krefftii*; top) and saw-shelled turtle (*Wollumbinia latisternum*; bottom) recorded within the Section D project footprint during 2016 surveys

4.6.3 Mammals

Platypus (*Ornithorhynchus anatinus*) are known to occur throughout the Mary River catchment and the species was confirmed present at Deep Creek during 2015 surveys. Anecdotal advice from landholders also indicates the species occurs in Curra Creek. One water rat (*Hydromys chrysogaster*) was observed at Six Mile Creek B during the 2016 surveys.

Table 4-5 Reptile survey results (2015 and 2016 survey events)

Species	Status	Six Mile Creek A	Six Mile Creek B	Curra Creek A	Curra Creek B	Deep Creek A	Deep Creek B	Tannery Creek D/S	Corella Creek	Unnamed Creek #1	Unnamed Creek #2	Curra Creek North	Keliher Creek	Upper Curra Creek	Tamaree Creek 1	Tamaree Creek 2	Banks Creek	Moody Creek	Deep Creek	Six Mile Creek
Reptiles																				
Eastern water dragon (*Intellagama lesueurii*)						1														
Saw-shelled turtle (*Wollumbinia latisternum*)			4			1						1				2				
Krefft's river turtle (*Emydura macquarii krefftii*)			3	4	1									1						
White-throated snapping turtle (*Elseya albagula*)	Critically endangered (EPBC Act); endangered (NC Act)				1															
Total reptile species richness		0	2	1	2	2	0	0	0	0	0	1	0	1	0	1	0	0	0	0
Total reptile abundance		0	7	4	2	2	0	0	0	0	0	1	0	1	0	2	0	0	0	0

Blue columns: GHD 2016 results; green columns: Jacobs 2016 results

4.6.4 Crustaceans

A total of six species of crustacean were recorded within the Section D project footprint during the 2015 and 2016 surveys (Table 4-6; Plate 4-5). The freshwater prawn (*Macrobrachium australiense*; Plate 4-5) was the most abundant (N = 616) species captured followed by the freshwater prawn (*Caridina sp*; N = 402). Deep Creek B and Six Mile Creek supported the highest species richness and abundance of crustaceans, respectively. Of note, *Tenuibranchiurus glypticus* (swamp crayfish) which is listed as endangered under the NC Act was recently recorded within the Section C project. This species was not recorded during the field survey however has been previously recorded within 50 km of the Section D project footprint on the State's Wildlife Online database. This species is a cryptic species which is reported to be restricted to wallum swamp lands across the south-east Queensland coast (Dawkins, 2010).

Plate 4-5 Slender yabby (*Cherax dispar*; left) and freshwater prawn (*Macrobrachium australiense*; right) recorded within the Section D project footprint during 2016 surveys

Table 4-6 Crustacean survey results (2015 and 2016 survey events)

Species	Status	Six Mile Creek A	Six Mile Creek B	Curra Creek A	Curra Creek B	Deep Creek A	Deep Creek B	Tannery Creek D/S	Corella Creek	Unnamed Creek #1	Unnamed Creek #2	Curra Creek North	Keliher Creek	Upper Curra Creek	Tamaree Creek 1	Tamaree Creek 2	Banks Creek	Moody Creek	Deep Creek	Six Mile Creek
Freshwater prawn (*Macrobrachium australiense*)		262	79	31			76					10		4	20	35	10	2		87
Freshwater shrimp (*Caridina sp*)												120		40	95	19	25	96	7	
Glass shrimp (*Paratya australiensis*)				154	45	27	35													
Queensland crayfish (*Cherax destructor*)							2													
Slender yabby (*Cherax dispar*)		16	1	1	2								2	1						
Orange-fingered yabby (*Cherax depressus*)							5						1		3	4				
Total crustacean species richness		2	2	3	2	1	4	0	0	0	0	2	2	3	3	3	2	2	1	1
Total crustacean abundance		278	80	186	47	27	118	0	0	0	0	130	3	45	118	58	35	98	7	87

Blue columns: GHD 2016 results; green columns: Jacobs 2016 results

4.7 Summary

Twenty-four fish species were recorded within the Section D project footprint during the 2015 (Jacobs, 2016) and 2016 (this study) field surveys. Species confirmed present included the endangered Mary River cod (*Maccullochella mariensis*), recorded at Six Mile Creek B, and two introduced exotic species: eastern mosquitofish (*Gambusia holbrooki*) and platy (*Xiphophorus maculatus*). All other fish species recorded during the field surveys were common least concern fauna.

The fish community within the Mary River is dominated by potamodromous species. Upstream and downstream migration within the freshwater environment is an important aspect of the life cycle for many species with movement strongly cued to hydrology. Two of the species confirmed present within the Section D project footprint (i.e. spangled perch (*Leiopotherapon unicolor*) and Mary River cod (*Maccullochella mariensis*) undertake particularly long distance migrations within the freshwater environment. Both the Mary River cod and spangled perch were recorded in Six Mile Creek either during this survey or the 2015 survey (Jacobs, 2016), while the spangled perch was also recorded in Curra Creek and Banks Creek (Jacobs, 2016). As a result, crossing structures over these waterways should consider the provision of fish passage during the detailed design phase of the project.

Five species confirmed present within the Section D project footprint are known to migrate between marine and freshwater environments (i.e. diadromous species).

Six species of freshwater turtle occur within the Mary River catchment (Limpus 2008). Species recorded within the Section D project footprint included the Krefft's river turtle (*Emydura macquarii krefftii*); saw-shelled turtle (*Wollumbinia latisternum*) and the critically endangered (EPBC Act) and endangered (NC Act) white-throated snapping turtle (*Elseya albagula*).

The special least concern platypus (*Ornithorhynchus anatinus*) was confirmed present at Deep Creek during 2015 surveys (Jacobs, 2016). Anecdotal advice from landholders also indicates the species occurs in Curra Creek. Other aquatic species recorded within the Section D footprint during field surveys included the eastern waterdragon (*Intellagama lesueurii*), water rat (*Hydromys chrysogaster*) and six species of crustacean.

5. Likelihood of occurrence assessment

5.1 Aims and objectives

The aim of the assessment was to update the likelihood of occurrence of conservation significant species within the Section D project footprint previously assessed by Jacobs in 2016 (Jacobs, 2016), refer to Table 2-1 of this document. The updated likelihood of occurrence will inform the impact assessment process and development of appropriate management actions. The specific objective of the assessment was to update the likelihood of occurrence rating for each conservation significant species within each of the main waterways within the Section D project footprint.

5.2 Methodology

The potential for species of conservation significance (protected under the EPBC Act and/or NC Act) to be present within the Section D project footprint was determined based on results of the aquatic habitat assessment surveys (refer to Section 3) and aquatic flora and fauna surveys (refer to Section 4). A likelihood of occurrence assessment has been undertaken for conservation significant species identified as potentially occurring within the survey area using the following categories:

- **Unlikely to occur:**
  - Species has not been recorded within the waterway **and/or**
  - Current known distribution does not encompass the waterway **and/or**
  - Suitable habitat is generally lacking from the waterway
- **Potential to occur:**
  - Species has not been recorded in the waterway although species' distribution incorporates the waterway **and**
  - Potentially suitable habitat occurs in the waterway (but may not be particularly abundant or optimal habitat)
- **Likely to occur:**
  - Species has been recorded in the waterway **and**
  - Suitable habitat is present (species determined to be 'likely to occur' are otherwise 'known to occur' within the waterway **and**
  - Has suitable habitat present; however, species was not recorded during field surveys
- **Known to occur:**
  - Species recorded during field surveys.

5.3 Results and discussion

The results of the likelihood of occurrence assessment are summarised in Table 5-1 with additional information on each species provided below.

Table 5-1 Summary of the likelihood of occurrence assessment

Species	Conservation status		Updated likelihood of occurrence			
	EPBC Act	NC Act	Six Mile Creek	Deep Creek	Curra Creek	Minor waterways (AUSRIVAS assessment sites)
Mary River turtle (*Elusor macrurus*)	Endangered	Endangered	**Likely to occur** (foraging)	**Potential to occur** (foraging)	**Potential to occur** (foraging)	**Unlikely to occur**
White-throated snapping turtle (*Elseya albagula*)	Critically endangered	Endangered	**Likely to occur** (foraging and low value breeding)	**Potential to occur** (foraging and low value breeding)	**Known to occur** (foraging and low value breeding)	**Unlikely to occur**
Mary River cod (*Maccullochella mariensis*)	Endangered	-	**Known to occur** (foraging and breeding)	**Potential to occur** (foraging and breeding)	**Potential to occur** (foraging and breeding)	**Unlikely to occur**
Australian lungfish (*Neoceratodus forsteri*)	Vulnerable	-	**Potential to occur** (foraging)	**Potential to occur** (foraging)	**Potential to occur** (foraging and breeding)	**Unlikely to occur**
Platypus (*Ornithorhynchus anatinus*)	-	Special least concern	**Potential to occur** (foraging and breeding)	**Known to occur** (foraging and breeding)	**Likely to occur** (foraging and breeding)	**Unlikely to occur**
Queensland lace plant (*Aponogeton elongatus*)	-	Near threatened	**Unlikely to occur**	**Unlikely to occur**	**Likely to occur**	**Known to occur**

5.3.1 Mary River turtle (*Elusor macrurus*)

The Mary River turtle has not been previously recorded in any of the waterways within the Section D project footprint and the species was not observed during field surveys. The majority of the waterways within the Section D project footprint are ephemeral and do not contain suitable habitat for this species. The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek do however, provide potentially suitable habitat conditions for the Mary River turtle. Key habitat features, such as instream woody debris, undercut banks, and overhanging riparian vegetation, are present in a relatively high abundance within these areas. The pool-riffle-glide sequences within Six Mile Creek represent ideal habitat conditions for the Mary River turtle and, due to the proximity of the Section D project footprint to the main channel of the Mary River, the Mary River turtle is considered likely to occur within this reach. Reduced connectivity and degradation from land use practises are likely to affect the distribution of the Mary River turtle within Deep Creek and Curra Creek. Habitat conditions within these waterways is considered sub-optimal with potential habitation by the Mary River turtle most likely during periods of increased water flows within the main channel of the Mary River. Overall, the Mary River turtle has the potential to occur within Deep Creek and Curra Creek within the Section D project footprint.

Nesting of the Mary River turtle is restricted to steep, sparsely vegetated sandy banks with aggregated nesting occurring primarily at a small number of traditional banks within the lower catchment near Tiaro. No aggregated nesting has been recorded within any of the waterways within the Section D project footprint. Although some sandy banks are present within Six Mile Creek, Deep Creek and Curra Creek, the suitability of these banks for turtle nesting is generally limited by the density of riparian bank vegetation and degradation by cattle. As a result, nesting of the Mary River turtle within the Section D project footprint is considered unlikely to occur.

5.3.2 White-throated snapping turtle (*Elseya albagula*)

The white-throated snapping turtle was opportunistically observed surfacing within Curra Creek during field surveys. This species primarily inhabits permanent flowing pools within the main channel of the Mary River and major tributaries. The white-throated snapping turtle had not been previously recorded from any of the waterways within the Section D project footprint. The majority of the waterways within the Section D project footprint are ephemeral and do not contain suitable habitat for this species. The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek do however, provide potentially suitable habitat conditions for the white-throated snapping turtle. Key habitat features, such as instream woody debris, undercut banks, and overhanging riparian vegetation, are present in a relatively high abundance within these areas. The pool-riffle-glide sequences within Six Mile Creek represent ideal habitat conditions for the white-throated snapping turtle and due to the proximity of the Section D project footprint to the main channel of the Mary River, the white-throated snapping turtle is considered likely to occur within this reach. One female white-throated snapping turtle was confirmed present within Curra Creek during field surveys. Habitat conditions within Curra Creek are considered sub-optimal for the white-throated snapping turtle, due to reduced connectivity and habitat degradation, and as such, the species is predicted to occur at lower densities than expected within pool-riffle-run sequences (e.g. within the main Mary River channel and Six Mile Creek). Similar habitat conditions occur within Deep Creek, and as such, the white-throated snapping has the potential to occur at low densities within this reach also. .

Similar to the Mary River turtle, aggregated nesting of the white-throated snapping turtle primarily occurs at a small number of traditional sandy banks. Nesting requirements for this species are, however, more variable than those for the Mary River turtle, with nests recorded in a variety of substrates ranging from sand to dark clay and grassed loam slopes (Limpus 2008; Limpus et al., 2011). No white-throated snapping turtle nesting has been recorded within any of the waterways within the Section D project footprint. Alluvial sandy/loam banks are present within Six Mile Creek, Deep Creek and Curra Creek and the suitability of these banks for turtle nesting is generally limited by the high density of riparian bank vegetation and degradation by cattle. Where bank vegetation and degradation is reduced within Six Mile Creek, Deep Creek and Curra Creek, nesting of the white-throated snapping turtle has the potential to occur; however, this habitat is likely to be low value and support only isolated nesting.

5.3.3 Mary River cod (*Maccullochella mariensis*)

The Mary River cod was confirmed present within Six Mile Creek during the 2016 electrofishing surveys. The deep permanent pool habitat within Six Mile Creek provides suitable habitat conditions for this species with key habitat features such as instream woody debris, undercut banks, overhanging riparian vegetation and shading present in a relatively high abundance. Less than 50 % (i.e. 20 km) of Six Mile Creek contains deep permanent pool habitat suitable for this species. The Section D project footprint forms part of the suitable cod habitat within the Six Mile Creek reach.

In accordance with the EPBC Act significant impact guidelines (DotE 2013), Six Mile Creek is considered habitat critical to the survival of the Mary River cod as the creek is necessary for critical activities such as foraging and breeding. Supporting one of only three populations of the species, Six Mile Creek is also critical for maintaining genetic diversity and for the long-term maintenance of the species.

The Mary River cod has not been previously recorded within Deep Creek or Curra Creek; however, an anecdotal record of the species exists from the confluence of Curra Creek and the Mary River (recorded in 1989, Simpson and Jackson 1996). Reaches of Deep Creek and Curra Creek that contain deep pools, high abundance of large woody debris, presence of overhanging vegetation and shaded habitat provide potentially suitable habitat conditions for the Mary River cod within the Section D project footprint. The likelihood of occurrence of the Mary River cod within these waterways, is; however, reduced by the distance and connectivity of these creeks from the three main populations of the species. The Mary River cod has the potential to occur in Deep Creek and Curra Creek at low densities.

Spawning of the Mary River cod is thought to occur in association with large woody debris, particularly hollow logs. Potentially suitable breeding habitat for this species therefore occurs throughout Six Mile Creek, Deep Creek and Curra Creek, where large woody debris is present.

5.3.4 Australian lungfish (*Neoceratodus forsteri*)

The Australian lungfish has not been previously recorded from any of the waterways within the Section D project footprint and the species was not observed during field surveys. The majority of the waterways within the Section D project footprint are ephemeral and do not contain suitable habitat for this species. The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek do however, provide potentially suitable habitat conditions for the Australian lungfish. Key habitat features, such as instream woody debris, undercut banks, and overhanging riparian vegetation, are present in a relatively high abundance within these areas. As a result, the adult Australian lungfish has the potential to occur within these waterways within the Section D project footprint.

Dense macrophyte beds are utilised by the Australian lungfish for spawning and as habitat for juveniles. Macrophytes were not observed within Six Mile Creek or Deep Creek and as a result, these waterways do not provide breeding or nursery habitat for this species. Some submerged macrophytes were present within Curra Creek but the suitability of this for lungfish spawning is likely to be reduced by limited connectivity to the main Mary River channel.

5.3.5 Platypus (*Ornithorynchus anatinus*)

The platypus is known to occur within the Mary River catchment and the species was confirmed present within Deep Creek during 2015 field surveys (Jacobs, 2016). Anecdotal advice from landholders also indicates the species occurs in Curra Creek.

The majority of the waterways within the Section D project footprint are ephemeral and do not contain suitable habitat for the platypus. The deep permanent pool habitats within Six Mile Creek, Deep Creek and Curra Creek do however, provide potentially suitable habitat conditions for the species. Key habitat features, such as instream woody debris, undercut banks, and overhanging riparian vegetation, are present in a relatively high abundance within these areas.

No burrows were observed during field surveys however, consolidated steep banks providing potentially suitable burrowing conditions, were observed within Six Mile Creek, Deep Creek and Curra Creek.

5.3.6 Queensland lace plant (*Aponogeton elongates*)

Backwater habitats within Curra Creek provide suitable habitat conditions for the Queensland lace plant. Substrates and flow through the reaches of Six Mile Creek and Deep Creek were not found to be suitable for this species.

6. Geomorphology assessment

6.1 Aims and objectives

The main objective of the geomorphic channel morphology survey is to acquire quantitative and descriptive data on the key physical features along 11 watercourse reaches in close proximity to the proposed crossing locations. This information will be used to identify potential habitat features for conservation significant species, and to assist in the development of the detailed design for diversion works and waterway barrier works approvals.

6.2 Survey sites

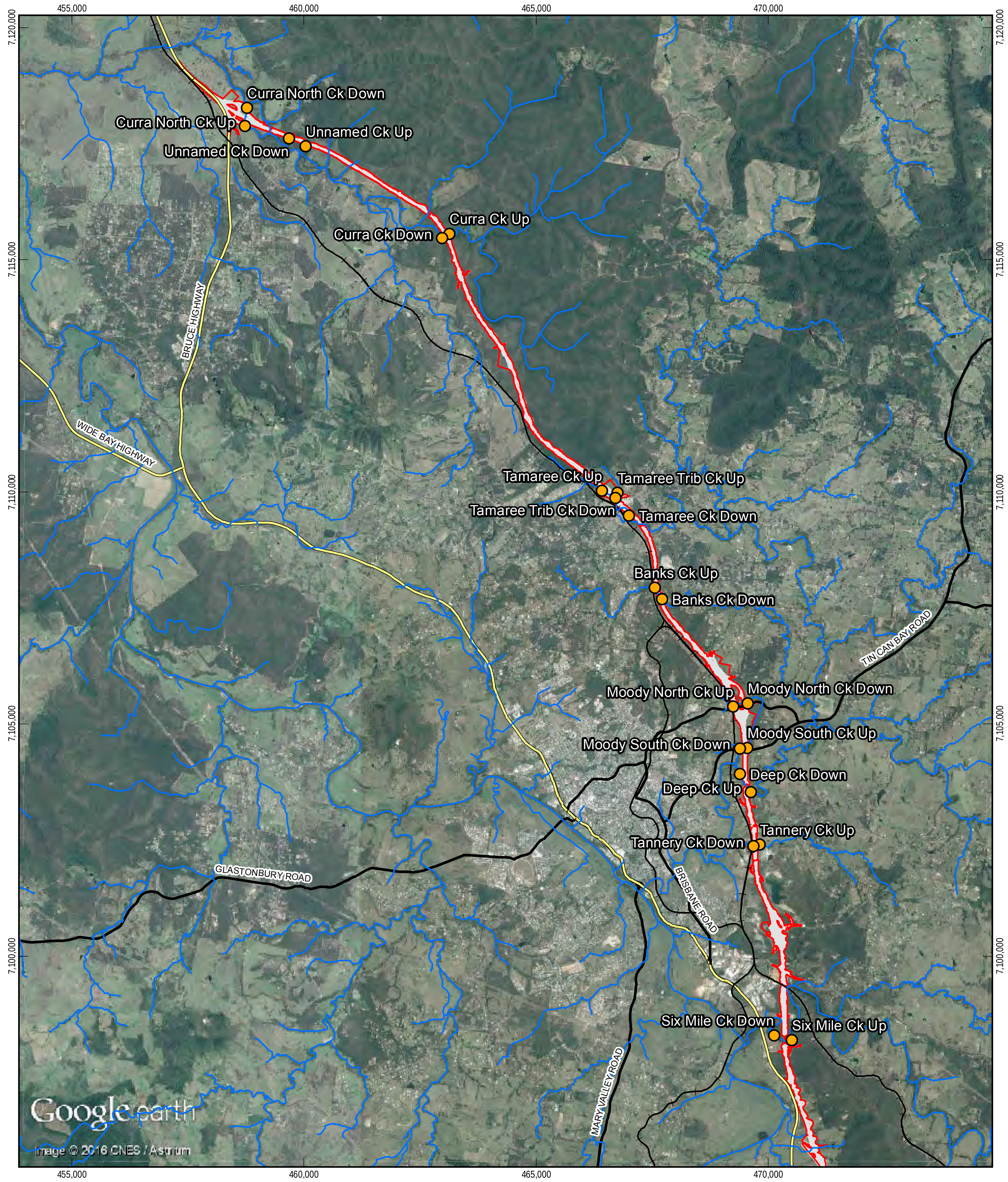
The location of the 11 watercourse reaches is displayed in Figure 6-1 and the upstream and downstream co-ordinates of each reach is provided in Table 6-1. The extent of each reach surveyed was as per the TMR brief with the exception of Deep Creek. Due to access limitations, the approximate 180 m upstream section of the reach as defined in the brief could not be surveyed.

Table 6-1 Morphology survey reaches – upstream and downstream coordinates

Watercourse	Upstream Co-ordinate		Downstream Co-ordinate	
	Easting	Northing	Easting	Northing
Six Mile Creek	470505	7098185	470130	7098260
Tannery Creek	469825	7102395	469690	7102365
Deep Creek	469545	7103660	469390	7103935
Moody Creek south	469550	7104480	469395	7104465
Moody Creek north	469245	7105370	469560	7105440
Banks Creek	467560	7107925	467715	7107685
Tamaree Creek	466420	7110015	467000	7109480
Tamaree Creek tributary	466755	7109970	466715	7109865
Curra Creek south	463140	7115550	462985	7115455
Unnamed (Lot 1717, M37818)	460050	7117435	459685	7117600
Curra Creek north	458730	7117855	458775	7118275

6.3 Survey timing

The channel morphology surveys were conducted between 23 – 26 May 2016.



LEGEND

- Morphology Sites
- Highway
- Secondary Road
- Railway
- Proposed Alignment
- Watercourse
- Project Footprint

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size A4

0 0.5 1 2 3 4

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29710
Revision	0
Date	11 Aug 2016

Location of geomorphology surveys

Figure 6-1

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

G:\41\29710\GIS\Maps\MXD\4129710_014_Rev0.mxd

Data source: TMR: Proposed Alignment, Project Footprint (2016); GHD: Morphology Sites (2016); DNRM: Railway, Watercourse (2014), Road (2016); GE: Imagery extracted 16/05/2016. Created by: RB

6.4 Methodology

6.4.1 Desktop assessment

A desktop review of TMR supplied aerial imagery and the recent 2015 LiDAR derived topographic information was undertaken for the purposes of:

- Reviewing and refining the proposed survey extents
- Preparing base maps for the recording and mapping of more detailed morphological information in the field
- Estimating preliminary morphometric values of each reach (e.g. average channel grade, bankfull widths) and inputting desktop derived values into the reach morphology templates.

In order to establish riparian width and continuity (which are instrumental in determining bank stability), aerial imagery was reviewed for the geomorphology survey reaches. For each, average riparian vegetation width was determined based on a series of measurements taken on both banks using GIS. Bank continuity classes were determined based on the following categories:

- None to isolated/scattered trees
- Regularly spaced trees – low density
- Occasional high density clumps of trees
- Semi-continuous tree coverage
- Continuous tree coverage.

Reaches with greater riparian widths and continuous cover are considered in better condition and offer greater bank stability compared to reaches with none or patchy riparian vegetation within a narrow band.

6.4.2 Field assessment

The field assessment involved walking the extent of each reach and noting the location and extent of the following key morphologic features:

- Pools
- Hydraulic controls (e.g. riffles, bedrock steps, weirs)
- Bars and benches
- Large woody debris accumulations
- Bank forms.

Local field measurements of the identified geomorphic features and bankfull channel dimensions (width and depth) were undertaken using a standard 30 metre measuring tape, clinometer and survey staff. Photographs of morphological features were taken with a GPS enabled camera.

The methodology employed for the riparian vegetation assessment was a modification of the Rapid Assessment Riparian Condition (RARC) assessment tool developed by Land and Water Australia (Jansen, Thompson and Wilson, 2004). This assessment tool assesses the ecological condition of riparian habitats using indicators that reflect functional aspects of the physical, community and landscape features of the riparian zone.

The assessments involved the following steps:

- Establishing a minimum of three 10 m wide transects from the edge of the low flow channel to the high bank within each nominated waterway reach. Transects were aligned perpendicular to the channel and traversed the entire width of the riparian zone (on one side of the waterway).
- Recording the following parameters on field data sheets: longitudinal continuity, width of riparian vegetation, vegetation structure and dominant flora species within each stratum, proportion of native vegetation cover, debris and other habitat features
- Undertaking a 20 m longitudinal meander along the edge of the low flow channel to record the presence of in-stream aquatic vegetation (centred on each perpendicular transect).

6.5 Scope and limitations

It should be noted that the results presented in this report reflect site conditions at the time of sampling and these may change through time.

Rainfall conditions preceding the survey had been well below average with 11 mm recorded in April 2015 and a further 44 mm in May to 25th May 2016 (Gympie Alert Station 40993). These drier conditions would have limited the extent and depth of many of the pool environments identified during the survey.

6.6 Results and discussion

In general, the watercourse reaches surveyed are characterised by low to moderate sinuosity channels with a relatively low width to depth ratio (i.e. relatively narrow and deep channels). Most reaches are set in partly confined valley settings such that a significant length of the channel runs adjacent to the bedrock valley margin. Reaches where the valley margin has limited influence on the channel are Deep Creek, Curra Creek (north), Unnamed watercourse (Lot 1717 on M37818) and the upstream section of Tamaree Creek. Most reaches are single channel systems with the exception of the Curra Creek (north) and the Unnamed watercourse (Lot 1717 on M37818) reaches which exhibit secondary channels (anabranches).

The systems are dominated by fine grained sediments (typically fine sand, silt and mud) and generally do not exhibit bed forms typical of gravel and cobble bed river systems such as riffles and bars. The downstream bed morphology of each reach was therefore classified as pool, pool crossing or relatively flat bed. Sections of channel bed where the local bed variability (difference in elevation between the top and bottom of bed features) is less than 0.5 m where classed as flat bed morphology. Pool crossings are shallow areas between pools and occur along watercourses dominated by fine grained bed material (sand, silt and clay). Pool crossings were further classed into vegetated and un-vegetated states. Vegetated pool crossings tend to be longer (10's of metres long compared to less than 10 metres for un-vegetated pool crossings) and may exhibit a discontinuous and poorly defined low flow channel of less than 0.5 metres deep.

Banks are generally steep with well-vegetated convex upper profiles with typical grades between 1 in 3 and 1 in 4. Lower bank profiles are often near vertical and un-vegetated with the change in profile from the upper bank marked by undercutting. The presence and extent of undercutting varies from reach to reach, but is usually located along the outside bank of pool features. In some instances, such as along Deep Creek, the presence of undercutting is the result of the ponding of water at a consistent level upstream of weir structures. Bench features are typically irregular and poorly defined. The more pronounced benches are generally associated with bends in the channel where higher rates of channel migration have resulted in a wider overall bankfull channel width.

Most reaches are relatively laterally and vertically stable, with evidence of bank erosion typically limited to sections of channel where erosion is generally expected (i.e. outside bank on bends). Reaches with a considered relatively high level of lateral or vertical instability due to anthropogenic influences are limited to the reach of Moody Creek (north), where four headcuts where identified, and the middle reach of Tamaree Creek, where an existing diversion is experiencing erosion along a section of the right bank. In addition, the reach of Moody Creek (south) exhibits evidence of past channel incision and some localised sections of increased bank erosion.

The results of the morphology surveys for each watercourse reach are further detailed in the following sections. All references to left and right banks are made as if viewing the channel in a downstream direction.

6.6.1 Six Mile Creek

The surveyed reach of Six Mile Creek is characterised by a single, low sinuosity channel set within a partly confined valley setting. The left bank abuts a steep bedrock valley margin for approximately 200 m in the upstream section of the reach. Here the left bank and channel invert is predominantly bound by bedrock. Elsewhere the channel has a sand bed with steep banks up to 6 metres high, composed of sandy silt sediment. Occasional narrow bank attached bar features are present in the more alluvial reaches.

The bed morphology of the entire reach consists of a pool feature of varying depth, typically between 1 and 2 metres. As a result, there are no hydraulic controls although log jams form cross channel spanning structures at two locations. Large woody debris loading is relatively high with over 70 visible submerged and emergent large woody debris pieces observed within the reach. Typically, individual pieces are bank attached and aligned more or less longitudinally with flow.

The overall condition of riparian vegetation of the assessed reach was considered to be average to good (RARC Score – 36), with excellent spatial connectivity, good canopy cover and moderate native representation recorded for the site. The most notable impact to vegetation condition was the presence of **Macfadyena unguis-cati* (cats claw creeper) which was dominant in the sub-canopy, shrub and ground layers and can affect the health and inhibit regeneration of all strata.

Riparian vegetation present was continuous along the banks of the channel and forms part a large patch (>50 ha) of native vegetation to the north and south east. The width of the riparian corridor to the south is limited by clearing for pastoral purposes.

Riparian vegetation within the extent of the reach generally consisted of an open forest comprising a mid-dense tree layer (T1 layer) ranging in height from 14 to 25 m over a sparse sub-canopy (T2 layer) with an average height ranging from 11 to 12 m. The T1 layer was dominated by native species whilst the T2 layer comprised a mix of native and introduced species, with **Celtis sinensis* (Chinese celtis) and **Macfadyena unguis-cati* common components of the T2 stratum. The shrub layer was sparse (30-35 % cover) and comprised a mix of native and introduced species, with **Celtis sinensis* and **Macfadyena unguis-cati* (cats claw creeper) once again being common components of the stratum. Common native species included *Streblus brunonianus* (whalebone tree) and *Ficus coronata* (sandpaper fig). The ground layer was sparse (30 % cover) and was principally comprised of mixed native and introduced species. The lower portion of the lower bank was near vertical and was largely devoid of vegetation. The lack of vegetation is likely due to this zone being inundated during typical standing water levels. *Lomandra hystrix* (mat rush) was a dominant component of the upper zone of the lower bank and is likely to be an important element for bank stability. No aquatic macrophytes were recorded at the transect locations.

Further detail on the morphology of the Six Mile Creek reach is provided in Table 6-2 and key features are mapped in Figure G1 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-2 Six Mile Creek morphology survey – key characteristics

Item	Value	Comment
Watercourse	Six Mile Creek	NA
Upstream Co-ordinate	X 470505 Y 7098185	NA
Downstream Co-ordinate	X 470130 Y 7098260	NA
Reach length (m)	500	NA
Flow at time of survey	Surface flow whole reach	NA
Valley setting and channel planform	Partly confined Single channel low sinuosity	Left bank abuts steep bedrock margin for approximately 200 m.
Average bed slope (m/m)	0.0005	NA
Bankfull width range (m)	20 to 40	Typically 25 to 35 m.
Bankfull depth range (m)	4.0 to 6.0	Depth to water surface level.
Low flow channel width range (m)	3 to 12	Typically 8 to 10 m, narrower (5 to 8 m) in bedrock section.
Pool depths	0.5 to 2.5	Shallower in bedrock section where scour depth is limited by bedrock to approximately 1.0 m.
Bed substrate	Dominantly fine to medium sand.	Cobbles and rock in bedrock section.
Bed morphology	Pool along entire reach.	Rippled flow and upwelling associated with cross-spanning large woody debris accumulations.
Bank profiles	Typically alluvial banks with graded upper and near vertical toe with variable height of between 0.5 and 4.0 m.	Upper banks convex with grades typically 1 in 2 to 1 in 3. Lower banks can be convex with grades typically between 2 in 1 to 4 in 1.
Bank materials and micro-forms	Alluvial silt. Presence of undercutting associated with overhanging root masses. Root exposure along alluvial banks 40 to 60 %. Lomandra sp. dominates understorey verge.	Bank attached bars typically 10 to 20 metres long and < 5 m wide and consist of sands to sandy silt materials. Benches are irregular and are typically poorly defined.
Large Woody Debris (LWD)	Over 70 visible submerged and emergent large woody debris pieces. Typically, individual pieces are bank attached and aligned more or less longitudinally with flow. Two locations where multiple pieces form a crossing spanning structure across the low flow channel.	Lower LWD loading in bedrock bounded section with approximately 1 piece per 10 metres compared to 1 piece in 5 metres along more alluvial sections. Lower LWD loading considered the result of higher flow energies in narrower, bedrock section.

6.6.2 Tannery Creek

The surveyed reach of Tannery Creek is characterised by a low to moderate sinuosity channel set within a partly confined valley setting. The right bank abuts the bedrock valley margin for approximately 120 m and bedrock outcrops in exposures along the right bank.

The reach is entirely influenced by an earthen dam located at the downstream extent of the reach. This causes water to pond at a consistent level throughout the reach. As a result, there are no natural hydraulic controls or geomorphic features to separate pools and the reach is considered to be relatively modified.

The overall condition of riparian vegetation of the assessed reach of Tannery Creek was considered to be very poor (RARC Score – 24), principally due to the break in longitudinal connectivity, reduced canopy and native cover across all strata and a lack of debris and other features (i.e. regenerating native species and large native tussock grasses).

Riparian vegetation is continuous along the majority of the channel although a large break in connectivity (approximately 1.1 km in length) is present where the creek has been dammed and realigned for use in an agricultural feed lot. The width of the riparian zone is variable, but is typically less than 5 m either side of the channel due to clearing for surrounding residential and agricultural activities. Vegetation present within the riparian corridor is mapped by DNRM Regulated Vegetation Management Mapping (Version 8.0) as non-remnant and the closest substantial polygon of mapped remnant vegetation (> 10 ha) is approximately 1.7 km to the south west of Tannery Creek.

Riparian vegetation present consisted of a very sparse canopy layer (T1 layer) with an average height of 18 m over a very sparse sub-canopy (T2 layer) with an average height of 8 m. The T1 layer was dominated by native species whilst the T2 layer comprised a mix of native and introduced species. The shrub layer was very sparse (<10 % cover) and was dominated by *Acacia* species and introduced species such as **Lantana camara* and **Macfadyena unguis-cati*. The ground layer was mid-dense to dense (80% cover). Common ground layer species included **Paspalum conjugatum*, **Macfadyena unguis-cati* and *Lomandra longifolia*, with the latter being a dominant component of the lower bank and an important element for bank stability. Leaf litter cover was high and minimal standing dead trees, hollow bearing trees or fallen logs were present. The aquatic flora species *Spirodela punctata* was present at two transect locations.

Further detail on the morphology of the Tannery Creek reach is provided in Table 6-3 and key features are mapped in Figure G2 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-3 Tannery Creek morphology survey – key characteristics

Description	Value	Comment
Watercourse	Tannery Creek	NA
Upstream Co-ordinate	X 469825 Y 7102395	NA
Downstream Co-ordinate	X 469690 Y 7102365	NA
Reach channel length (m)	215	NA
Flow at time of survey	Surface flow whole reach	Ponded water entire reach due to earthen dam wall at downstream extent.
Valley setting and channel planform	Partly confined Single channel low to moderate sinuosity	Right banks abuts bedrock valley margin for approximately 120 m.
Average bed slope (m/m)	NA	No slope due to earthen dam wall at downstream extent.
Bankfull width range (m)	15 to 25	Typically 15 to 20 m. Consistently wider (20 to 25 m) at downstream extent due to ponded area upstream of earthen dam.
Bankfull depth range (m)	1.0 to 2.0	Typically 1.0 to 1.5.
Low flow channel width range (m)	3 to 10	Typically 4 to 6 m in upstream extent and 6 to 8 m in downstream extent due to ponding by earthen dam wall.
Pool depths	0.5 to 1.0	Near middle of channel.
Bed substrate	Dominantly fine sand and silt	
Bed morphology	Ponded water entire reach	Earthen dam at downstream extent.
Bank profiles	Graded upper and vertical toe with variable height of between 0.1 and 1.0 m	No pronounced bench features. Outside bank grades range from near vertical to 1 in 4. Inside bank grades range from 1 in 2 to 1 in 8.
Bank materials	Sandy silt to silt. Weathered bedrock exposed for 10 to 15 % in lower bank profiles. Undercutting on bends up to 0.3 metres. Root exposure <20 %. Lomandra sp. and grasses dominate verge.	Middle section of right bank abuts bedrock valley margin and weathered bedrock is exposed in sections of the lower right bank profile.
Large Woody Debris	Visible large woody debris limited to six single pieces and one bank attached log jam.	Three LWD pieces comprise whole small to medium sized trees.

6.6.3 Deep Creek

The surveyed reach of Deep Creek is characterised by a low sinuosity channel set within a laterally confined valley setting. The bed morphology reach is dominated by long pools (50 to 100 m plus). However, the reach is strongly influenced by a sheet pile and concrete weir (approximately 1.5 m high) located towards the downstream extent of the reach. This causes water to pond upstream at a consistent level, with upstream banks exhibiting continuous undercutting at a level consistent with the weir crest. At this level, upstream low flow hydraulic controls (an earthen stop bank and a gravel riffle) will be drowned out. The weir is showing signs of potential future failure with erosion and outflanking on the left bank.

Large woody debris loading includes numerous individual pieces, typically bank attached and four log jams of which two are bank attached and the other two cross spanning. Log jams are associated with points of channel contraction and at the entry and exit of bends.

The overall condition of riparian vegetation associated with Deep Creek was considered to be average (RARC Score – 33). This score was attributed to the high habitat and cover scores including longitudinal continuity of riparian vegetation, width of riparian vegetation and high canopy cover and number of vegetation strata.

Riparian vegetation is continuous along the majority of the creek extent with only small narrowing of the vegetation at infrastructure crossings such as a rail way and the existing Bruce Highway. The width of the riparian zone varies only slightly for the majority of the creek's extent and is typically between 15 m – 20 m either side of the channel. Vegetation present within the riparian corridor is mapped by DNRM Regulated Vegetation Management Mapping (Version 8.0) as non-remnant; with the closest polygon of mapped remnant vegetation (> 10 ha) located approximately 1.0 km to the north of Deep Creek.

Riparian vegetation present consisted of a mid-dense canopy layer (T1 layer - average canopy cover of 50 - 70 % and a height of 8 - 12 m) over a very sparse to very sparse sub-canopy (T2 layer) with an average height of 8 m. The canopy and sub-canopy layers comprised a mix of native species (e.g. *Waterhousea floribunda, Streblus brunonianus* and *Aphananthe philippinensis*) and introduced species (e.g. **Cinnamomum camphora* and **Celtis sinensis*). The shrub layer was dominated by regrowth native species that are present in the canopy layer (T1) with **Macfadyena unguis-cati* also commonly observed within the stratum. The ground layer was mid-dense to dense (80 % cover) and was dominated by **Macfadyena unguis-cati.* The lower portion of the lower bank was near vertical and was largely devoid of vegetation. The lack of vegetation is likely due to this zone being inundated during typical standing water levels. *Lomandra hystrix* was a dominant component of the upper zone of the lower bank and is likely to be an important element for bank stability. Leaf litter cover was high and minimal standing dead trees, hollow bearing trees or fallen logs were present. The aquatic flora species *Spirodela punctata* was present within the channel.

Further detail on the morphology of the Deep Creek reach is provided in Table 6-4 and key features are mapped in Figure G3 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-4 Deep Creek morphology survey – key characteristics

Item	Value	Comment
Watercourse	Deep Creek	NA
Upstream Co-ordinate	X 469545 Y 7103660	NA
Downstream Co-ordinate	X 469390 Y 7103935	NA
Reach channel length (m)	350	NA
Flow at time of survey	No flow but pools present	NA
Valley setting and channel planform	Laterally unconfined Single channel low sinuosity	Limited valley influence on channel.
Average bed slope (m/m)	0.0005 weir controlled	0.002 without weir
Bankfull width range (m)	22 to 38	Typically 24 to 26 m.
Bankfull depth range (m)	3.0 to 6.0	Typically 3.5 to 4.5 m.
Low flow channel width range (m)	3 to 12	Typically 8 to 10 m. Typically narrower (5 to 8 m) in bedrock section.
Pool depths (m)	0.5 to 1.0	Typically 0.6 to 0.8 m.
Bed substrate	Dominantly silt and organic debris	NA
Bed morphology	Long narrow pools separated by a weir, stopbank and gravel riffle	Sheet pile and concrete weir is primary hydraulic control with the upstream stopbank and riffle flooded out in low flow events.
Bank profiles	Typically alluvial banks with graded upper and near vertical toe with variable height of between 0.5 and 2.0 m	Upper banks convex with grades range typically 1 in 3 to 1 in 4. Lower banks can be convex with grades typically between 2 in 1 to 4 in 1.
Bank materials and micro-forms	Alluvial silt. Banks upstream of weir undercut by up to 0.7 m at a height of up to 1.0 m above water surface level. This level is consistent with height of weir, with undercutting a response to prolonged pooling by weir. Lomandra sp. dominates understorey verge, while lower bank below undercut is un-vegetated.	Concave bank benches present indicating phases of channel expansion and contraction in response to lateral migration.
Large Woody Debris	Numerous individual pieces, typically bank attached. Four log jams of which two are bank attached and the other two cross spanning.	Log jams associated with points of channel contraction and at entry and exit of bends.

6.6.4 Moody Creek (south)

The surveyed reach of Moody Creek (south) is characterised by a low to moderate sinuosity channel set within a partly confined valley setting. The right bank abuts the bedrock valley margin in the downstream half of the reach. The channel exhibits a flat bed morphology for the entire reach with local bed variability of less than 0.3 m. This form is consistent with a system that has undergone channel incision in the past, resulting in a fairly featureless channel of low morphological diversity. This has also resulted in some sections of the lower bank exhibiting increased levels of bank erosion.

The overall condition of riparian vegetation associated with Moody Creek (south) was considered to be poor (RARC Score – 25). The low score was attributed to the limited canopy cover, low proportion of native species and limited amount of debris present.

The width of the riparian zone was generally less than 10 m either side of the channel due to previous clearing activities. The reach surveyed is mapped by DNRM as non-remnant vegetation however, the eastern extent of the reach lies adjacent to a large patch (> 50 ha) of remnant vegetation to the north.

Riparian vegetation present consisted of regrowth vegetation comprising a sparse canopy layer (T1 layer) with an average height of 8 to 12 m. The canopy layer was dominated by native species (e.g. *Melaleuca salicina*, *Lophostemon suaveolens* and *Eucalyptus tereticornis*). The shrub layer was dominated by juvenile native species that are present in the canopy layer (T1) and *Acacia* species. The ground layer was mid-dense (60 % cover). Common ground layer species included *Paspalum* species and *Lomandra longifolia*, with the latter being a dominant component of the lower bank. Leaf litter cover was low and no standing dead trees or hollow bearing trees were present and fallen logs were present at one location only. Low density aquatic flora species were present at one transect.

Further detail on the morphology of the Moody Creek (south) reach is provided in Table 6-5 and key features are mapped in Figure G4 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-5 Moody Creek (south) morphology survey – key characteristics

Item	Value	Comment
Watercourse	Moody Creek (south)	NA
Upstream Co-ordinate	X 469550 Y 7104480	NA
Downstream Co-ordinate	X 469395 Y 7104465	NA
Reach channel length (m)	250	NA
Flow at time of survey	Dry bed	NA
Valley setting and channel planform	Partly confined Single channel low sinuosity	Right bank abuts bedrock valley margin along downstream half of reach.
Average bed slope (m/m)	Approximately 0.004	NA
Bankfull width range (m)	3 to 5	NA
Bankfull depth range (m)	Consistently between 1.5 to 2.0 m	NA
Low flow channel width range (m)	NA	Essentially a slot channel with invert width ranging from 1 to 2 m
Pool depths (m)	No pools, essentially planar bed.	Local bed variability typically less than 0.3 m.
Bed substrate	Dominantly sand and fine gravel.	NA
Bed morphology	Flat bed along entire reach with bed variability < 0.3 m.	Tin Can Bay Road culvert located 30 m downstream from end of reach. This would exert some level of hydraulic control on the reach at high flow stages.
Bank profiles	Convex rounded profile in upper 0.5 m. Lower bank is near vertical with variable height of between 1.0 and 1.5 m	Upper banks convex with grades range typically 1 in 4. Lower banks can be convex with grades typically between 2 in 1 to vertical.
Bank materials and micro-forms	Alluvial sandy silt. Lomandra sp. dominates rounded upper bank profile, while lower bank is largely unvegetated and exhibits localised undercutting up to 0.3 m primarily on outside banks..	Occasional bedrock outcrops in toe of bank profile. No pronounced bench features.
Large Woody Debris	Limited to occasional buried timber embedded in channel invert.	NA

6.6.5 Moody Creek (north)

The surveyed reach of Moody Creek (north) is characterised by a low to moderate sinuosity channel set within a partly confined valley setting. The bed morphology includes elongate pools which are typically separated by sections of flat bed channel consisting of silt, mud and clay sediments. However, the reach contains two culvert road crossings and one concrete block weir structure. Banks along the pool upstream of the weir are consistently undercut at a level matching the weir crest.

The reach exhibits signs of past and ongoing channel incision (bed downcutting) with four channel knickpoints (headcuts) of between 0.4 and 1.2 m high identified along the reach. Given the incision processes and the presence of the weir and road crossing, the morphology of the reach is considered to be relatively highly modified.

The overall condition of riparian vegetation associated with Moody Creek (north) was considered to be poor (RARC Score – 29). The low score was attributed to the low percentage of native species and limited amount of debris present.

The width of the riparian zone was typically 25 m either side of the channel. The reach surveyed is mapped by DNRM as non-remnant vegetation however, the north western extent of the reach lies adjacent to a large patch (> 50 ha) of remnant vegetation to the north.

Riparian vegetation present consisted of an open forest comprising a mid-dense canopy layer (T1 layer - average canopy cover of 60 % and a height of 12 – 16 m) over a sub-canopy with an average height of 6 m. The canopy layer was dominated by **Cinnamomum camphora* and *Lophostemon suaveolens* with occasional emergent *Eucalyptus tereticornis* to 22 m. The sub-canopy was dominated by regrowth of the same species present in the canopy layer. The shrub layer was dominated by a mix of Acacia species, **Ochna serrulata, *Lantana camara* and *Leptospermum polygalifolium*. The ground layer was very sparse (10 % cover). Common ground layer species included *Paspalum* species, *Ottochloa gracillima* and *Lomandra longifolia*, with the latter being a dominant component of the lower bank and an important element for bank stability. Leaf litter cover was moderate and standing dead trees and fallen logs were present; however, no hollow bearing trees were observed.

Further detail on the morphology of the Moody Creek (north) reach is provided in Table 6-6 and key features are mapped in Figure G5 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-6 Moody Creek (north) morphology survey – key characteristics

Item	Value	Comment
Watercourse	Moody Creek (north)	NA
Upstream Co-ordinate	X 469245 Y 7105370	NA
Downstream Co-ordinate	X 469560 Y 7105440	NA
Reach channel length (m)	430	NA
Flow at time of survey	No flow but pools present	NA
Valley setting and channel planform	Partly confined Single channel low to moderate sinuosity	NA
Average bed slope (m/m)	Approximately 0.005	NA
Bankfull width range (m)	10 to 15	Typically 12 to 14
Bankfull depth range (m)	Up to 2.5, typically between 1.5 to 2.0 m	NA
Low flow channel width range (m)	Pools typically 3 to 5 m wide. Pool crossings and flat bed sections are 1 to 3 m wide.	NA
Pool depths (m)	0.3 to 1.5, typically < 0.6	One deeper pool of up to 1.5 m located at downstream extent of reach.
Bed substrate	Dominantly silt and organic matter.	NA
Bed morphology	Elongate pools are typically separated by sections of flat bed channel. Reach contains two culvert road crossings and one concrete block weir structure.	Local bed variability typically less than 0.5 m along flat bed sections. Four channel knickpoints (headcuts) of between 0.4 and 1.2 m high.
Bank profiles	Convex rounded upper profile. Lower bank is near vertical with variable height of up to 1.5 m, typically < 1.0 m.	Upper banks convex with grades range typically 1 in 3 to 1 in 6. Lower banks can be convex with grades typically between 2 in 1 to vertical.
Bank materials and micro-forms	Alluvial sandy silt with clay where channel abuts valley margins. Lomandra sp. dominates rounded upper bank profile, while lower bank is largely unvegetated and exhibits localised undercutting up to 0.3 m primarily on outside banks..	Banks along pool upstream of weir are consistently undercut at a level matching weir crest. No pronounced bench features.
Large Woody Debris	Limited to occasional individual pieces.	Frequent branch piles racked behind tree trunks.

6.6.6 Banks Creek

The surveyed reach of Banks Creek is characterised by a low to moderate sinuosity channel set within a partly confined to laterally unconfined valley setting. Channel sinuosity is higher in the middle section of the reach where the channel has limited to no contact with the valley margins. The left bank abuts the bedrock valley margin in the downstream extent of the reach where bedrock outcrops in the left bank profile.

Pools are only present in the middle and downstream sections of the reach and are typically less than 0.5 m deep. Pools are up to 60 m long and are separated by un-vegetated pool crossing features in downstream half of reach that will be drowned out in relatively low level flow stages. Upstream half of reach relatively flat bed with no distinct hydraulic controls or pool features.

The upstream section exhibits a flat bed morphology with local bed variability of less than 0.3 m. Sand and gravel deposits are present in the section and are possibly the product of upstream disturbances including a track crossing and the railway bridge.

The overall condition of riparian vegetation of the assessed reach was considered to be poor to average (RARC Score – 28), principally due to the lack of connectivity to remnant vegetation, reduced native cover, particularly within the ground layer and the largely absent tall tree layer (T1).

Riparian vegetation present was largely continuous along the banks of the channel although the width was typically limited to less than 20 m either side of the channel due to clearing for grazing and other associated pastoral activities. Vegetation present is mapped by DNRM Regulated Vegetation Management Mapping (Version 8.0) as non-remnant and the closest substantial patch of mapped remnant vegetation (> 10 ha) is approximately 470 m to the south east of the site.

Riparian vegetation present consisted of a sparse to mid-dense narrow woodland with an average canopy cover of 40 % and a height of 8 m. The T2 layer comprised a mix of native and introduced species, with invasive species such as **Cinnamomum camphora* and **Celtis sinensis* present on the lower banks. The shrub layer and ground layer were both sparse and comprised high proportions of introduced species (18 % and 40 % respectively). *Lomandra longifolia* was a dominant native ground layer species on the lower bank and was an important element for bank stability. Leaf litter cover was low to moderate and minimal standing dead trees, hollow bearing trees or fallen logs were present. No aquatic macrophytes were recorded during the survey.

Further detail on the morphology of the Banks Creek reach is provided in Table 6-7 and key features are mapped in Figure G6 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-7 Banks Creek morphology survey – key characteristics

Item	Value	Comment
Watercourse	Banks Creek	NA
Upstream Co-ordinate	X 467560 Y 7107925	NA
Downstream Co-ordinate	X 467715 Y 7107685	NA
Reach channel length (m)	480	NA
Flow at time of survey	Dry bed	NA
Valley setting and channel planform	Partly confined to laterally unconfined Single low sinuosity channel in upstream and downstream extents. Single moderate to high sinuosity channel in middle of reach.	Right bank abuts bedrock valley margin along downstream half of reach. Middle sinuous reach exhibits meander cut-offs.
Average bed slope (m/m)	Approximately 0.003	NA
Bankfull width range (m)	9 to 15	Typically 10 to 12 m
Bankfull depth range (m)	Up to 2.0 m, typically between 1.0 to 1.5 m	NA
Low flow channel width range (m)	1 to 10	Typically between 3 to 5 m in downstream sinuous reach and between 1 to 3 m in upstream straight reach.
Pool depths (m)	0.3 to 1.0 m	Typically < 0.5 m
Bed substrate	Typically silt with fine sand and gravel deposits in upstream section.	Sand and gravel in upstream section possibly the result of disturbance from railway or track crossing.
Bed morphology	8 pool crossing features in downstream half of reach which will be drowned out in relatively low level flow stages. Upstream half of reach relatively flat bed with no distinct hydraulic controls or pool features.	Channel is typically narrower at pool crossings and typically between 1 to 3 m.
Bank profiles	Graded profile in upper bank. Lower bank is typically near vertical, particularly on outside bends, with variable height of between 0.5 and 1.5 m.	Outside bank grades range from near vertical to 1 in 1. Inside bank grades range from 1 in 2 to 1 in 8. Along straight reach bank grades range from 1 in 2 to 1 in 6.
Bank materials and micro-forms	Alluvial sandy silt. Lomandra sp. dominates rounded upper bank profile, while lower bank is largely unvegetated and exhibits undercutting of up to 0.3 m along approximately 50 % of reach.	Occasional bedrock outcrops in toe of bank profile where channel abuts valley margin. More pronounced bench features associated with areas of higher rates of channel migration.
Large Woody Debris	Two jams composed of branch pieces. Pool crossings typically littered with branch piles. Pools exhibit occasional emergent small timber pieces.	No significant large timber pieces (i.e. tree trunks).

6.6.7 Tamaree Creek

The surveyed extent of Tamaree Creek can be sub-divided into three distinct reaches as described as follows.

Upstream reach

This reach extends 500 m upstream of Tamaree Road and is characterised by a low to moderate sinuosity channel set within a laterally unconfined valley setting. The bed morphology consists of pools in the range of 20 to 110 m long. Pools are separated by a range of natural and man-made structures, including vegetated and un-vegetated pool crossings, culvert crossing and a rock ford structure. Large woody debris loading is relatively low with occasional individual pieces in pools and one log jam/branch pile feature associated with a pool crossing.

Middle reach

This reach extends 320 m downstream of Tamaree Road and is characterised by a low sinuosity channel set within a partly confined valley setting. This reach is highly modified with a constructed on-line dam leading into an existing channel diversion. The on-line dam is controlled by a concrete and rock wall approximately 1.0 to 1.5 m high. The diversion exhibits a substantial pool at its upstream extent, but is dominated by a wide flat bed invert along the downstream approximate 170 m. While well vegetated, this length represents a substantial extent of reach with limited morphological diversity. Additionally, although primarily excavated within rock, the right bank of the diversion is experiencing ongoing erosion.

Downstream reach

The downstream reach extends for 460 m downstream of the end of the existing diversion channel. This reach is characterised by a low sinuosity channel set within a partly confined valley setting. Typically, one side of the channel abuts the bedrock valley margin where bedrock is exposed in the lower banks and bed of the channel.

The bed morphology consists of long pools (generally in the range of 30 to 60 m long) typically separated by vegetated pool crossings up to 60 m long. Pools are also separated by two bedrock steps and a culvert crossing structure towards the upstream extent.

Riparian vegetation along the combined reach

The overall condition of riparian vegetation of the combined reach (upstream, middle and downstream) was considered to be poor to average (RARC Score – 29), principally due to the narrow width of the riparian corridor, the break in longitudinal connectivity, reduced native cover across all strata and a lack of debris and other features (i.e. regenerating native species and large native tussock grasses).

Riparian vegetation is continuous along the majority of the channel although a large break in connectivity (approximately 290 m in length) is present where the creek has been realigned to accommodate the rail corridor. The width of the riparian zone is variable but is typically less than 8 m either side of the channel due to clearing for surrounding pastoral activities. Vegetation present within the riparian corridor is mapped by DNRM Regulated Vegetation Management Mapping (Version 8.0) as non-remnant and the closest substantial patch of mapped remnant vegetation (> 10 ha) is approximately 180 m to the south west of the site.

Riparian vegetation present consisted of a sparse to mid-dense canopy layer (T1 layer - average canopy cover of 50 % and a height of 11 m) over a sparse sub-canopy (T2 layer) with an average height of 6 m. The canopy and sub-canopy layers comprised a mix of native and introduced species, with invasive species such as **Cinnamomum camphora* (camphor laurel) and **Celtis sinensis* (Chinese elm) present at all transect locations. The shrub layer was sparse

(<10 % cover) and was dominated by introduced species, with **Lantana camara* (lantana) and **Celtis sinensis* (Chinese elm) common components of the shrub layer. The ground layer was also sparse (20-30 % cover). Common ground layer species included *Ottochloa gracillima* (forest grass), *Pteridium esculentum* (bracken fern)*, Lomandra longifolia* (spiny headed mat rush) *and Lomandra hystrix* (mat rush), with the latter being a dominant component of the lower bank and an important element for bank stability. Leaf litter cover was low to moderate and minimal standing dead trees, hollow bearing trees or fallen logs were present. Aquatic macrophytes recorded included *Typha orientalis* (cumbungi)*, Ottelia ovalifolia* (swamp lily) and *Schoenoplectus mucronatus* (sedge).

Further detail on the morphology of the Tamaree Creek reach is provided in Table 6-8 and key features are mapped in Figure G7 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-8 Tamaree Creek morphology survey – key characteristics

Item	Value	Comment
Watercourse	Tamaree Creek	NA
Upstream Co-ordinate	X 466420 Y 7110015	NA
Downstream Co-ordinate	X 467000 Y 7109480	NA
Reach channel length (m)	Approximately 1,280	NA
Flow at time of survey	Surface flow just perceptible.	NA
Valley setting and channel planform	Upstream reach – laterally unconfined with low to moderate sinuosity channel. Downstream reaches – partly confined with low sinuosity channel.	NA
Average bed slope (m/m)	Upstream and downstream reaches are approximately 0.0035.	Middle modified reach is approximately 0.001.
Bankfull width range (m)	Upstream reach: 12 to 24, typically 14 to 18 Downstream reach: 12 to 16, typically 12 to 14	Diversion width ranges from 17 to 24 m.
Bankfull depth range (m)	2.0 to 3.0, typically around 2.5	Diversion depth is 2.0 m on right bank.
Low flow channel width range (m)	Pools 2.0 to 10.0, typically 4 to 6. Pool crossing are 2 to 5 m. Where low flow channels exist, channel is up to 0.5 deep and < 1.0 wide.	Diversion width ranges from 11 to 14 m.
Pool depths (m)	0.5 to 1.5, typically 0.6 to 0.8.	Depths not measured in online dam.
Bed substrate	Dominantly silt and organic materials.	Downstream reach exhibits localised sections with bedrock outcrops and cobbles.
Bed morphology	Upstream reach exhibits a number of vehicle/road crossings (causeways and culverts) and one dam wall. Downstream reach exhibits vegetated pool crossings 5 to 60 m long and two bedrock steps.	Middle reach has a rock chute structure on entry to on line dam and dam wall. Diversion channel has a flat bed.
Bank profiles	Graded profile in upper bank. Lower bank is typically near vertical, particularly on outside bends, with height generally less than 0.3 m.	Outside bank grades range from near vertical to 1 in 2. On inside and straight reach banks grades range from 1 in 2 to 1 in 6.
Bank materials and micro-forms	Alluvial sandy silt. Limited presence of undercut banks, predominantly located on the outside bank of the channel at pools. Lomandra sp. dominates verges and typically overhangs along pool margins..	Bedrock outcrops in bank profile where channel abuts valley margin in the downstream reach. No pronounced bench features.
Large Woody Debris	Visible woody debris loading is low and typically limited to 2 to 3 individual visible pieces per pool. Two log jams observed, one in upstream reach and one in downstream reach. Both associated with pool crossing features.	No woody debris observed in middle reach.

6.6.8 Tamaree Creek (tributary)

Vegetation present within the riparian corridor is mapped by DNRM Regulated Vegetation Management Mapping (Version 8.0) as non-remnant vegetation. This reach is similar to the upstream reach of Tamaree Creek and is also characterised by a low to moderate sinuosity channel set within a laterally unconfined valley setting. Key differences include smaller channel dimensions, shallower pools and a semi-continuous vegetated riparian zone. Due to the lack of shading and their shallowness, pools are generally completely vegetated with emergent macrophytes.

Further detail on the morphology of the Tamaree Creek (tributary) reach is provided in Table 6-9 and key features are mapped in Figure G7 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-9 Tamaree Creek (tributary) morphology survey – key characteristics

Item	Value	Comment
Watercourse	Tamaree Creek (Tributary)	NA
Upstream Co-ordinate	X 466755 Y 7109970	NA
Downstream Co-ordinate	X 466715 Y 7109865	NA
Reach channel length (m)	Approximately 150 m.	NA
Flow at time of survey	No flow, ponds present.	NA
Valley setting and channel planform	Laterally unconfined, low to moderate sinuosity channel.	NA
Average bed slope (m/m)	Approximately 0.004	NA
Bankfull width range (m)	8 to 14	Typically 10 to 12 m.
Bankfull depth range (m)	1.0 to 1.5	NA
Low flow channel width range (m)	1.0 to 7.0	Typically 4.0 to 6.0 m
Pool depths (m)	0.4 to 0.6	NA
Bed substrate	Silts and organic material	Pools well-vegetated with emergent macrophytes.
Hydraulic controls	Pool extents largely controlled by two vehicle crossings which includes a log causeway and a raised rock causeway.	One short natural, vegetated pool crossing feature located in the downstream section of the reach,
Bed morphology	Typically, entire bank is graded. Minor vertical toe of < 0.2 m high in lower profiles limited to outside bends.	Outside bank grades range from 1 in 2 to 1 in 6. Inside bank grades range from 1 in 3 to 1 in 6.
Bank materials and micro-forms	Sandy silt to silt.	Irregular, poorly defined bench features, typically located on inside bends.
Large Woody Debris	No large woody debris observed.	Absence of woody debris potentially product of limited fringing riparian vegetation.

6.6.9 Curra Creek South

The surveyed reach of Curra Creek South is characterised by a low sinuosity channel set within a partly confined valley setting. The right bank abuts the bedrock valley margin in the upstream half of the reach and adjacent floodplains are narrow and discontinuous.

The entire reach consists of a single pool of varying depth, typically between 1 and 2 metres deep near the edges of banks. Deeper sections up to around 3 m would be expected towards the middle of the channel.

Channel bankfull width and depth is relatively consistent thought the reach, although there is some constriction in the low flow channel width at the downstream extent of the reach. Banks are steep and any benches are irregular and poorly defined. No instream bars were present.

The only hydraulic control is a bed level ford crossing at the downstream extent of the reach. There are two locations where multiple large woody debris pieces form a crossing spanning log jam across the low flow channel. Elsewhere, large woody debris comprise individual pieces typically submerged with an estimated one piece pre 5 m on average.

The overall condition of riparian vegetation of the assessed reach was considered to be excellent (RARC Score – 42), with excellent spatial connectivity and high native representation recorded for the site.

Riparian vegetation present was continuous along the banks of the channel and forms part a large patch (>50 ha) of remnant vegetation surrounding the Creek.

Riparian vegetation within the extent of the reach generally consisted of a woodland to open forest comprising a sparse to mid-dense tree layer (T1 layer) ranging in height from 11 to 25 m over a sparse sub-canopy (T2 layer) with an average height ranging from 9 to 13.5 m. Both canopy layers were dominated by mixed native species. The shrub layer was sparse (35 % cover) and comprised a mix of native and introduced species, with **Lantana camara* present at all transect locations along the reach. The ground layer was mid-dense (50 % cover) and was principally comprised of mixed forbs and grasses such as *Lomandra longifolia, Ottochloa gracillima* and *Oplismenus aemulus*. The lower portion of the lower bank was near vertical and was largely devoid of vegetation. The lack of vegetation is likely due to this zone being inundated during typical standing water levels. *Lomandra longifolia* was a dominant component of the upper zone of the lower bank and is likely to be an important element for bank stability. No aquatic macrophytes were recorded at the transect locations.

Further detail on the morphology of the Curra Creek South reach is provided in Table 6-10 and key features are mapped in Figure G8 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-10 Curra Creek South morphology survey – key characteristics

Item	Value	Comment
Watercourse	Curra Creek South	NA
Upstream Co-ordinate	X 463140 Y 7115550	NA
Downstream Co-ordinate	X 462985 Y 7115455	NA
Reach channel length (m)	185	NA
Flow at time of survey	Surface flow whole reach	Rippled flow associated with cross-spanning large woody debris accumulation.
Valley setting Channel planform	Partly confined Single channel low sinuosity	Right bank abuts steep bedrock margin in upstream half of reach
Average bed slope (m/m)	0.0005	NA
Bankfull width range (m)	24 to 28	Relatively consistent width
Bankfull depth range (m)	2.5 to 3.5	Typically, 3 m deep to WSL.
Low flow channel width range (m)	3 to 12	Typically 8 to 10 m. Short 30 m constricted section between 3 to 6 m at downstream extent.
Pool depths	Near bank depths up to 2.0 metres. Potentially up to 3 metres in places.	NA
Bed substrate	Dominantly fine to medium sand.	NA
Bed morphology	Pool along entire reach.	Ford crossing at downstream extent controls pool level at low flows.
Bank profiles	Typically alluvial banks with graded upper and near vertical toe with variable height of between 0.5 and 1.5 m	Bank grades between 1 in 2 and 1 in 3 with near vertical lower profiles.
Bank materials and micro-forms	Alluvial silt with clay present in lower profiles. Presence of undercutting near continuous along banks up to 0.5 m, typically < 0.3 m. Lomandra sp. dominates understorey verge.	Benches are irregular and poorly defined.
Large Woody Debris	Typically, individual pieces are submerged with an estimated one piece pre 5 m on average. Two locations where multiple pieces form a crossing spanning log jam across the low flow channel.	One large cross spanning aerial log in upstream half of reach.

6.6.10 Unnamed Watercourse (Lot 1717 on M37818)

This reach is located on a secondary channel of the anabranching Curra Creek system. The channel is essentially set within a laterally unconfined valley setting, with only a short section of the channel abutting bedrock in the upstream extent. Here, bedrock is exposed in the channel bank.

The bed morphology consists of long pools generally in the range of 30 to 40 m long, however two longer pools over 100 m long dominate the downstream half of the reach. Both these pools extend upstream and downstream of relatively tight bends in the channel. The pools are wider at these locations and bank attached benches are present due to channel expansion in response to higher rates of channel migration at the bends.

The pools are typically separated by vegetated pool crossings 10 to 30 m long and shorter un-vegetated pool crossings. The crest of the latter is typically elevated by less 0.5 m above the low flow water surface level of the adjacent pools. Visible large woody debris in pools is limited to occasional single bank attached pieces.

The overall condition of riparian vegetation of the assessed reach was considered to be good to excellent (RARC Score – 38), with excellent spatial connectivity and high native representation recorded for the site.

Riparian vegetation present was continuous along the banks of the channel and forms part a large patch (>50 ha) of remnant vegetation surrounding the Creek.

Riparian vegetation within the extent of the reach generally comprised a sparse tree layer (T1 layer) approximately 15 m high over a sparse to mid-dense sub-canopy (T2 layer) with an average height of 8 m. Both canopy layers were dominated by mixed native species. The shrub layer was sparse (35 % cover) and comprised a mix of native and introduced species, with **Lantana camara* present at all transect locations along the reach. The ground layer was mid-dense (50 % cover) and was comprised of mixed forbs and grasses such as *Lomandra longifolia, Ottochloa gracillima* and *Oplismenus aemulus*. *Lomandra longifolia* was a dominant component of the lower bank and an important element for bank stability. No aquatic macrophytes were recorded at the transect locations.

Further detail on the morphology of the Unnamed Watercourse (Lot 1717 on M37818) reach is provided in Table 6-11 and key features are mapped in Figure G9 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-11 Unnamed Watercourse morphology survey – key characteristics

Item	Value	Comment
Watercourse	Unnamed Watercourse (Lot 1717 on M37818)	NA
Upstream Co-ordinate	X 460050 Y 7117435	NA
Downstream Co-ordinate	X 459685 Y 7117600	NA
Reach channel length (m)	Approximately 640 m.	NA
Flow at time of survey	No flow but pools present.	NA
Valley setting and channel planform	Laterally unconfined, multi-channel system of low to moderate sinuosity.	Channel abuts bedrock valley margin at upstream extent of reach. Subject reach is a secondary channel (anabranch) of Curra Creek.
Average bed slope (m/m)	Approximately 0.003	NA
Bankfull width range (m)	20 to 40	Typically 20 to 25 m. Wider channels sections associated with channel migration at bends.
Bankfull depth range (m)	2.5 to 3.5	Typically 2.5 to 3.0 m.
Low flow channel width range (m)	2 to 16	Wider at pools, typically 6 to 8 metres. Width at pool crossings typically 2 to 6 m.
Pool depths (m)	0.5 to 2.5	Larger pools typically 1.5 to 2.0 m deep. Smaller pools 0.5 to 1.0 metres deep and dry at time of survey.
Bed substrate	Typically silt and organic debris.	NA
Bed morphology	Larger pools separated by both un-vegetated and vegetated pool crossings. Vegetated pool crossings are dominated by Lomandra sp. and can contain small, dry pools. A discontinuous and poorly defined low flow channel may also be present.	Un-vegetated pool crossings are short (< 5 m) and composed of silt and clay. These are typically elevated by up to 0.3 m above pool water surface level. Vegetated pool crossings can be relatively long (10 o 50 m) and are typically raised 0.5 to 1.0 m above the water surface level of adjacent pools.
Bank profiles	Typically alluvial banks with graded upper and near vertical toe with variable height of between 1.0 and 2.0 m.	Upper banks convex with grades typically 1 in 3 to 1 in 4. Steeper banks up to 1 in 1 present where channel abuts bedrock. Lower banks concave and typically steeper than 2 to 1.
Bank materials and micro-forms	Alluvial sandy silt. Banks of pools undercut by up to 0.3 m at a height of 0.5 to 1.0 m above water surface level. Lomandra sp. dominates understorey verge, while lower bank below undercut is un-vegetated.	Benches present at bends indicating channel expansion in response to lateral migration. This is in association with the presence of the larger pools along the reach. Bedrock exposed in lower bank profile where channel abuts bedrock valley margin at the upstream extent of the reach.
Large Woody Debris	Visible large woody debris in pools limited to occasional single bank attached pieces.	Vegetated pool crossings exhibit small branch piles, often at the upstream extent.

6.6.11 Curra Creek North

This reach is located along the main channel of the anabranching Curra Creek system. The channel is essentially set within a laterally unconfined valley setting, with a short section of the channel abutting the bedrock valley margin in the downstream half of the reach. The upper section of the reach is dominated by a pool which ponds upstream of a rock/gravel ford located just downstream of the Ashfords Road bridge.

Downstream, the channel exhibits a number of shorter pools (20 to 50 metres long) separated by vegetated and non-vegetated natural pool crossing features. Along part of the downstream section, where the channel abuts the left valley margin, the invert is characterised by a flat bed channel up to 4 m wide and 0.5 to 1.0 m deep. Banks here are composed of clay material, likely representing highly weathered bedrock.

Large wood debris loading is moderate to high, with pools typically exhibiting up to 8 pieces per 10 metres. Occasional log jams are also present, typically consisting of 2 to 3 large pieces and racks of smaller branches.

The overall condition of riparian vegetation of the assessed reach was considered to be average (RARC Score – 33), with moderate spatial connectivity, canopy cover and native representation recorded for the site.

Riparian vegetation present was largely continuous along the banks of the channel although the width was typically limited to less than 12 m either side of the channel due to clearing for grazing and other associated pastoral activities. Vegetation present is mapped by DNRM Regulated Vegetation Management Mapping (Version 8.0) as non-remnant and although a narrow band of remnant vegetation exists immediately to the north, the closest substantial patch of mapped remnant vegetation (> 10 ha) is approximately 240 m to the south east of the site.

Riparian vegetation present consisted of a sparse to mid-dense T2 tree layer, with the T1 layer mostly absent. The T2 layer was approximately 9 m in height with an average canopy cover of 45 % and was largely dominated by mixed native species. The T1 layer was approximately 19 m high and was dominated by native eucalypts. The shrub layer was approximately 2 m high and comprised a mix of native and introduced species, with **Lantana camara* and **Cinnamomum camphora* being dominant components of the shrub stratum. The ground layer varied from sparse to dense, with introduced species, such as **Solanum seaforthianum * Megathyrsus maximus, *Ageratum houstonianum* and **Paspalum conjugatum,* comprising approximately 36 % of the ground cover. Common native species present in the ground layer included *Ottochloa gracillima, Pteridium esculentum* and *Lomandra longifolia*, with the latter being a dominant component of the lower bank and an important element for bank stability. Aquatic macrophytes recorded included *Ottelia ovalifolia, *Myriophyllum aquaticum, Nymphoides indica, Persicaria decipiens, *Persicaria orientalis* and *Juncus usitatus.*

Further detail on the morphology of the Curra Creek North reach is provided in Table 6-12 and key features are mapped in Figure G10 (Appendix G). Details on riparian vegetation associations and coverage are provided in Table H1 (Appendix H). RARC sub-index scores are provided in Appendix H. Photographs of the reach are provided in Appendix I.

Table 6-12 Curra Creek North morphology survey – key characteristics

Item	Value	Comment
Watercourse	Curra Creek North	NA
Upstream Co-ordinate	X 458730 Y 7117855	NA
Downstream Co-ordinate	X 458775 Y 7118275	NA
Reach channel length (m)	Approximately 500 m	NA
Flow at time of survey	No flow, pools present.	NA
Valley setting and channel planform	Laterally unconfined, multi-channel system of low to moderate sinuosity.	Channel abuts left bank bedrock valley margin along downstream extent of reach. Subject reach is the main Curra Creek channel.
Average bed slope (m/m)	Approximately 0.004	NA
Bankfull width range (m)	15 to 30	Typically 20 to 25 m.
Bankfull depth range (m)	2.5 to 4.0	Typically 2.5 to 3.0 in upstream half of reach and 3.0 to 4.0 in downstream half.
Low flow channel width range (m)	2 to 10	Wider at pools, typically 6 to 8 metres. Width at pool crossings typically 2 to 5 m.
Pool depths (m)	0.5 to 1.0	NA
Bed substrate	Sandy silt	NA
Bed morphology	Gravel and rock ford immediately downstream of Ashfords Road bridge and controls upstream pool level. Elsewhere pools are separated by vegetated pool crossings. A discontinuous and poorly defined low flow channel may be present in pool crossings.	Where the channel abuts the left valley margin, the invert is characterised by a flat bed channel up to 4 m wide and 0.5 to 1.0 m deep. Bed elevation variability along this section is < 0.3 m.
Bank profiles	Typically alluvial banks with graded upper and near vertical toe with variable height of between 0.5 and 1.5 m.	Upper banks convex with grades typically 1 in 3 to 1 in 6. Lower banks concave and typically steeper than 1 in 2..
Bank materials and micro-forms	Alluvial sandy silt. Upper banks well-vegetated, while lower banks are un-vegetated. Limited presence of undercut banks, predominantly located on the outside bank of the channel at pools. .	Clay banks present where channel abuts the left bank valley margin. Numerous stable “breakaway” gully channels leading away from the left bank in upstream section of the reach. Benches present at bends indicating phases of channel in response to lateral migration.
Large Woody Debris	Large wood debris loading is moderate to high. Pools typically have a high loading with up to 8 pieces per 10 metres.	Occasional log jams typically consisting of 2 to 3 large pieces and smaller branches.

6.7 Design recommendations

The results of the morphology assessment can be used to guide the design of any creek diversions required as part of the proposed Section D of the Cooroy to Curra Bruce Highway Upgrade. Key features of the existing creek systems recommended for inclusion in the design form of any diversions include:

- A channel of low to moderate sinuosity and low width to depth ratio (typically 6 to 8).
- Average longitudinal grades in the order of 0.003 to 0.005 m/m. This grade range is based on all creeks with the exception of Six Mile Creek and Curra Creek. Based on the current concept design, it is not expected that these two creeks will be diverted.
- Long pools (30 to 50 m long and up to 8 m wide) with low flow depths in the order of 1 metre separated by shorter sections of vegetated pool crossing (10 to 30 m). In the event any diversion is constructed in bedrock, pool crossing features are unlikely to be viable as their construction would involve placing fill material within the excavated channel and the fill will most likely be eroded out during high flow events. Hence, it would be considered appropriate to incorporate bedrock step type features as the main grade controls through the diversion.
- Along pools, provide convex upper bank profiles with typical grades between 1 in 3 and 1 in 4 and near vertical lower bank profiles to a height equivalent to the level of ponding in pools during low flows. Typically, lower bank profiles display gentler grades at pool crossings and on the inside bank of bends.
- Vegetation to promote bank stability, particularly *Lomandra longifolia* in combination with deeper rooted endemic riparian tree species. Consideration should also be given to replication the structure of nature vegetation canopy layers with respect to position on the bank.
- Floodplains or areas to permit overbank flows to spread and dissipate beyond the channel at a similar flow stage to the bankfull channel capacity of the existing creek system.
- Large woody debris pieces and multi log jams in pools with at least one large log per 10 metres of pool length.

Features identified through the morphology survey that are not considered necessary for inclusion in any diversion include:

- Riffles and bars – as the existing creek systems are dominated by fine grained sediments (typically fine sand, silt and mud) and generally do not exhibit bed forms typical of gravel and cobble bed river systems such as riffles and bars
- Benches - as the more pronounced benches are generally associated with bends in the channel where higher rates of channel migration have resulted in a wider overall bankfull channel width. Sections of channel with high rates of channel migration are not considered desirable in proximity to high values assets such as a dual carriageway highway. Further, given the general lack of defined benches along the existing creek systems, benches are unlikely to represent a critical habitat for survival of local native aquatic species.
- Knickpoints - as these represent vertical channel instability through bed incision.
- Flat bed morphology sections - as this morphology has limited aquatic habitat value. Additionally, the presence of this morphology in the existing creek systems is considered a likely indicator of past channel incision.

Ultimately the morphology represented in any diversion will be influenced by other factors including geotechnical and topographic conditions along the proposed diversion alignment as well as the necessity to minimise any adverse flood inundation impacts. As a result, it is likely that there will be a trade-off between mimicking the existing morphology of the local creek with considerations to geotechnical, channel stability and hydraulic requirements.

As part of the design process, it will also be necessary to undertake detailed topographic survey of the existing creek channels at the proposed exit and entry points of any diversions. This information will be important for defining the longitudinal grade of any diversion and determining the need to incorporate any grade control structures to maintain channel stability.

7. Conclusion and recommendations

The aquatic habitat condition assessments identified that the majority of waterways within the Section D project footprint were ephemeral and ranged from 'poor' to 'excellent'. Much of the land in the catchment has been deforested and converted to grazing or cropping land. Cattle damage to banks and gully erosion was common at many of the sites. A layer of silt on the substrate was a common occurrence which is indicative of high levels of erosion and sedimentation throughout the catchment. Although riparian vegetation along the banks of the creeks was often dense, it often supported a high diversity and abundance of introduced exotic species. Water quality monitoring indicates that waterways within the Section D project footprint were generally characterised by moderate to high turbidity and low dissolved oxygen levels, when compared to the relevant water quality objectives. Waterway barriers were observed at almost all sites consisting of bed level crossings, road crossings and pipe culverts. These structures form a barrier to aquatic fauna movement under normal flow conditions but quickly 'drown out' following substantial rainfall.

The detailed aquatic habitat assessments recorded habitat conditions suitable for conservation significant fish, turtles and platypus in all three major creek systems. Six Mile Creek was characterised by pool, run and riffle sequences with a high abundance of in-stream habitat features and intact riparian zone. Six Mile Creek has good connectivity to the Mary River and was determined to have the best habitat condition of all sites assessed. Areas of Deep Creek contained deep pools and high abundance of in-stream habitat features including overhanging vegetation and shade. Curra Creek is an anabranching system with backwaters and lagoons. Key habitat features observed included: deep pools; high abundance of large woody debris and macrophytes. Degradation from land use practises, combined with reduced with connectivity (natural and as a result of waterway barriers) make it less likely that conservation significant species will occur in the sections of Deep Creek that fall within the footprint of construction. The targeted fauna surveys confirmed the presence of the Mary River cod (*Maccullochella mariensis*) within Six Mile Creek and the white-throated snapping turtle (*Elseya albagula*) within Curra Creek. Six Mile Creek is considered habitat critical to the survival of the Mary River cod as the creek is necessary for critical activities such as foraging, breeding, maintaining genetic diversity and for the long-term maintenance of the species. Habitat conditions within Curra Creek are considered sub-optimal for the white-throated snapping turtle due to reduced connectivity and habitat degradation, and as such, the species is predicted to occur at lower densities than expected within pool-riffle-run sequences (e.g. within the main Mary River channel and Six Mile Creek).

The results of the habitat assessments and targeted surveys, combined with knowledge of species' distributions and previous recorded refined the likelihood of occurrence assessment ratings for each conservation significant species predicted to occur within the Section D project footprint. Results of the assessment are as follows:

- Mary River turtle (*Elusor macrurus*) – likely to occur within Six Mile Creek, potential to occur in Deep Creek and Curra Creek; unlikely to occur within minor waterways; unlikely breeding habitat within all waterways
- White-throated snapping turtle – confirmed present within Curra Creek, likely to occur within Six Mile Creek, potential to occur in Deep Creek; unlikely to occur within minor waterways; low value breeding habitat within Curra Creek
- Mary River cod – confirmed present within Six Mile Creek, potential to occur in Deep Creek and Curra Creek; unlikely to occur within minor waterways

- Australian lungfish (*Neoceratodus forsteri*) – potential to occur within Six Mile Creek, Deep Creek and Curra Creek; breeding habitat only present in Curra Creek; unlikely to occur within minor waterways
- Platypus (*Ornithorynchus anatinus*) – known to occur within Deep Creek, likely to occur in Curra Creek, potential to occur in Six Mile Creek; unlikely to occur within minor waterways
- Queensland lace plant (*Aponogeton elongates*) – confirmed present within minor waterways; likely to occur in Curra Creek; unlikely to occur in Six Mile Creek or Deep Creek.

Due to the known and/or likely occurrence of conservation significant species within the Section D project footprint, an assessment of potential impacts associated with project construction and operation, should be undertaken for each species. The assessment should include management actions proposed to avoid or minimise potential direct and indirect impacts to species and their habitat. Assessment of the significance of impacts will be required in accordance with DEE significant impact criteria. The results of the significant impact assessment will inform the requirement for referral of the Section D project under the EPBC Act. Given Six Mile Creek supports a number of conservation significant species and is habitat critical to the survival of the species, referral of the Section D project works is likely to be triggered at this location.

Potential breeding habitat for the Mary River cod, Australian lungfish and platypus was confirmed present within the Section D project footprint. A species management program (SMP) should be prepared for these species in accordance with the NC Act. The SMP will detail the management requirements of the project for the protection of the species.

The DAF's *Queensland waterways for waterway barrier works* spatial layer has identified many of the waterways within the Section D project footprint, including Six Mile Creek, Deep Creek and Curra Creek, are important waterway for fish passage and as such, the presence of artificial barriers has the potential to have a major risk of impact on fish movement . The fish community within the Mary River is dominated by potamodromous species. Upstream and downstream migration within the freshwater environment is an important aspect of the life cycle for many species with movement strongly cued to hydrology. This study identified seven species of fish that are either confirmed diadromous or are known to move long distances within freshwater reaches. The latter includes Mary River cod. The design of temporary and permanent structures for the Section D project must therefore consider potential impacts on fish movement and avoid increased cumulative impacts on fauna movement.

Results of the morphology survey show that the survey reaches were typically single, incised channels with steep, undercut banks and characterised by pool habitat between 0.5m and 1m in depth. In most cases, riparian vegetation condition was poor due to lack of continuity and the invasion of introduced species. However, understory present at the base of the bank was frequently characterised by *Lomandra longifolia* and this species is regarded as being of importance to maintaining bank stability.

Results of the morphology survey carried out as part of this study can be used to guide the design of any creek diversions required as part of the proposed Section D of the Cooroy to Curra Bruce Highway Upgrade. This includes characteristics such as sinuosity, width to depth ratio, longitudinal grade, pool dimensions, bank topography, vegetation cover, structure and floristic composition, bank full levels and large woody debris distribution. The ability to replicate these features will, however, potentially be a trade-off between maintaining natural ecological characteristics and maintaining structural integrity of engineering assets.

As part of the design process, in addition to geotechnical and hydraulic assessments, detailed topographic survey of the existing creek channels will need to be carried out at the proposed exit and entry points of any diversions. This information will be important for defining the longitudinal grade of any diversion and determining the need to incorporate any grade control structures to maintain channel stability.

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Appendices

Appendix A – Summary of aquatic assessment survey sites

Waterway survey site	Aquatic habitat assessment			Aquatic flora and fauna surveys			Geomorphic channel morphology surveys
	AUSRIVAS habitat assessment	Detailed habitat assessment and mapping	Water Quality Monitoring	Target threatened flora survey	Target threatened fauna surveys	General fish community surveys	
Unnamed (Lot 3, RP165151)	✓		✓			✓	
Six Mile Creek	✓	✓	✓	✓	✓	✓	✓
Tannery Creek	✓		✓			✓	✓
Deep Creek	✓	✓	✓	✓	✓	✓	✓
Moody Creek south	✓		✓				✓
Moody Creek north							✓
Banks Creek	✓		✓				✓
Tamaree Creek	✓		✓				✓
Tamaree Creek tributary	✓		✓				✓
Corella Creek	✓		✓			✓	
Curra Creek	✓	✓	✓	✓	✓	✓	✓
Keliher Creek	✓		✓				
Unnamed #1 (Lot 889, CP864404)	✓		✓			✓	
Unnamed #2 (Lot 889, CP864404)						✓	
Unnamed (Lot 1717, M37818)	✓		✓			✓	✓
Curra Creek overflow	✓		✓				
Curra Creek north	✓		✓				✓

Appendix B – Detailed habitat assessment fields

Detailed habitat assessment fields

Description	Value	Comment
Pool > 0.8 m average depth	Downstream coordinate	
	Upstream coordinate	
	Average width (m)	
	Evidence of sedimentation -Y/N	
	Substrate type	
	Average Depth (m)	
Riffle Habitat	Downstream coordinate	
	Upstream coordinate	
	Average width (m)	
	Evidence of sedimentation -Y/N	
	Average Depth (m)	
Run/Glide Habitat	Downstream coordinate	
	Upstream coordinate	
	Average width (m)	
Backwater	Downstream coordinate	
	Upstream coordinate	
	Average width (m)	
	Dominant sediment type	
Sand-Gravel Bar	Downstream coordinate	
	Upstream coordinate	
	Average width (m)	
	Slope	
	% Vegetated	
	% cover of weed species	
	% of bank and/or water's edge covered by vegetation	
	Height from water's edge to top of bank (m)	
	Distance from waters' edge to top of bank (m)	
	Evidence of aggradation/erosion -Y/N	
	Evidence of predator activity - Y/N (potential species)	
	Evidence of cattled degradation - Y/N	
	Likely suitable turtle nesting site -Y/N	
Submerged macrophye vegetation > 10% cover	Downstream coordinate	
	Upstream coordinate	
	% cover	
	Dominant species	
	Habitat where found mainly	

Major LWD clusters	Coordinates	
Major bank undercut areas	Coordinates	
Coordinates		
Coordinates		
	Dominant Species	
% cover		
	Dominant species	
Suitable Burrowing Bank	Bank height	
	Bank consolidation (drop down)	consolidated
		unconsolidated
	Bank Material (check list)	silt
		sand
		gravel
		pebble
		cobble
		boulder
		bedrock
	Bank height (drop down)	0-1m
		1-2m
		2-5m
		5m+
	Macrophytes present (checklist)	Submerged
		Emergent
		No macrophytes
Burrow	burrow present (drop down)	Active
		Inactive
	Approx size (drop down)	Small
		Medium
		Large
	Type	Resting
		Nesting

Species

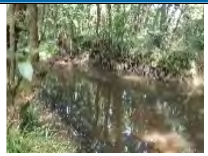
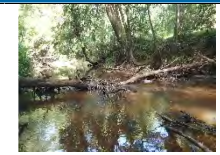
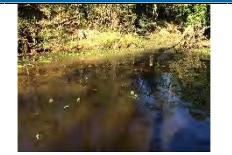
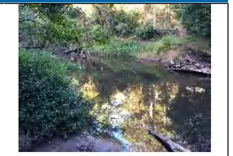
Description	Value	Comment
Mary River turtle	Coordinates Habitat where found	
White-throated snapping turtle	Coordinates Habitat where found	
Mary River cod	Coordinates Habitat where found	
Australian lungfish	Coordinates Habitat where found	
Platypus	Coordinates Habitat where found Active burrows present -Y/N	
Queensland lace plant	Coordinates Habitat where found	
Replicated according to System and Reach Sampled		

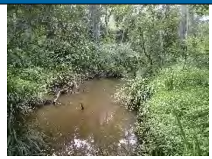
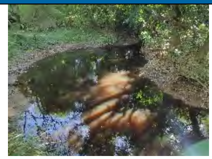
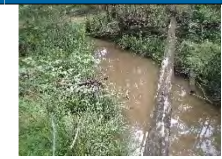
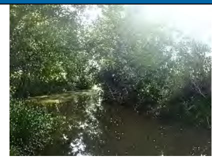
Fish Passage Barriers

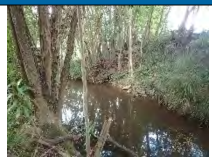
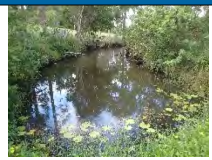
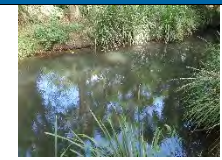
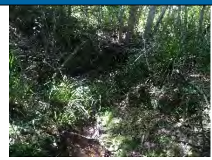
Description	Value
	Natural
	Log jam
	Sand bar aggradation
	Cascade
	Anthropogenic
	Weir
	Low level causeway
	Pipes/culvert
	Barrier form
	Obstacle
	Outfall drop
	Velocity/turbulence
	Barrier persistence
	Barrier under baseflow only
	Barrier under moderate flow conditions
	Barrier under most flow conditions
	Water velocity (through barrier)
	high
	medium
	low
	Water depth (in barrier)
	Wetted width (in barrier)

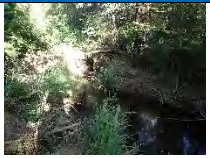
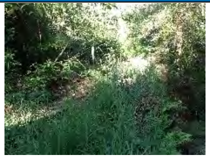
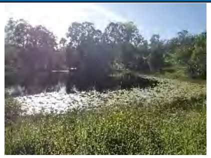
	Wetted width - above barrier
	Wetted width - below barrier
	Water depth - above barrier
	Water depth - below barrier
	Barrier evaluation
	Full
	Partial

Appendix C – AUSRIVAS habitat assessment site characteristics

Site	Six Mile Creek A	Six Mile Creek B	Deep Creek A	Deep Creek B	Curra Creek A	Curra Creek B
Photo						
# habitats present	5	4	2	4	3	3
Stream width: min (m)	5	2.5	8	2.5	10	3
Stream width: mode (m)	10	5	8	4	14	6
Stream width: max (m)	12	15	9	6	15	8
Water level	Flowing	Flowing	Flowing	Flowing	No Flow, Isolated	No Flow, Isolated
Shading of river	Moderate	Moderate	High	High	Moderate	High
Type of river system	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent
Bank erosion	Moderate	Some	Moderate	Some	Moderate	None
Dams/barriers	No	No	Yes	No	No	No
Hydrological variation	Little	Little	None	Little	Some	None
Point source pollution	No	No	No	No	No	No
Non-point source pollution	Yes	Yes	No	No	No	No
Position in catchment	Lowland	Lowland	Midland	Midland	Midland	Upland
Geomorphology	Broad Valley	Floodplain	Broad Valley	Broad Valley	Broad Valley	Broad Valley
Bare ground	Some	Little	Little	Some	Little	None
Grass	Extensive	Some	Little	Little	Moderate	Some
Shrubs	Some	Moderate	Little	Little	Moderate	Moderate
Trees<10 m	Little	Little	Little	Little	Some	Little
Trees>10 m	Moderate	Moderate	Extensive	Extensive	Some	Moderate

Site	Curra Creek North Upstream	Curra Creek North Downstream	Curra Creek Overflow	Corella Creek Upstream	Corella Creek Downstream	Keliher Creek Upstream
Photo						
# habitats present	3	3	2	2	2	3
Stream width: min (m)	6	1	0	1.5	1.5	3
Stream width: mode (m)	6	2	1	2.5	2	4
Stream width: max (m)	7	5	3	4	2.5	8
Water level	No Flow, Isolated	No Flow, Isolated	No Flow, isolated	No Flow, dry	No Flow, Isolated	No Flow, Isolated
Shading of river	High	Low	High	High	High	High
Type of river system	Permanent	Permanent	Intermittent	Permanent	Permanent	Permanent
Bank erosion	Some	Moderate	Some	Some	Some	Little
Dams/barriers	No	Downstream	No	No	No	No
Hydrological variation	Little	Some	Little	None	None	None
Point source pollution	No	Yes	No	No	No	No
Non-point source pollution	No	Yes	Yes	No	No	No
Position in catchment	Midland	Midland	Midland	Upland	Upland	Upland
Geomorphology	Broad Valley	Floodplain	Broad Valley	Steep Valley	Broad Valley	Steep Valley
Bare ground	Little	Little	Some	Little	None	None
Grass	Little	Extensive	Moderate	Some	Little	Some
Shrubs	Some	Extensive	Some	Some	Moderate	Some
Trees<10 m	Moderate	Little	Moderate	Some	Little	Some
Trees>10 m	Little	None	Some	Moderate	Extensive	Moderate

Site	Keliher Creek Downstream	Tannery Creek Upstream	Tannery Creek Downstream	Moody Creek North Upstream	Moody Creek North Downstream	Banks Creek Upstream
Photo						
# habitats present	2	2	2	2	3	1
Stream width: min (m)	5	0	1	0	0.5	6
Stream width: mode (m)	8	6	4	1.5	1.5	8
Stream width: max (m)	10	8	6	3	2.5	10
Water level	No Flow, Isolated	No Flow, isolated	No Flow, isolated	No Flow, dry	No Flow, isolated	No Flow, Isolated
Shading of river	High	Moderate	High	High	Low	High
Type of river system	Permanent	Intermittent	Permanent	Intermittent	Intermittent	Permanent
Bank erosion	Some	Little	Little	Some	Some	Little
Dams/barriers	No	Upstream, Downstream	Upstream	4	4	No
Hydrological variation	Little	Some	Extensive	-	None	None
Point source pollution	No	No	No	No	No	No
Non-point source pollution	No	Yes	Yes	No	No	No
Position in catchment	Upland	Upland	Lowland	Midland	Midland	Midland
Geomorphology	Broad Valley	Broad Valley	Broad Valley	Broad Valley	Broad Valley	Broad Valley
Bare ground	None	None	Some	Some	None	Little
Grass	Little	Moderate	Little	Little	Extensive	Some
Shrubs	Some	Extensive	Moderate	Some	Little	Some
Trees<10 m	Some	Little	None	Moderate	Little	Moderate
Trees>10 m	Some	Some	Extensive	Moderate	Little	Little

Site	Banks Creek Downstream	Tamaree Creek Upstream	Tamaree Creek Downstream	Tamaree Creek Tributary	Unnamed Creek Lot 3 on RP16151 Upstream	Unnamed Creek Lot 3 on RP16151 Downstream
Photo						
# habitats present	2	2	2	2	2	3
Stream width: min (m)	0	0.4	5	0	10	1
Stream width: mode (m)	1.5	1.5	5	2	60	1.5
Stream width: max (m)	3	2	6	2.5	60	2.5
Water level	No Flow, dry	No Flow, 3	No Flow, Isolated	No Flow, dry	No Flow, Isolated	No Flow, dry
Shading of river	High	High	High	High	Low	Low
Type of river system	Intermittent	Intermittent	Permanent	Intermittent	Permanent	Intermittent
Bank erosion	Some	Some	Little	Little	None	Moderate
Dams/barriers	Downstream	No	No	No	Upstream, Downstream	Upstream
Hydrological variation	None	None	None	None	Extensive	Extensive
Point source pollution	No	No	No	No	No	No
Non-point source pollution	No	No	No	No	No	Yes
Position in catchment	Midland	Midland	Midland	Upland	Midland	Lowland
Geomorphology	Broad Valley	Broad Valley	Broad Valley	Broad Valley	Broad Valley	Floodplain
Bare ground	Little	Little	Some	None	Little	Little
Grass	Some	Moderate	Little	Some	Extensive	Extensive
Shrubs	Some	Moderate	Moderate	Moderate	Little	Little
Trees<10 m	Little	Moderate	Little	None	Little	Little
Trees>10 m	Moderate	Some	Moderate	Extensive	None	None

Site	Unnamed Creek Lot 1717 on M37818	Unnamed Creek #2 Upstream Lot 889 on CP864404	Unnamed Creek #2 Downstream Lot 889 on CP864404
Photo			
# habitats present	3	3	3
Stream width: min (m)	0	0	1.5
Stream width: mode (m)	0.5	0	2
Stream width: max (m)	1	3	4
Water level	No Flow, dry	No Flow, dry	No Flow, dry
Shading of river	Moderate	High	High
Type of river system	Intermittent	Intermittent	Intermittent
Bank erosion	Moderate	Some	Some
Dams/barriers	No	No	Upstream, Downstream
Hydrological variation	Little	None	Moderate
Point source pollution	No	No	Yes
Non-point source pollution	No	No	Yes
Position in catchment	Midland	Upland	Midland
Geomorphology	Broad Valley	Steep Valley	Broad Valley
Bare ground	None	Little	Little
Grass	Some	Little	Moderate
Shrubs	Some	Some	Moderate
Trees<10 m	Some	Some	Some
Trees>10 m	Some	Moderate	Some

Appendix D – AUSRIVAS habitat assessment scores and ratings

Site name	Site code	Bottom substrate /available cover	Embedd-edness	Velocity/ depth category	Channel alteration	Bottom scouring and deposition	Pool/riffle, run/bend ratio	Bank stability	Bank vegetative stability	Stream-side cover	Total score	Overall rating
Six Mile Creek A	SMCA	11	10	16	8	12	12	5	8	6	88	Good
Six Mile Creek B	SMCB	15	14	20	11	11	12	9	10	10	112	Excellent
Deep Creek A	DCA	10	10	10	11	11	7	6	9	9	83	Good
Deep Creek B	DCB	11	11	11	8	11	8	6	9	9	84	Good
Curra Creek A	CCA	6	5	5	7	8	4	5	8	5	53	Moderate
Curra Creek B	CCB	10	10	5	12	12	7	6	8	8	78	Good
Curra Creek North Upstream	CCNUS	10	10	6	11	11	7	5	6	6	72	Moderate
Curra Creek North Down-stream	CCNDS	10	10	5	8	8	4	5	9	6	65	Moderate
Curra Creek Overflow	CCOF	6	5	5	7	11	4	5	8	9	60	Moderate
Corella Creek Upstream	CORUS	11	10	5	12	11	7	6	9	10	81	Good
Corella Creek Down-stream	CORDS	11	10	5	4	8	7	5	9	10	69	Moderate
Keliher Creek Upstream	KCUS	10	5	5	12	8	4	8	8	6	66	Moderate

Site name	Site code	Bottom substrate /available cover	Embedd-edness	Velocity/ depth category	Channel alteration	Bottom scouring and deposition	Pool/riffle, run/bend ratio	Bank stability	Bank vegetative stability	Stream-side cover	Total score	Overall rating
Keliher Creek Down-stream	KCDS	11	10	5	8	11	8	5	9	9	76	Good
Tannery Creek Upstream	TANUS	6	6	2	8	7	4	8	9	5	55	Moderate
Tannery Creek Down-stream	TANDS	10	5	5	7	11	7	8	9	10	72	Moderate
Moody Creek North Upstream	MCNUS	5	5	0	7	12	7	8	10	9	63	Moderate
Moody Creek North Down-stream	MCNDS	6	5	5	12	11	4	6	9	5	63	Moderate
Banks Creek Upstream	BCUS	16	10	0	12	11	4	9	8	8	78	Good
Banks Creek Down-stream	BCDS	16	11	5	7	11	7	8	10	8	83	Good
Tamaree Creek Upstream	TCUS	16	11	6	8	8	4	7	9	10	79	Good
Tamaree Creek Down-stream	TCDS	15	6	3	8	12	7	9	10	10	80	Good

Site name	Site code	Bottom substrate /available cover	Embedd-edness	Velocity/ depth category	Channel alteration	Bottom scouring and deposition	Pool/riffle, run/bend ratio	Bank stability	Bank vegetative stability	Stream-side cover	Total score	Overall rating
Tamaree Creek Tributary	TCTRIB	11	0	5	8	7	4	5	9	8	57	Moderate
Unnamed Creek Lot 3 on RP16151 Upstream	UCRPUS	0	0	1	3	7	0	3	8	3	25	Poor
Unnamed Creek Lot 3 on RP16151 Down-stream	UCRPDS	4	4	1	7	4	4	3	5	3	35	Poor
Unnamed Creek Lot 1717 on M37818	UNC1717	6	5	2	8	3	3	2	8	6	43	Moderate
Unnamed Creek #2 Upstream Lot 889 on CP864404	UC2US	11	5	5	8	7	4	3	8	8	59	Moderate
Unnamed Creek #2 Down-stream Lot 889 on CP864404	UC2DS	5	5	10	4	4	8	5	8	6	55	Moderate

Appendix E – *In situ* water quality testing results

Site name	Site code	Habitat	Time collected	Sample depth (m)	Water temperature (°C)	Conductivity (mS/cm)	DO (% sat)	DO (mg/L)	pH	Turbidity (NTU)
WQO		-	-	-	-	578	85 - 110	-	6.5 - 8	50
Six Mile Creek A	SMCA	Edge	13:15	0.45	24.23	222	70.20	5.77	6.72	3.70
Six Mile Creek A	SMCA	Riffle	13:00	0.25	24.21	222	84.10	6.91	6.99	3.60
Six Mile Creek B	SMCB	Edge	9:50	0.60	23.82	241	73.50	6.08	6.93	12.40
Six Mile Creek B	SMCB	Riffle	7:30	0.30	23.46	234	62.60	5.21	6.94	12.00
Deep Creek A	DCA	Edge	11:40	0.50	23.34	592	48.50	4.04	7.05	9.50
Deep Creek B	DCB	Edge	14:45	0.15	24.45	549	48.10	3.93	7.11	9.50
Curra Creek A	CCA	Edge	12:15	0.20	25.36	291	36.50	2.94	6.85	37.80
Curra Creek B	CCB	Edge	9:40	0.30	23.69	159	28.80	2.39	6.20	11.80
Curra Creek North Upstream	CCNUS	Edge	15:20	0.50	25.94	287	26.70	2.13	6.71	11.10
Curra Creek North Down-stream	CCNDS	Edge	15:11	0.15	27.59	290	26.80	2.16	6.82	56.40
Curra Creek Overflow	CCOF	Edge	14:45	0.30	25.77	179	54.00	4.33	6.48	61.10
Corella Creek Upstream	CORUS	Edge	11:00	1.00	23.51	125	46.20	3.84	6.27	52.00
Corella Creek Down-stream	CORDS	Edge	10:15	0.50	23.20	147	32.30	2.70	6.31	69.00

Site name	Site code	Habitat	Time collected	Sample depth (m)	Water temperature (°C)	Conductivity (mS/cm)	DO (% sat)	DO (mg/L)	pH	Turbidity (NTU)
Keliher Creek Upstream	KCUS	Edge	9:00	1.00	22.91	259	59.70	5.01	6.28	10.30
Keliher Creek Down-stream	KCDS	Edge	16:10	1.50	24.63	190	15.00	1.21	6.13	15.70
Tannery Creek Upstream	TANUS	Edge	12:40	0.30	27.17	670	84.80	6.64	7.32	22.20
Tannery Creek Down-stream	TANDS	Edge	7:30	0.30	23.03	455	48.90	4.09	7.15	12.30
Moody Creek North Upstream	MCNUS	Edge	13:30	0.30	25.98	450	96.50	7.71	7.16	59.40
Moody Creek North Down-stream	MCNDS	Edge	14:00	0.15	27.47	415	24.70	1.92	6.82	52.50
Banks Creek Upstream	BCUS	Edge	15:40	1.50	24.44	405	29.70	2.43	6.48	32.70
Banks Creek Down-stream	BCDS	Edge	15:00	0.30	25.39	362	53.50	4.32	6.92	36.80
Tamaree Creek Upstream	TCUS	Edge	10:48	0.50	25.74	382	60.90	4.88	6.71	20.90
Tamaree Creek Down-stream	TCDS	Edge	14:30	1.00	24.22	339	44.80	3.68	6.98	30.80

Site name	Site code	Habitat	Time collected	Sample depth (m)	Water temperature (°C)	Conductivity (mS/cm)	DO (% sat)	DO (mg/L)	pH	Turbidity (NTU)
Tamaree Creek Tributary	TCTRIB	Edge	13:50	0.50	24.90	156	49.20	4.00	6.63	29.30
Unnamed Creek Lot 3 on RP16151 Upstream	UCRPUS	Edge	8:15	0.20	25.65	157	41.10	3.35	6.49	13.30
Unnamed Creek Lot 3 on RP16151 Down-stream	UCRPDS	Edge	10:30	0.15	23.14	1880	109.60	9.17	7.15	20.40
Unnamed Creek Lot 1717 on M37818	UNC1717	Edge	7:35	1.00	22.89	238	132.90	11.16	7.19	10.10
Unnamed Creek #2 Upstream Lot 889 on CP864404	UC2US	DRY								
Unnamed Creek #2 Down-stream Lot 889 on CP864404	UC2DS	Edge	14:30	0.20	23.66	575	37.10	3.25	6.59	29.50

Highlighted cells indicate results outside WQOs

Appendix F – Survey guidelines and methodology employed for conservation significant species

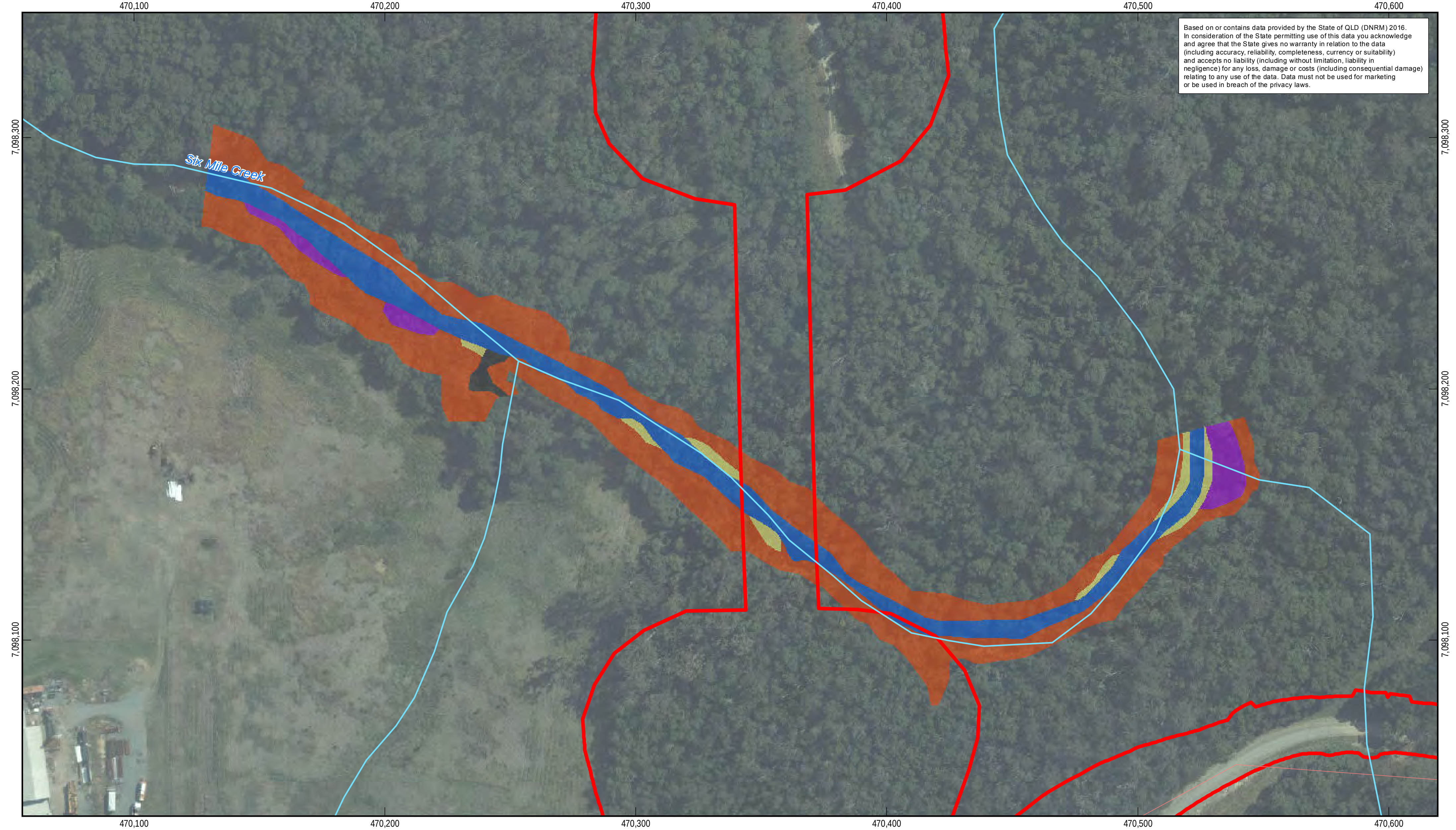
Species	Survey guidelines			Methodology employed
	Appropriate methodology	Seasonal considerations	Daily considerations	
Australian lungfish (*Neoceratodus forsteri*)	Electrofishing is considered the most effective method. Angling using barbless hooks is also used successfully. Other methods include: • Set lining • Gillnetting • Daytime snorkelling • Fyke netting	Surveys are potentially more effective during spring and summer when fish are more active. Surveys should avoid spawning between August and December.	A nocturnal species. Survey methods should target nigh time when the species is most active	Electofishing Fkye netting at night Snorkelling* Opportunistic observations
Mary River cod (*Maccullochella mariensis*)	A combination of angling using barbless hooks, electrofishing and visual observation via snorkelling are considered the most effected methods. Other methods include: • Set lining • Gillnetting • Fyke netting	Generally more active during spring and summer. However, spawning occurs in spring and sometimes into summer, and surveys should avoid these periods.	Most active at dawn, dusk and at night, however, sight-dependant methods such as snorkelling are best during the daytime.	Electofishing Fkye netting at night Snorkelling* Opportunistic observations

Species	Survey guidelines			Methodology employed
	Appropriate methodology	Seasonal considerations	Daily considerations	
Mary River turtle (*Elusor macrurus*)	Snorkelling, where appropriate, is considered the most effective method. Other methods include: • Trapping • Seine netting • Dip netting	Generally more active during warmer months of the year (late spring and through summer). Nesting occurs in late October - January	Can be observed basking on emergent logs during morning and afternoon hours.	Fkye netting Turtle cathedral traps Snorkelling* Opportunistic observations
White-throated snapping turtle (*Elseya albagula*)	Trapping is considered the most effective method. Other methods include: • Snorkelling • Seine netting • Dip netting	Most breeding occurs during autumn and winter.	Most active during morning and afternoon hours.	Fkye netting Turtle cathedral traps Snorkelling* Opportunistic observations
Platypus (*Ornithorhynchus anatinus*)	Wildlife surveys would rarely need to capture platypus to establish their presence. Visual observation is considered the most appropriate method to determine species presence. Other methods include: • Gillnetting	Trapping must not be carried out during the months of October to March, when females are laying eggs and raising young, unless justified to the AEC.	Most active during dawn and dusk.	Opportunistic observations.

Species	Survey guidelines			Methodology employed
	Appropriate methodology	Seasonal considerations	Daily considerations	
Queensland lace plant (*Aponogeton elongates*)	Meander surveys are considered the preferred approach to identify and locate protected plants. If a protected plant is identified and located, a population survey should be conducted to determine the population extent and density. Other methods include: • Systematic transect search • Plot survey	Flowering occurs from October to March, however the previous record from the area was identified in December.	Daylight hours are most appropriate for an effective survey to be conducted.	Meander survey Opportunistic observations.

Sources: DSEWPC (2011a and 2011b); EHP (2014;2015); Animal Ethics InfoLink (2015); Limpus et al. (2011); Hellquist et al. (1998). *Snorkelling surveys for conservation significant species were attempted at all nominated sites; however, due to high turbidity levels, visibility was less than 30 cm and this survey technique could not be completed.

Appendix G – Morphology maps



Paper Size A4

0 12.5 25 50 75

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Minor watercourse
Street/Local Road
Project footprint

Morphology

Bank
Bar
Bench
Pool
Tributary

GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number 41-29710
Revision 0
Date 11 Aug 2016

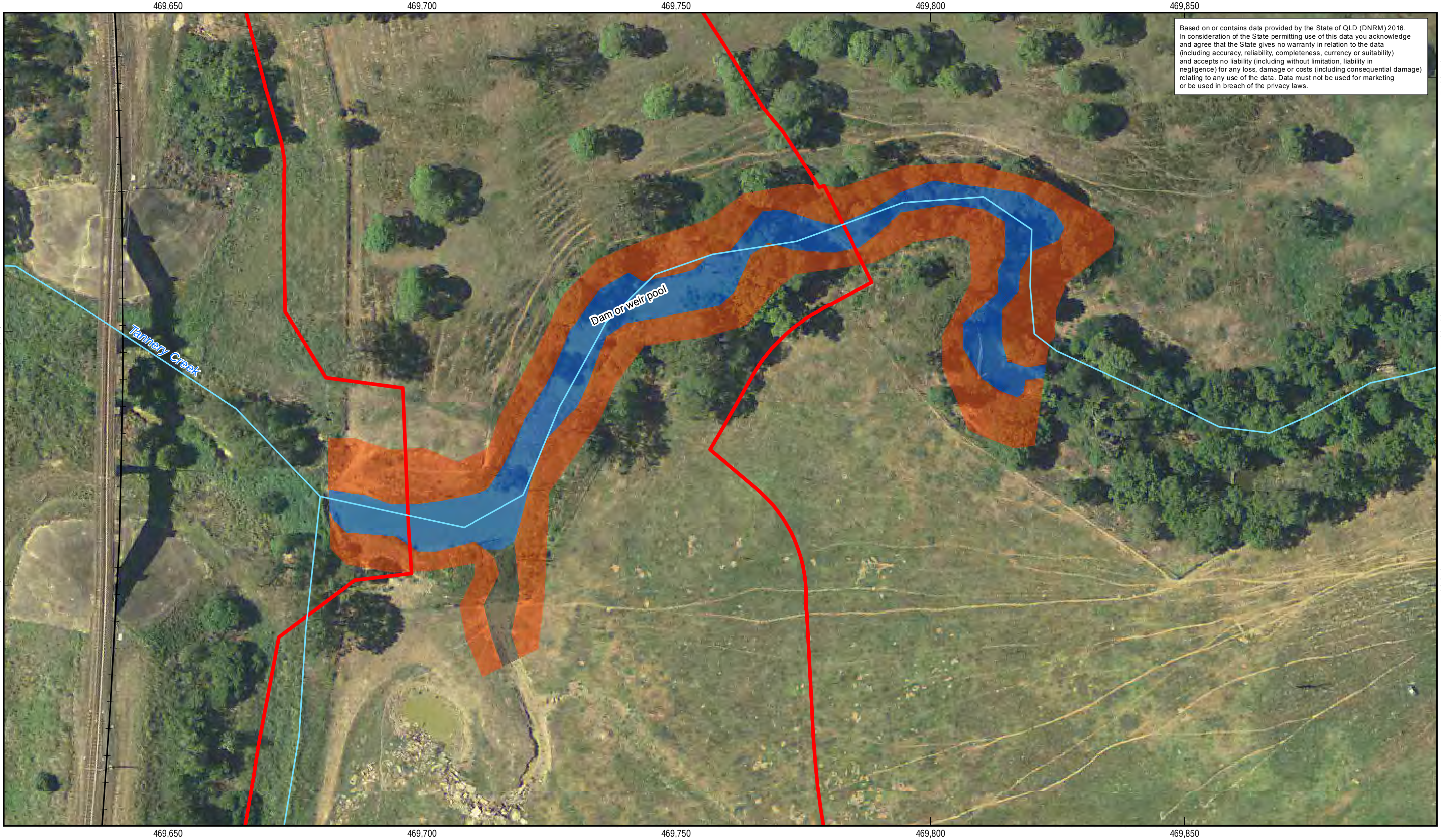
Morphology of Six Mile Creek

Figure G1

G:\41\29710\GIS\Maps\MXD\4129710_024_Land_Rev0.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2011). Created by: RB



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Minor watercourse
Railway
Project footprint

Morphology

Bank
Pool
Tributary

GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number 41-29710
Revision 0
Date 11 Aug 2016

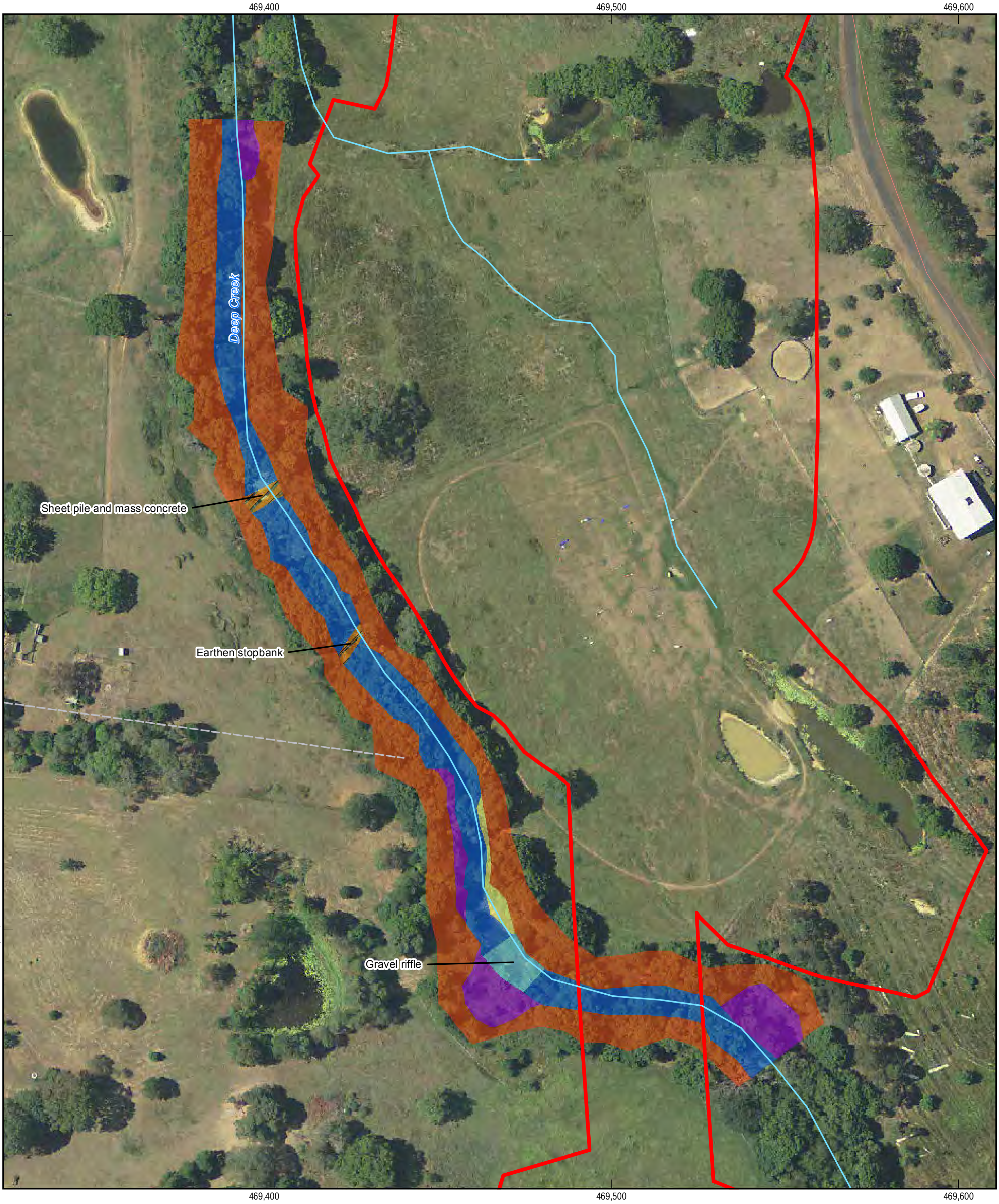
Morphology of Tannery Creek

Figure G2

G:\41\29710\GIS\Maps\MXD\4129710_023_Land_Rev0.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB



LEGEND

- Street/Local road
- Unconstructed Road
- Minor watercourse
- Project footprint

Morphology

- Bank
- Bar
- Bench
- Pool
- Pool crossing
- Weir

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Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29710
Revision	0
Date	11 Aug 2016

Morphology of Deep Creek

Figure G3

145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

G:\41\29710\GIS\Maps\MXD\4129710_022_Port_Rev0.mxd

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB

Paper Size A4

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Minor watercourse

Secondary Road

Street/Local Road

Project footprint

Morphology

Flat bed

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number 41-29710
Revision 0
Date 11 Aug 2016

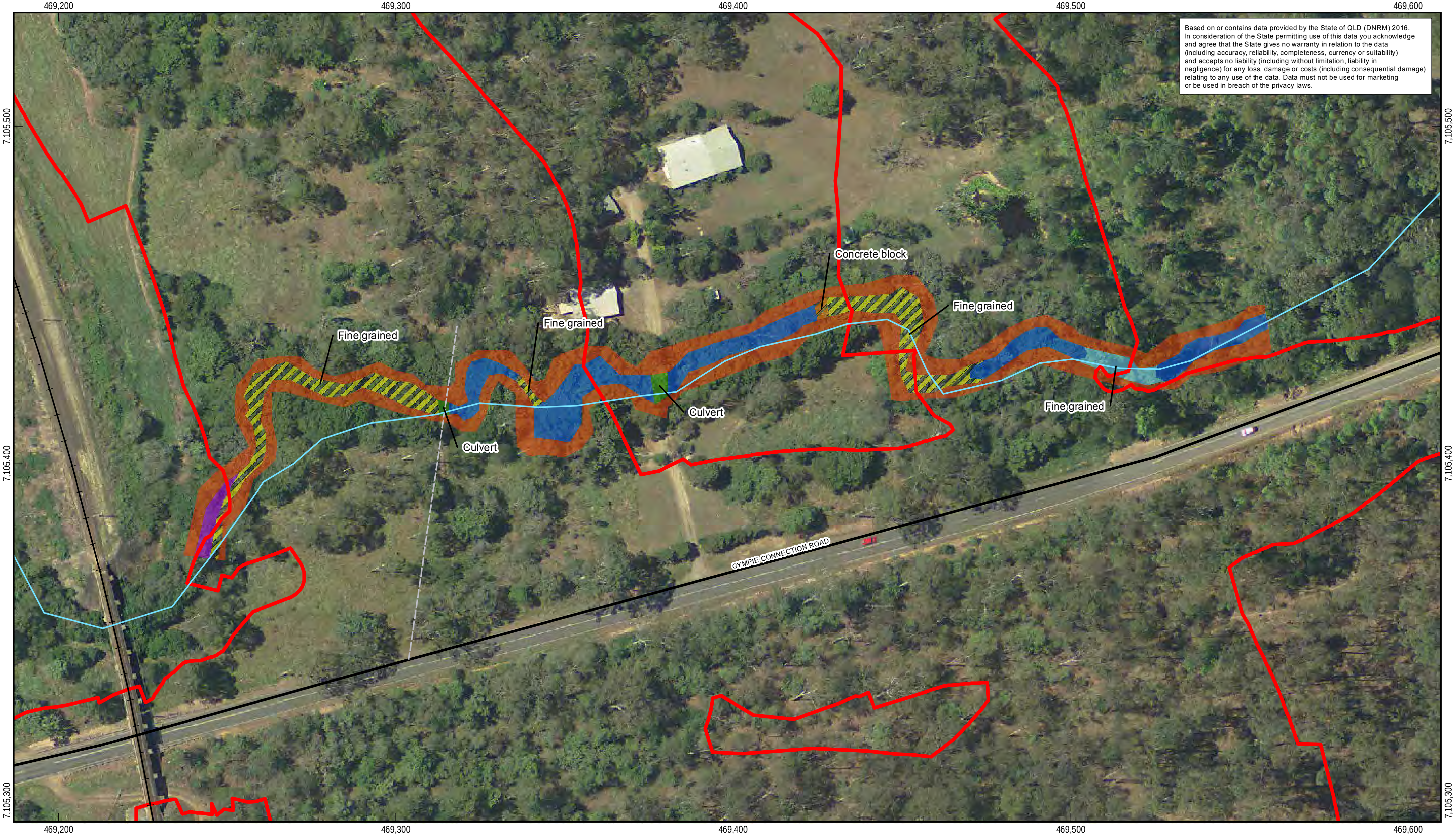
Morphology of Moody Creek South

Figure G4

G:\41\29710\GIS\Maps\MXD\4129710_021_Land_Rev0.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Minor watercourse
- Railway
- Secondary Road
- Unconstructed Road
- Project footprint
- **Morphology**
- Bank
- Bench
- Crossing
- Flat bed
- Pool
- Pool crossing
- Weir

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29710
Revision	0
Date	11 Aug 2016

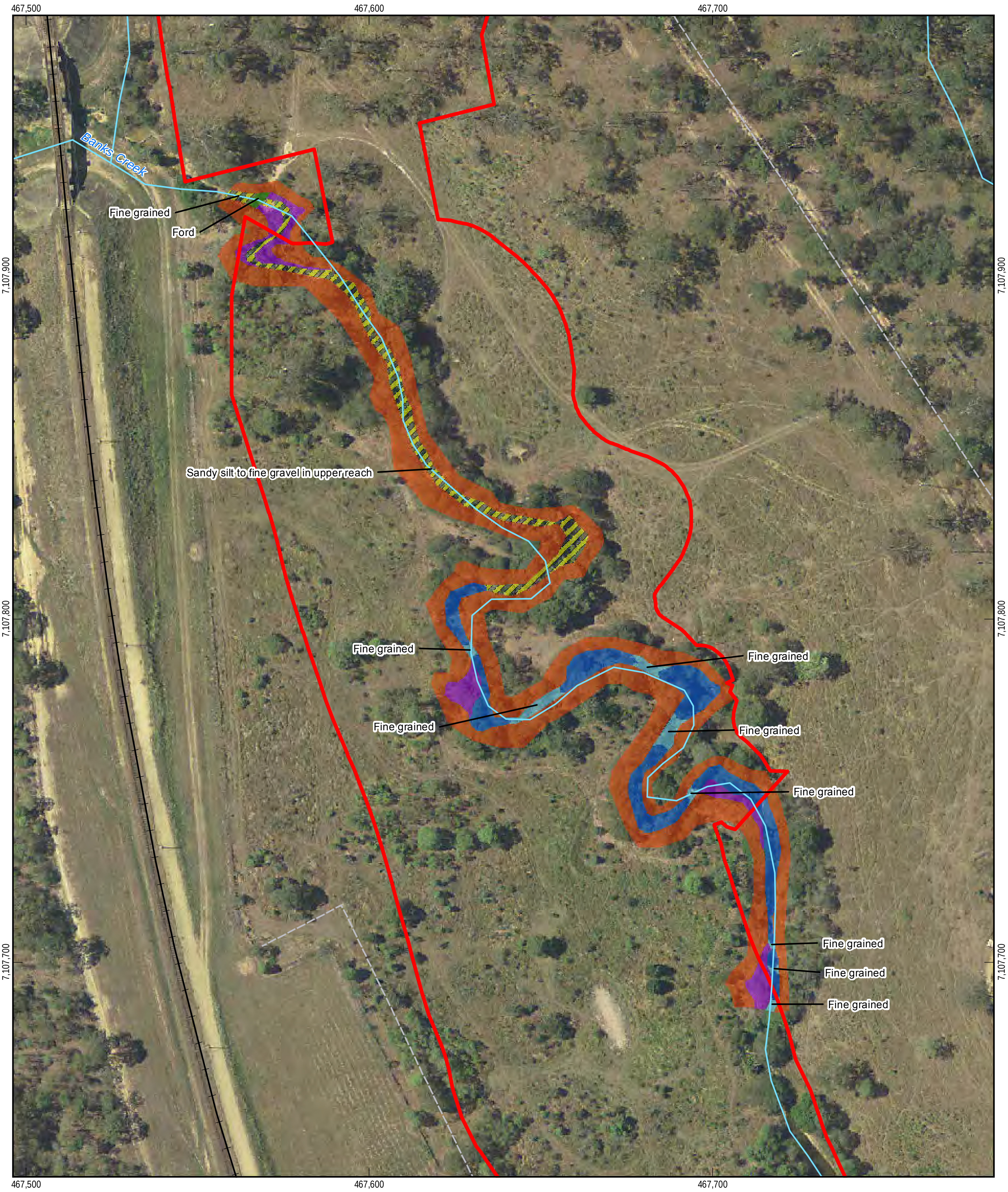
Morphology of Moody Creek North

Figure G5

G:\41\29710\GIS\Maps\MXD\4129710_020_Land_Rev0.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB



LEGEND

- Railway
- Unconstructed Road
- Minor watercourse
- Project footprint

Morphology

- Bank
- Bench
- Crossing
- Flat bed
- Pool
- Pool crossing

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Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29710
Revision	0
Date	11 Aug 2016

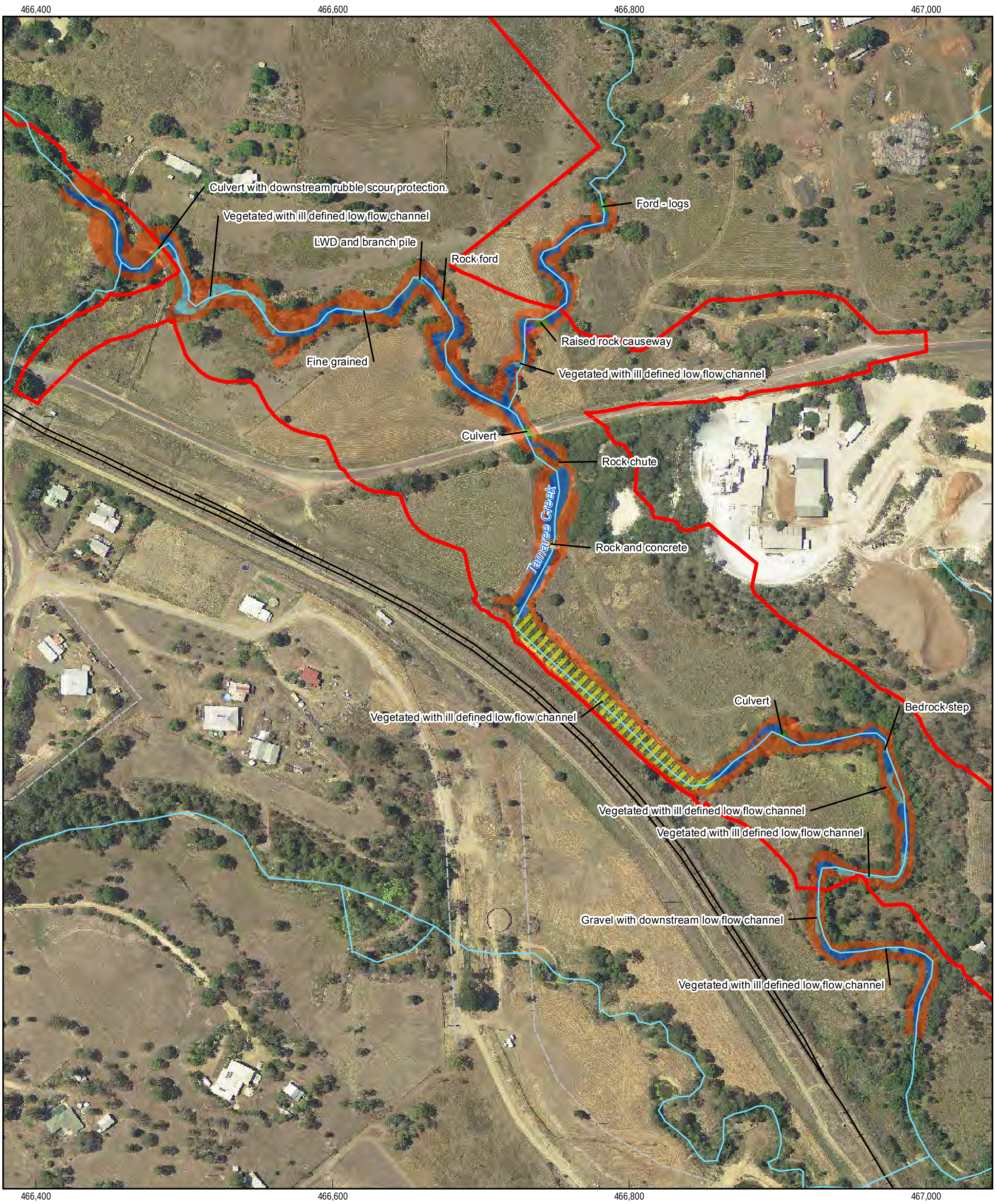
Morphology of Banks Creek

Figure G6

145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

G:\41\29710\GIS\Maps\MXD\4129710_019_Port_Rev0.mxd

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB



LEGEND

Railway	**Morphology**	Pool
Street/Local road	Bank	Pool crossing
Unconstructed Road	Bench	Tributary
Minor watercourse	Crossing	Weir
Project footprint	Flat bed	

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Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number 41-29710
Revision 0
Date 11 Aug 2016

Morphology of Tamaree Creek

Figure G7

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

G:\41\29710\GIS\Maps\MXD\4129710_018_Port_Rev0.mxd

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB

Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Minor watercourse
- Project footprint

Morphology

- Bank
- Crossing
- Pool
- Tributary

GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29710
Revision	0
Date	11 Aug 2016

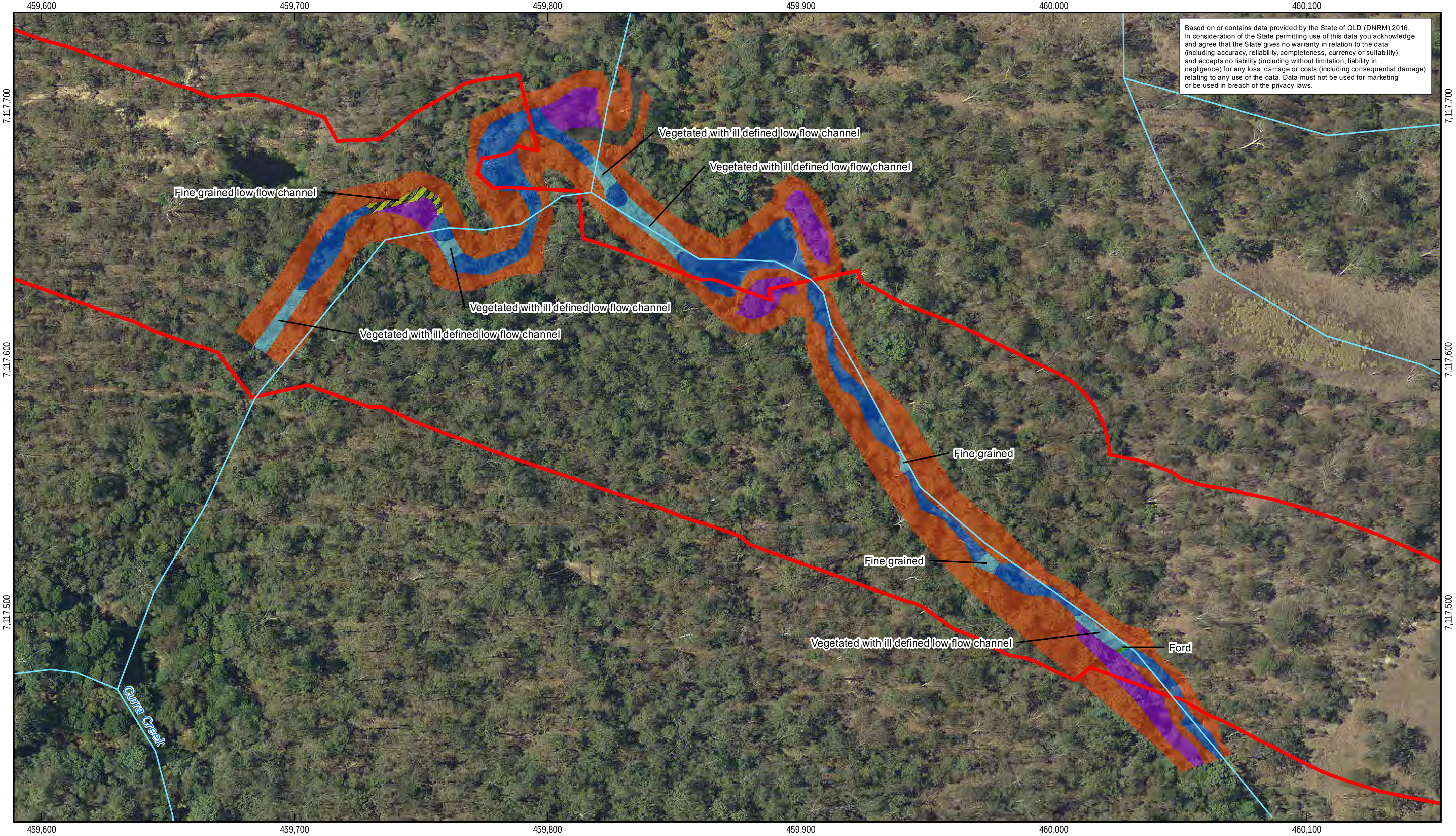
Morphology of Curra Creek

Figure G8

G:\41\29710\GIS\Maps\MXD\4129710_017_Land_Rev0.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB



Paper Size A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

Minor watercourse

Project footprint

Morphology

Bank

Bench

Crossing

Flat bed

Pool

Pool crossing

Tributary

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number 41-29710
Revision 0
Date 11 Aug 2016

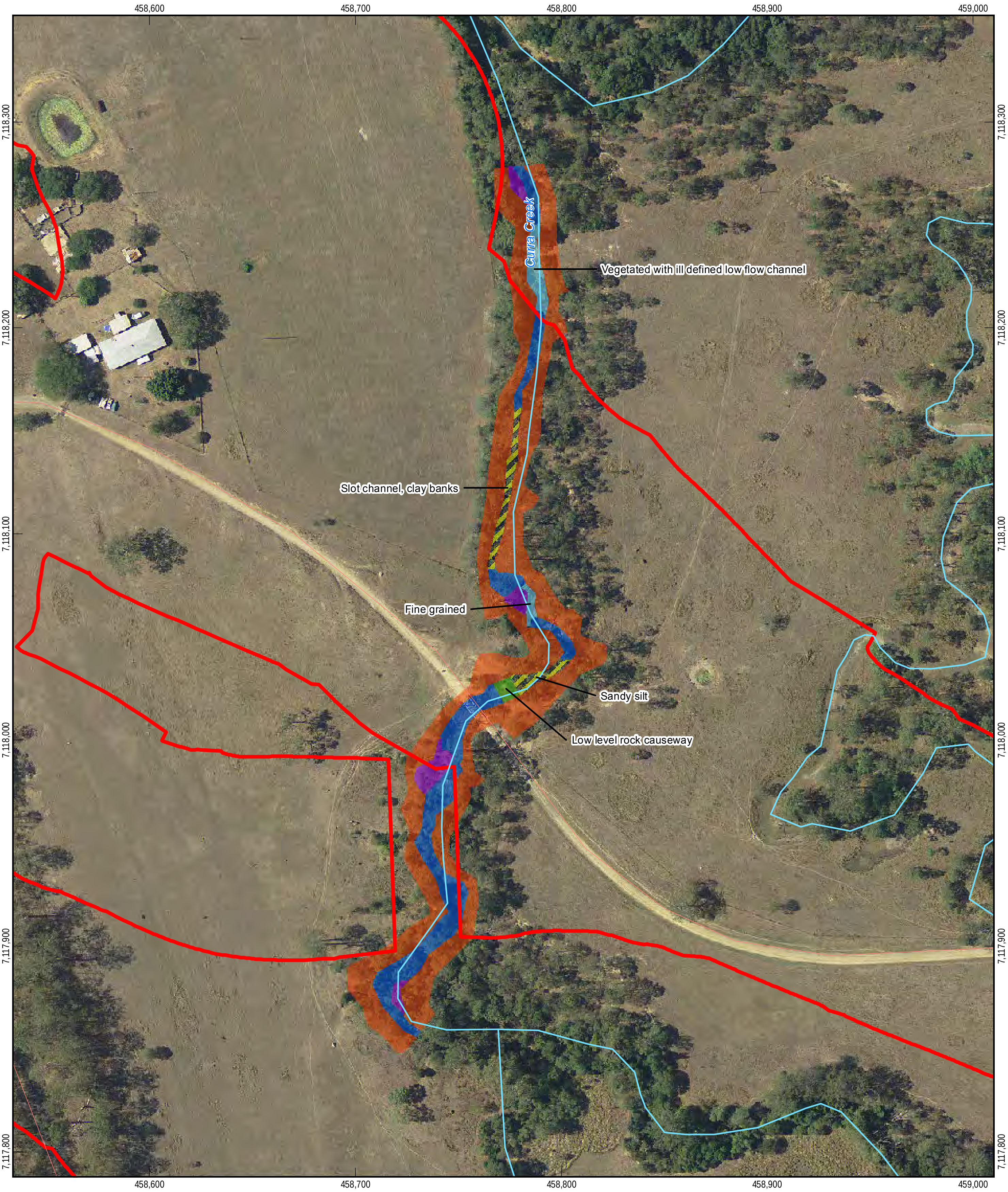
Morphology of Unnamed Watercourse
(Lot 1717 on M37818)

Figure G9

G:\41\29710\GIS\Maps\MXD\4129710_016_Land_Rev0.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB



LEGEND

- Street/Local road
- Minor watercourse
- Project footprint

Morphology

- Bank
- Bench
- Crossing
- Flat bed
- Pool
- Pool crossing

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Paper Size A4

0 12.5 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29710
Revision	0
Date	11 Aug 2016

Morphology of Curra Creek North

Figure G10

145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

G:\41\29710\GIS\Maps\MXD\4129710_015_Port_Rev0.mxd

Data source: TMR: Project Footprint (2016); DNRM: Railway, Watercourse (2014), Road (2016); GHD: Morphology (2016); TMR: Imagery (2014). Created by: RB

Appendix H – Riparian vegetation assessment

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
Six Mile Creek	Average width of riparian vegetation (one side of channel) – 21 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) – 55 Native proportion of understorey cover (%) – 12 Native proportion of ground cover (%) – 35 Leaf litter cover (%) – 56 Standing dead trees – <2 Hollow bearing trees – <2 Fallen logs – present	**T1:** Average height (m) – 20 Total canopy cover (%) – 10 Dominant flora species – *Eucalyptus tereticornis, Lophostemon suaveolens* **T2:** Average height (m) – 12 Total canopy cover (%) – 20 Dominant flora species – **Celtis sinensis, Castanospermum australe Ficus coronata, *Macfadyena unguis-cati, Lophostemon suaveolens, Acronychia oblongifolia, Waterhousea floribunda, Cryptocarya triplinervis var. pubens* **S1:** Average height (m) – 1.5 Total cover (%) – 30 Dominant flora species – *Streblus brunonianus, *Celtis sinensis, Ficus coronata, *Macfadyena unguis-cati, Trophis scandens subsp. scandens, Atractocarpus chartaceus, Pavetta australiensis, Endiandra*	**T1:** Average height (m) – 14 Total canopy cover (%) – 40 Dominant flora species – *Streblus brunonianus, Waterhousea floribunda, Lophostemon suaveolens* **T2:** Average height (m) – 11 Total canopy cover (%) – 35 Dominant flora species – *Ficus coronata, Streblus brunonianus, Waterhousea floribunda, Cryptocarya triplinervis var. pubens, Acronychia oblongifolia* S1: Average height (m) – 2 Total cover (%) – 35 Dominant flora species – *Streblus brunonianus, *Celtis sinensis, Ficus coronata* **G:** Average height (m) – 0.6 Total cover (%) – 30 Dominant flora species – *Lomandra longifolia*, *Lomandra hystrix*, *Adiantum atroviride,*	*Cyperus polystachyos Fimbristylis nutans, Cyperus gracilis*	 Upper/mid bank  Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			discolor, Cleistanthus cunninghamii **G:** Average height (m) – 0.6 Total cover (%) – 30 Dominant flora species – *Ottochloa gracilis, *Macfadyena unguis-cati, Adiantum atroviride, Smilax australis*	*Ottochloa gracilis, Smilax australis, *Macfadyena unguis-cati, Atractocarpus chartaceus, Pavetta australiensis, Trophis scandens subsp. scandens*		
Tannery Creek	Average width of riparian vegetation (one side of channel) – 5 m Break in longitudinal connectivity for approximately 60 m along both banks at downstream extent of the reach.	Native proportion of canopy cover (%) – 10 Native proportion of understorey cover (%) – 4 Native proportion of ground cover (%) – 20 Leaf litter cover (%) – 60 Standing dead trees – present Hollow bearing trees – present Fallen logs – present	**T1:** Average height (m) – 17 Total canopy cover (%) – 15 Dominant flora species – *Eucalyptus tereticornis, Lophostemon suaveolens,* **T2:** Average height (m) – 8 Total canopy cover (%) – 7 Dominant flora species – *Melaleuca salicina, Lophostemon suaveolens, Acacia disparrima, *Celtis sinensis, Waterhousea floribunda, Parsonsia straminea*	**T1:** Not present in this location **T2:** Average height (m) – 8 Total canopy cover (%) – 7 Dominant flora species – Melaleuca salicina, *Lophostemon suaveolens, Acacia disparrima, *Celtis sinensis, Parsonsia straminea* **S1:** Average height (m) – 3 Total cover (%) – 10 Dominant flora species – **Celtis sinensis, Lophostemon suaveolens, Cupaniopsis anacardioides, Cryptocarya*	*Spirodela punctata*	 Upper/mid bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			S1: Average height (m) – 3 Total cover (%) – 10 Dominant flora species – **Celtis sinensis, Parsonsia straminea, Sauropus albiflorus, *Lantana camara, *Macfadyena unguis-cati, Streblus brunonianus, Acacia maidenii* **G:** Average height (m) – 1 Total cover (%) – 80 Dominant flora species – **Macfadyena unguis-cati, Lomandra longifolia, Paspalum conjugatum, Megathyrsus maximums, Ageratum houstonianum*	*triplinervis var pubens, Acacia maidenii* **G:** Average height (m) – 1 Total cover (%) – 80 Dominant flora species – **Macfadyena unguis-cati, Lomandra longifolia, Paspalum conjugatum, Sida rhombifolia, Verbena littoralis, Conyza bonariensis, Sauropus albiflorus*		 Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
Deep Creek	Average width of riparian vegetation (one side of channel) – 16 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) – 25 Native proportion of understorey cover (%) – 17 Native proportion of ground cover (%) – 5 Leaf litter cover (%) – 56 Standing dead trees – present Hollow bearing trees – present Fallen logs – present	**T1:** Average height (m) – 11 Total canopy cover (%) – 60 Dominant flora species – **Cinnamomum camphora*, *Ficus rubiginosa, Aphananthe philippinensis, Flindersia schottiana* **T2:** Average height (m) – 8 Total canopy cover (%) – 20 Dominant flora species – *Waterhousea floribunda, Acronychia oblongifolia* **S1:** Average height (m) – 3 Total cover (%) – 13 Dominant flora species – *Aphananthe philippinensis, Streblus brunonianus, *Macfadyena unguis-cati, Smilax australis, Rhodamnia dumicola, Trophis scandens subsp. scandens* **G:** Average height (m) – 1 Total cover (%) – 30 Dominant flora species – **Macfadyena unguis-cati, Lomandra longifolia, Ottochloa gracilis, Imperata*	**T1:** Average height (m) – 8 Total canopy cover (%) – 70 Dominant flora species – *Streblus brunonianus, Ficus coronata, Waterhousea floribunda, Acronychia oblongifolia, Flindersia schottiana* **T2:** Not present in this location **S1:** Average height (m) – 3 Total cover (%) – 5 Dominant flora species – *Ficus coronata, Waterhousea floribunda, *Ligustrum sinense, Streblus brunonianus, *Macfadyena unguis-cati, Rhodamnia dumicola, Trophis scandens subsp. scandens* **G:** Average height (m) – 1 Total cover (%) – 17 Dominant flora species – **Macfadyena unguis-cati, Lomandra longifolia, Lomandra hystrix, Ottochloa gracilis, Imperata cylindrica, Oplismenus aemulus, Paspalum conjugatum, Adiantum hispidulum, Gahnia aspera, Doodia aspera*		 Upper/mid bank  Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			cylindrica, Oplismenus aemulus, Doodia aspera			
Moody Creek (south)	Average width of riparian vegetation (one side of channel) – 4 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) – 20 Native proportion of understorey cover (%) – 3 Native proportion of ground cover (%) – 60 Leaf litter cover (%) – 7 Standing dead trees – Nil Hollow bearing trees – Nil Fallen logs – low density	**T1:** Average height (m) – 9 Total canopy cover (%) – 25 Dominant flora species – *Melaleuca salicina, Eucalyptus tereticornis, *Celtis sinensis, Lophostemon suaveolens, Cryptocarya triplinervis var. pubens* **T2**: Not present in this location **S1:** Average height (m) – 3 Total cover (%) – 10 Dominant flora species – *Acacia maidenii, Acacia disparrima, Streblus brunonianus,* **G:** Average height (m) – Total cover (%) – Dominant flora species – *Imperata cylindrica, Lomandra longifolia, *Paspalum conjugatum, *Macfadyena unguis-cati, Smilax australis*	**T1:** Average height (m) – Total canopy cover (%) – 5 Dominant flora species – *Melaleuca salicina, Lophostemon suaveolens, Cryptocarya triplinervis var. pubens* **T2:** Not present in this location **S1:** Average height (m) – Total cover (%) – 2 Dominant flora species – *Melaleuca salicina* **G:** Average height (m) – 1 Total cover (%) – 60 Dominant flora species – *Imperata cylindrica, Lomandra longifolia, *Paspalum conjugatum, *Macfadyena unguis-cati, Smilax australis, Ottochloa gracilis*	*Cyperus polystachyos, Juncus usitatus, Cyperus gracilis*	 Upper/mid bank  Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
Moody Creek (north)	Average width of riparian vegetation (one side of channel) – 25 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) – 20 Native proportion of understorey cover (%) – 20 Native proportion of ground cover (%) – 5 Leaf litter cover (%) – 60 Standing dead trees – Yes Hollow bearing trees – Nil Fallen logs – Yes	**T1:** Average height (m) – 14 Total canopy cover (%) – 53 Dominant flora species – *Lophostemon suaveolens, *Cinnamomum camphora, Eucalyptus tereticornis* **T2:** Average height (m) – 6 Total canopy cover (%) – 11 Dominant flora species – **Cinnamomum camphora, *Celtis sinensis, Melaleuca salicina, *Schefflera actinophylla, *Ligstrum lucidum, Litsea leefeana* **S1:** Average height (m) – 2 Total cover (%) – 13 Dominant flora species – **Ochna serrulata, Leptospermum polygalifolium, *Lantana camara, *Cinnamomum camphora, Acacia maidenii, *Celtis sinensis*	**T1:** Average height (m) – 14 Total canopy cover (%) – 65 Dominant flora species – *Lophostemon suaveolens, *Celtis sinensis *Cinnamomum camphora* **T2:** Average height (m) – 6 Total canopy cover (%) – 11 Dominant flora species – **Cinnamomum camphora, *Celtis sinensis, Melaleuca salicina, *Schefflera actinophylla, Lophostemon suaveolens* **S1:** Average height (m) – 2 Total cover (%) – 10 Dominant flora species – *Ficus coronata, Acacia maidenii, *Ochna serrulata, *Celtis sinensis, *Cinnamomum camphora, *Schefflera actinophylla, Smilax australis* **G:** Average height (m) – 1		 Upper/mid bank  Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			G: Average height (m) – 1 Total cover (%) – 25 Dominant flora species – **Macfadyena unguis-cati, Lomandra longifolia, Adiantum hispidulum, *Paspalum paniculatum*	Total cover (%) – 25 Dominant flora species – **Macfadyena unguis-cati, Lomandra longifolia, Adiantum hispidulum, *Paspalum conjugatum, Ottochloa gracilis, Juncus usitatus, Gahnia aspera, *Passiflora suberosa*		
Banks Creek	Average width of riparian vegetation (one side of channel) – 33 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) - 90 Native proportion understorey cover - 82 Native proportion of ground cover (%) – 60 Leaf litter cover (%) – 25 Standing dead trees – <2 Hollow bearing trees – <2 Fallen logs - few	**<u>T1 layer:</u>** Average height (m) – 14.0 Total canopy cover (%) – 50 Dominant flora species – *Eucalyptus tereticornis* *T1 layer only present at one transect **<u>T2 layer:</u>** Average height (m) – 8.0 Total canopy cover (%) – 30 Dominant flora species - *Melaleuca salicina, Acacia leiocalyx, Melaleuca styphelioides, Lophostemon suaveolens, Acacia disparrima, Acacia maidenii, Euroschinus falcatus var. falcatus, Syzygium oleosum*	**<u>T1 layer:</u>** Average height (m) – 8 Total canopy cover (%) – 10 Dominant flora species - *Acacia disparrima, Melaleuca salicina, Melaleuca styphelioides, Acacia maidenii, *Cinnamomum camphora, Myrsine variabilis, Lophostemon suaveolens, *Celtis sinensis, Syzygium oleosum* **<u>S1 layer:</u>** Average height (m) – 1.5 Total cover (%) – 10 Dominant flora species - *Waterhousea floribunda, Acronychia oblongifolia, Smilax australis, *Senna septemtrionalis, *Schinus terebinthifolius, *Macfadyena unguis-cati*	*Cyperus polystachyos* *Cyperus exaltatus* **Cuphea carthagenensis*	 Upper/mid bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			<u>S1 layer:</u> Average height (m) – 1.5 Total cover (%) – 10 Dominant flora species - *Sauropus albiflorus, Phyllanthus gunnii, Melaleuca styphelioides, Acacia maidenii, Leptospermum polygalifolium, Lophostemon suaveolens, Acronychia oblongifolia*, *Stephania japonica,* **<u>G layer:</u>** Average height (m) – 0.6 Total cover (%) – 25 Dominant flora species - **Ageratum houstonianum, Pteridium esculentum, Lomandra longifolia, Ottochloa gracillima, *Paspalum conjugatum, *Setaria sphacelata, Themeda triandra, Adiantum hispidulum, Imperata cylindrica*	**<u>G layer:</u>** Average height (m) – 0.9 Total cover (%) – 25 Dominant flora species - *Lomandra longifolia, Ottochloa gracillima, Cyperus polystachyos, Adiantum hispidulum, Persicaria decipiens, Smilax australis, * Passiflora suberosa, *Macfadyena unguis-cati, Capillipedium spicigerum, *Cuphea carthagenensis*		 Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
Tamaree Creek	Average width of riparian vegetation (one side of channel) – 8 m Break in longitudinal connectivity for approximately 180 m at the site of the creek diversion adjacent to the railway line	Native proportion of canopy cover (%) - 42 Native proportion of understorey cover (%) - 34 Native proportion of ground cover (%) – 57 Leaf litter cover (%) – 33 Standing dead trees – nil Hollow bearing trees – nil Fallen logs - few	**T1 layer:** Average height (m) – 11.0 Total canopy cover (%) – 50 Dominant flora species - **Pinus elliottii, Eucalyptus tereticornis, *Cinnamomum camphora, *Celtis sinensis, Lophostemon confertus, Corymbia intermedia* **T2 layer:** Average height (m) – 6.0 Total canopy cover (%) – 30 Dominant flora species - *Acacia fimbriata, Acacia maidenii, *Cinnamomum camphora, Leptospermum polygalifolium, Melaleuca salicina, Acronychia oblongifolia, Decaspermum humile* **S1 layer:** Average height (m) – 2.5 Total cover (%) – 8 Dominant flora species - **Lantana camara, *Cinnamomum camphora, Acacia fimbriata, *Celtis sinensis, Acacia irrorata subsp. irrorata, *Baccharis*	**T1 layer:** Average height (m) – 6 Total canopy cover (%) – 42 Dominant flora species - *Melaleuca salicina, Melaleuca styphelioides, Acacia maidenii, *Cinnamomum camphora, Elaeocarpus reticulatus* **S1 layer:** Average height (m) – 1.5 Total cover (%) – 10 Dominant flora species – **Cinnamomum camphora, Ficus coronata, *Baccharis halimifolia, Acronychia oblongifolia, Acacia maidenii, *Senna pendula, Atalaya salicifolia, *Corymbia torelliana, *Celtis sinensis* **G layer:** Average height (m) – 1.0 Total cover (%) – 20 Dominant flora species – *Adiantum hispidulum, Pteridium esculentum, Lomandra longifolia, Lomandra hystrix, *Passiflora suberosa, Dianella caerulea, Gahnia aspera, Ottochloa gracillima, Rubus moluccanus var.*	**Sphagneticola trilobata,* *Typha orientalis, Ottelia ovalifolia,* *Schoenoplectus mucronatus,*	 Upper/mid bank  Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			*halimifolia, Melaleuca salicina, *Solanum mauritianum, Sarcopetalum harveyanum, Breynia oblongifolia, Geitonoplesium cymosum, *Maclura cochinchinensis* **<u>G layer:</u>** Average height (m) – 1.0 Total cover (%) – 30 Dominant flora species – *Lomandra longifolia, Imperata cylindrica, Pteridium esculentum, Ottochloa gracillima, *Lantana montevidensis, *Setaria sphacelata, *Ageratum houstonianum, *Bidens pilosa, *Chloris gayana, Sorghum nitidum forma aristatum, Adiantum hispidulum*	*moluccanus, Geitonoplesium cymosum*		

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
Curra Creek South	Average width of riparian vegetation (one side of channel) – 15 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) - 100 Native proportion of understorey cover (%) - 50 Native proportion of ground cover (%) – 90 Leaf litter cover (%) – 70 Standing dead trees – <2 Hollow bearing trees – <2 Fallen logs – few	**T1:** Average height (m) – 25 Total canopy cover (%) – 40 Dominant flora species – *Corymbia intermedia, Eucalyptus tereticornis, Eucalyptus propinqua* **T2:** Average height (m) – 13.5 Total canopy cover (%) – 30 Dominant flora species - *Lophostemon suaveolens, Melaleuca salicina, Eucalyptus propinqua* **S1:** Average height (m) – 2 Total cover (%) – 20 Dominant flora species - *Leptospermum polygalifolium, *Lantana camara, Acacia maidenii, Acacia irrorata subsp. irrorata, Myrsine variabilis, Cryptocarya triplinervis, Alphitonia excelsa, Pittosporum revolutum, Parsonsia straminea, *Ligustrum lucidum Polyscias elegans, Cissus*	**T1:** Average height (m) – 11 Total canopy cover (%) – 50 Dominant flora species – *Lophostemon suaveolens, Streblus brunonianus* **T2:** Average height (m) – 9 Total canopy cover (%) – 15 Dominant flora species - *Cryptocarya triplinervis, Streblus brunonianus, Lophostemon suaveolens, Melaleuca salicina* **S1:** Average height (m) – 2 Total cover (%) – 20 Dominant flora species - *Lantana camara, Acacia maidenii, Streblus brunonianus, Myrsine variabilis, Aphananthe philippinensis, Smilax australis, Acronychia oblongifolia* **G:** Average height (m) – 0.5 Total cover (%) – 60 Dominant flora species – *Lomandra longifolia, Ottochloa gracillima, Oplismenus aemulus,*		 Upper/mid bank  Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			oblonga, Myrsine porosa, Acmena smithii **G:** Average height (m) – 0.5 Total cover (%) – 60 Dominant flora species – *Imperata cylindrica, Ottochloa gracillima, Lomandra longifolia, Pandorea pandorana, *Ageratum houstonianum, Smilax australis, Geitonoplesium cymosum, Adiantum atroviride,*	*Imperata cylindrica, Dianella caerulea, Adiantum atroviride, Smilax australis, Geitonoplesium cymosum*		
Curra Creek North	Average width of riparian vegetation (one side of channel) – 11 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) - 90 Native proportion of understorey cover (%) - 68 Native proportion of ground cover (%) – 64 Leaf litter cover (%) – 40 Standing dead trees – <2 Hollow bearing trees – <2	**T1:** Average height (m) – 19.0 Total canopy cover (%) – 25 Dominant flora species - *Eucalyptus tereticornis, Eucalyptus siderophloia, Eucalyptus moluccana, Acacia disparrima,* **T2:** Average height (m) – 9.5 Total canopy cover (%) – 40 Dominant flora species - *Eucalyptus tereticornis, Angophora subvelutina, Melaleuca salicina,*	**<u>T1 layer:</u>** Average height (m) – 19 Total canopy cover (%) – 10 Dominant flora species - *Eucalyptus tereticornis* *T1 layer only present at one transect **T2:** Average height (m) – 8.0 Total canopy cover (%) – 50 Dominant flora species - *Melaleuca viminalis, Streblus brunonianus, Melaleuca salicina, Lophostemon suaveolens*	*Ottelia ovalifolia,* **Myriophyllum aquaticum,* *Nymphoides indica, Persicaria decipiens, *Persicaria orientalis, , Juncus usitatus, Cyperus polystachyos, Cyperus gracilis*	 Upper/mid bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
		Fallen logs - few	*Lophostemon suaveolens, Acacia maidenii, Ficus coronata, Jagera pseudorhus, Melaleuca viminalis, Cryptocarya triplinervis, Notelaea longifolia,* **S1:** Average height (m) – 2.0 Total cover (%) – 26 Dominant flora species - *Streblus brunonianus, Aphananthe philippinensis, *Lantana camara, Acacia maidenii, Breynia oblongifolia, Ficus coronata, Melaleuca salicina, Carissa ovata, Hibiscus heterophyllus, Cryptocarya triplinervis, Acmena smithii, Cayratia clematidea, Gynochthodes jasminoides, Sauropus albiflorus, Melodinus australis, Trophis scandens subsp. scandens, Acmena smithii* **G:** Average height (m) – 0.6 Total cover (%) – 60 Dominant flora species - *Ottochloa gracillima, Lomandra longifolia, Solanum stelligerum, * Sida*	**<u>S1 layer:</u>** Average height (m) – 2.0 Total cover (%) – 5 Dominant flora species – **Cinnamomum camphora, Ficus coronata, *Baccharis halimifolia, Acronychia oblongifolia, Acacia maidenii, *Senna pendula, Atalaya salicifolia, *Corymbia torelliana, *Celtis sinensis, Hibiscus heterophyllus, Cryptocarya triplinervis, Acmena smithii* **<u>G layer:</u>** Average height (m) – 0.6 Total cover (%) – 18 Dominant flora species – *Ottochloa gracillima, Lomandra longifolia, Juncus usitatus, Cyperus polystachyos, Adiantum hispidulum, Oplismenus aemulus, * Megathyrsus maximus, *Ageratum houstonianum, *Conyza bonariensis, *Solanum seaforthianum, *Maclura cochinchinensis, *Paspalum conjugatum, Persicaria decipiens, *Persicaria orientalis, Cissus oblonga, Doodia aspera*		 Lower bank

Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			*rhombifolia, *Solanum seaforthianum, *Conyza bonariensis, Dianella caerulea, *Sida cordifolia, Themeda triandra, *Setaria sphacelata, Pseuderanthemum variabile, *Ageratum houstonianum, Cissus oblonga, Doodia aspera*			
Unnamed Creek Lot 1717 on M37818	Average width of riparian vegetation (one side of channel) – 15 m Vegetated bank – No longitudinal discontinuities (gaps greater than 50 m)	Native proportion of canopy cover (%) - 90 Native proportion of understorey cover (%) - 70 Native proportion of ground cover (%) – 86 Leaf litter cover (%) – 46 Standing dead trees – <2 Hollow bearing trees – <2 Fallen logs – few	**T1:** Average height (m) – 14 Total canopy cover (%) – 16 Dominant flora species - *Eucalyptus tereticornis, Alphitonia excelsa, Angophora subvelutina, Eucalyptus siderophloia* **T2:** Average height (m) – 9 Total canopy cover (%) – 56 Dominant flora species - *Alphitonia excelsa, Lophostemon suaveolens, Aphananthe philippinensis, Acacia maidenii, Eucalyptus tereticornis* **S1:** Average height (m) – 2	**T1:** Average height (m) – 15 Total canopy cover (%) – 40 Dominant flora species - *Angophora subvelutina, Lophostemon suaveolens* **T2:** Average height (m) – 7 Total canopy cover (%) – 30 Dominant flora species – *Elaeocarpus reticulatus, Lophostemon suaveolens, Melaleuca salicina* **S1:** Average height (m) – 2 Total cover (%) – 35 Dominant flora species - *Streblus brunonianus, Melaleuca salicina, Leptospermum polygalifolium,*		 Upper/mid bank

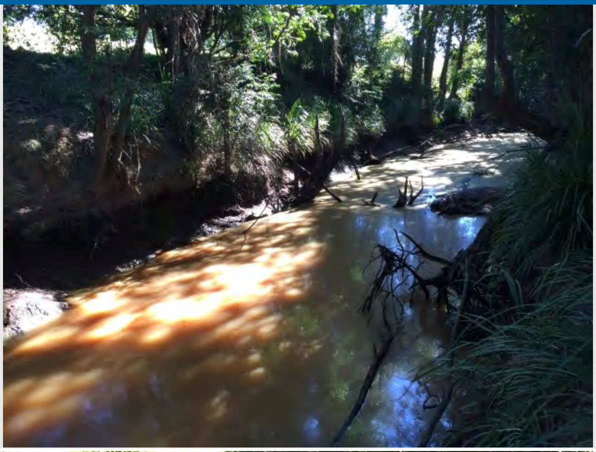
Waterway	Average width of riparian vegetation and longitudinal continuity	Native vegetation cover & Debris/ other features	Upper/mid bank vegetation	Lower bank vegetation	Aquatic vegetation	Representative photograph
			Total cover (%) – 35 Dominant flora species - *Aphananthe philippinensis, Streblus brunonianus, Myrsine variabilis, *Lantana camara, *Solanum seaforthianum, Sauropus albiflorus, Hibiscus heterophyllus, Lomandra filifolia, Breynia oblongifolia, Acacia disparrima, Myrsine variabilis, Cryptocarya triplinervis var. pubens, Pavetta australiensis* **G:** Average height (m) – 0.6 Total cover (%) – 50 Dominant flora species - *Ottochloa gracillima, Eustrephus latifolius, Lomandra longifolia, Parsonsia straminea, Dianella caerulea, Adiantum hispidulum, Pandorea pandorana, Solanum stelligerum*	**Lantana camara, Acacia disparrima, Alphitonia excelsa, Smilax australis, Parsonsia straminea, Pandorea pandorana, Cryptocarya triplinervis var. pubens* **G:** Average height (m) – 0.6 Total cover (%) – 50 Dominant flora species – *Ottochloa gracillima, Lomandra longifolia, Eustrephus latifolius, *Solanum seaforthianum, Oplismenus aemulus, Adiantum aethiopicum, Hibiscus heterophyllus*		 Lower bank

Sub-Index	Indicator	Range	Banks Creek	Tamaree Creek	Curra Creek North	Unnamed Creek Lot 1717 on M37818	Curra Creek South	Tannery Creek	Deep Creek	Moody Creek (south)	Moody Creek (north)	Six Mile Creek
HABITAT												
	Longitudinal continuity of riparian vegetation (≥ 5 m wide)	0-4	3	2	4	4	4	0	4	4	4	4
	Width of riparian vegetation	0-4	3	2	2	3	3	4	2	0	0	4
	Proximity to nearest patch of intact native vegetation > 10 ha	0-3	1	2	1	3	3	0	1	3	3	3
COVER												
	Canopy (> 5 m tall)	0-3	2	2	3	3	3	1	3	1	3	2
	Understorey (1-5 m tall)	0-3	2	2	2	2	2	1	2	1	3	3
	Ground (< 1 m tall)	0-3	2	3	2	2	3	3	2	3	1	2
	Number of layers	0-3	3	3	3	3	3	3	3	3	3	3
NATIVES												
	Canopy (> 5 m tall)	0-3	2	1	3	3	3	1	1	1	1	2
	Understorey (1-5 m tall)	0-3	2	2	2	2	2	1	2	1	2	2
	Ground (< 1 m tall)	0-3	2	2	2	2	3	1	3	3	1	1
DEBRIS												
	Leaf litter	0-3	1	2	2	3	3	2	3	1	3	2
	Native leaf litter	0-3	1	1	2	2	3	2	2	1	1	2
	Standing dead trees (> 20 cm dbh)	0-1	1	0	1	1	1	1	1	0	1	1
	Hollow-bearing trees	0-1	1	0	1	1	1	1	1	0	0	1
	Fallen logs (> 10 cm diameter)	0-2	1	1	1	1	1	1	1	1	1	2
FEATURES												
	Native canopy species regeneration	0-2	1	1	1	2	2	1	1	1	1	1
	Native understorey regeneration	0-2	0	1	1	2	2	1	1	1	1	1
	Large native tussock grasses	0-2	0	0	0	0	0	0	0	0	0	0
	Reeds	0-2	0	2	0	0	0	0	0	0	0	0
TOTAL		**0-50**	**28**	**29**	**33**	**39**	**42**	**24**	**33**	**25**	**29**	**36**

Appendix I – Morphology photographs

Six Mile Creek	
Photograph	Comment
	Downstream view displaying bank attached bar on left bank
	View of multi log cross spanning structure associated with bank attached bar feature. Photograph taken from left bank.
	Upstream view displaying steep, relatively stable banks.
	Upstream view of bedrock section.

Tannery Creek	
Photograph	Comment
	Upstream view displaying stable banks and single
	View of right bank with outcropping bedrock in profile.
	Downstream view displaying steeper right bank valley margin.
	View across channel at downstream extent where wider ponding occurs in response to earthen dam wall.

Deep Creek	
Photograph	Comment
	Undercut banks upstream of weir.
	Downstream view to sheet pile and concrete weir.
	Downstream of weir the presence of undercut banks is limited.
	Log jam and branch rack.

Moody Creek (south)	
Photograph	Comment
	Downstream view displaying typical channel depth. Note bedrock outcrop from toe of left bank.
	Upstream view with timber embedded in invert.
	Upstream view displaying typical channel form with graded convex upper profile and near vertical lower profile.
	Downstream view along section where right bank abuts the valley margin,.

Moody Creek (north)	
Photograph	Comment
	View of deeper pool at downstream extent of reach
	View of one of four headcuts observed in the reach.
	Undercut banks upstream of concrete block weir.
	Downstream view of flat bed section along upstream extent of reach.

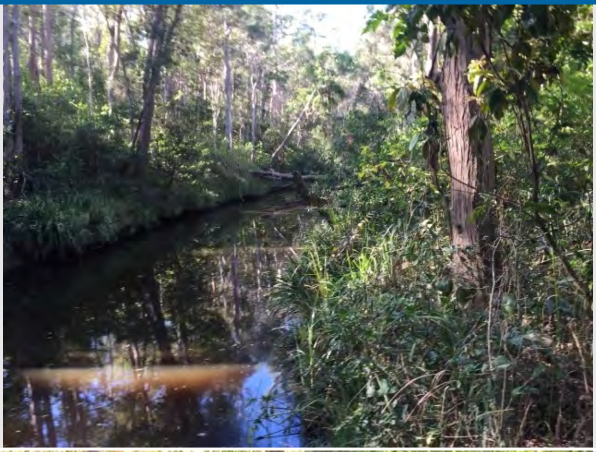
Banks Creek	
Photograph	Comment
	View of pool and outcropping bedrock where channel abuts valley margin along downstream extent of the reach
	Downstream view of long pool from apex of bend, displaying more graded inside right bank.
	Downstream view with un-vegetated pool crossing in foreground and pool in background.
	View of channel invert along upstream flat bed section.

Tamaree Creek – Upstream reach	
Photograph	Comment
	Upstream view of pool with undercut bank.
	Downstream view of vegetated pool crossing.
	View of log jam at pool crossing.
	Across channel view with rock ford structure in invert.

Tamaree Creek – Middle Reach	
Photograph	Comment
	View of rock chute upstream of on line dam.
	Upstream view of on line dam,
	Downstream view of diversion with eroding right bank. Note suspended fence.
	View towards downstream extent of diversion channel.

Tamaree Creek –Downstream Reach	
Photograph	Comment
	Track crossing towards upstream extent of reach.
	Upstream view of bedrock step where channel abuts left valley bedrock.
	Downstream view of vegetated pool crossing.
	Upstream view of long pool at downstream extent of reach.

Tamaree Tributary	
Photograph	Comment
	View of log ford at upstream extent of the reach..
	View of pool densely vegetated with emergent macrophytes.
	Upstream of pool where shading by fringing riparian vegetation limits macrosphyte growth.
	Downstream view towards confluence with Tamaree Creek.

Curra Creek	
Photograph	**Comment**
	Upstream view displaying long pool and steep, well vegetated banks.
	View to right banks displaying undercut banks.
	Cross-spanning large woody debris structure.
	Downstream view of more constricted channel at downstream extent of reach.

Unnamed Watercourse Lot 1717 on M37818	
Photograph	Comment
	Upstream view of pool in middle section of reach.
	Upstream view of un-vegetated pool crossing feature.
	Downstream view of vegetated pool crossing.
	Upstream view displaying bedrock outcropping from right bank.

Curra Creek (North)	
Photograph	Comment
	Upstream view of pool in the upper section of the reach.
	Upstream view from rock and gravel ford crossing.
	Downstream view of flat bed section where channel abuts left bank valley margin.
	Downstream view of vegetated pool crossing with poorly defined low flow channel.

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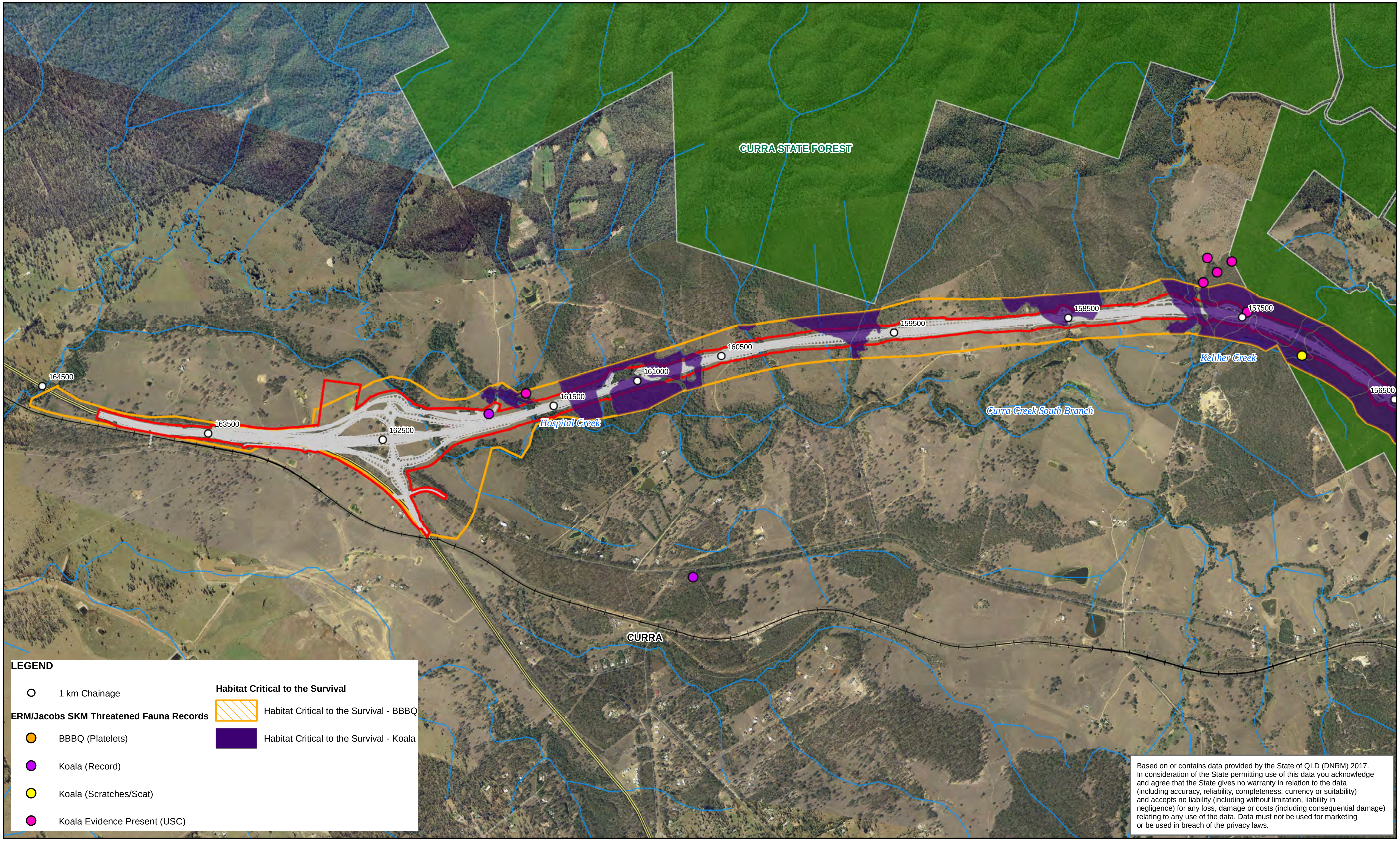
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	N. Clark G. Lampert P. Mooney	J. Corfield	*on file	D. Wilis		11/08/2016

Appendix N – Habitat critical to the survival of the black-breasted button-quail and koala



Paper Size A3

0 0.125 0.25 0.5 0.75 1

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- Town
- Railway
- Highway
- Street/Local Road
- Watercourses
- Protected Areas
- Survey Area
- Contract 2

Project Area

- Contract 1

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
Revision	0
Date	04 Apr 2017

Habitat Critical to the Survival of the Black-breasted Button-quail and Koala

Appendix N
Sheet 1 of 4

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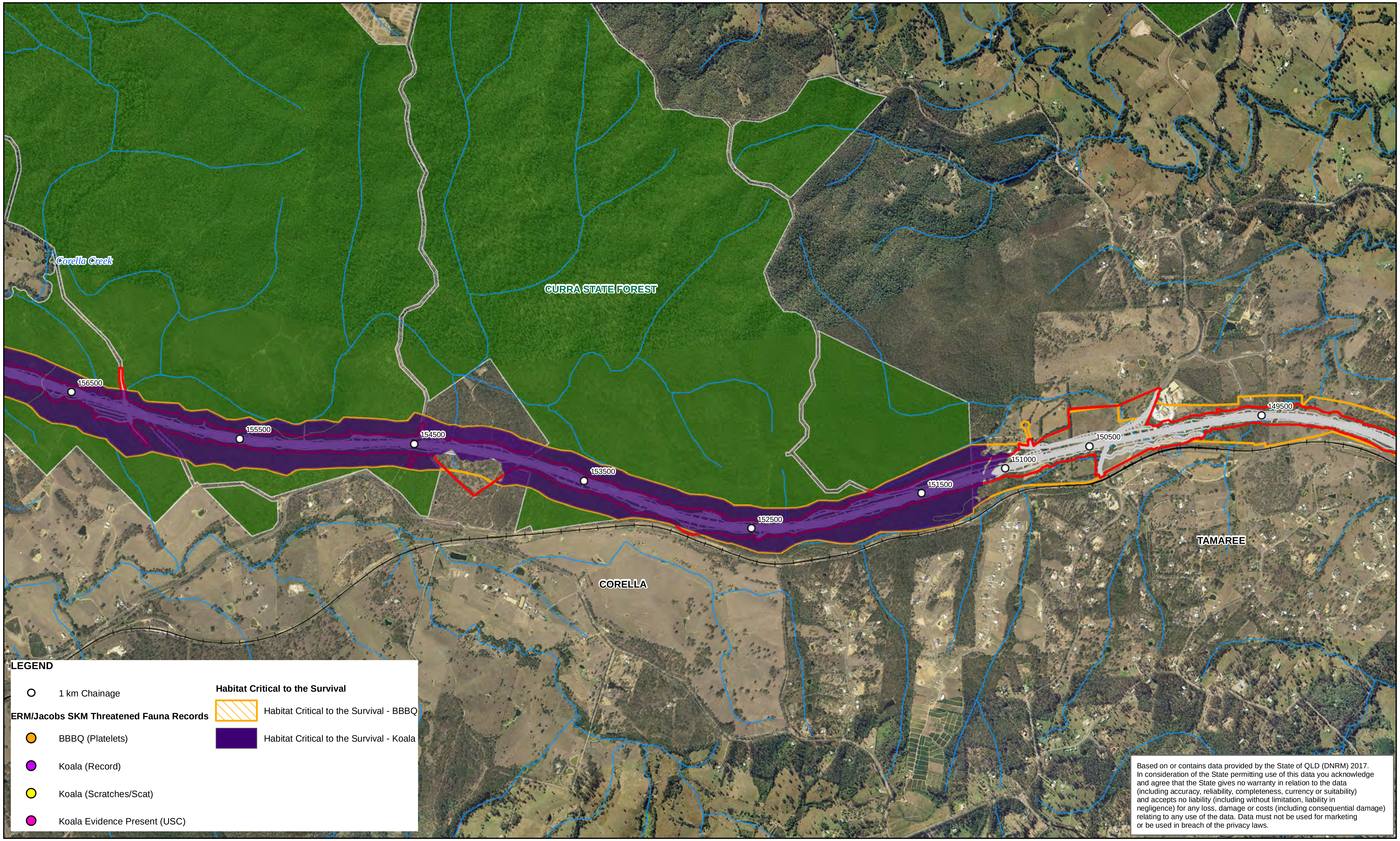
6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick



Paper Size A3

0 0.125 0.25 0.5 0.75 1

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- Town
- Railway
- Local Connector Road
- Street/Local Road
- Watercourses
- Protected Areas
- Survey Area
- Contract 2
- **Project Area**
- Contract 1

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
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Habitat Critical to the Survival of the Black-breasted Button-quail and Koala

Appendix N
Sheet 2 of 4

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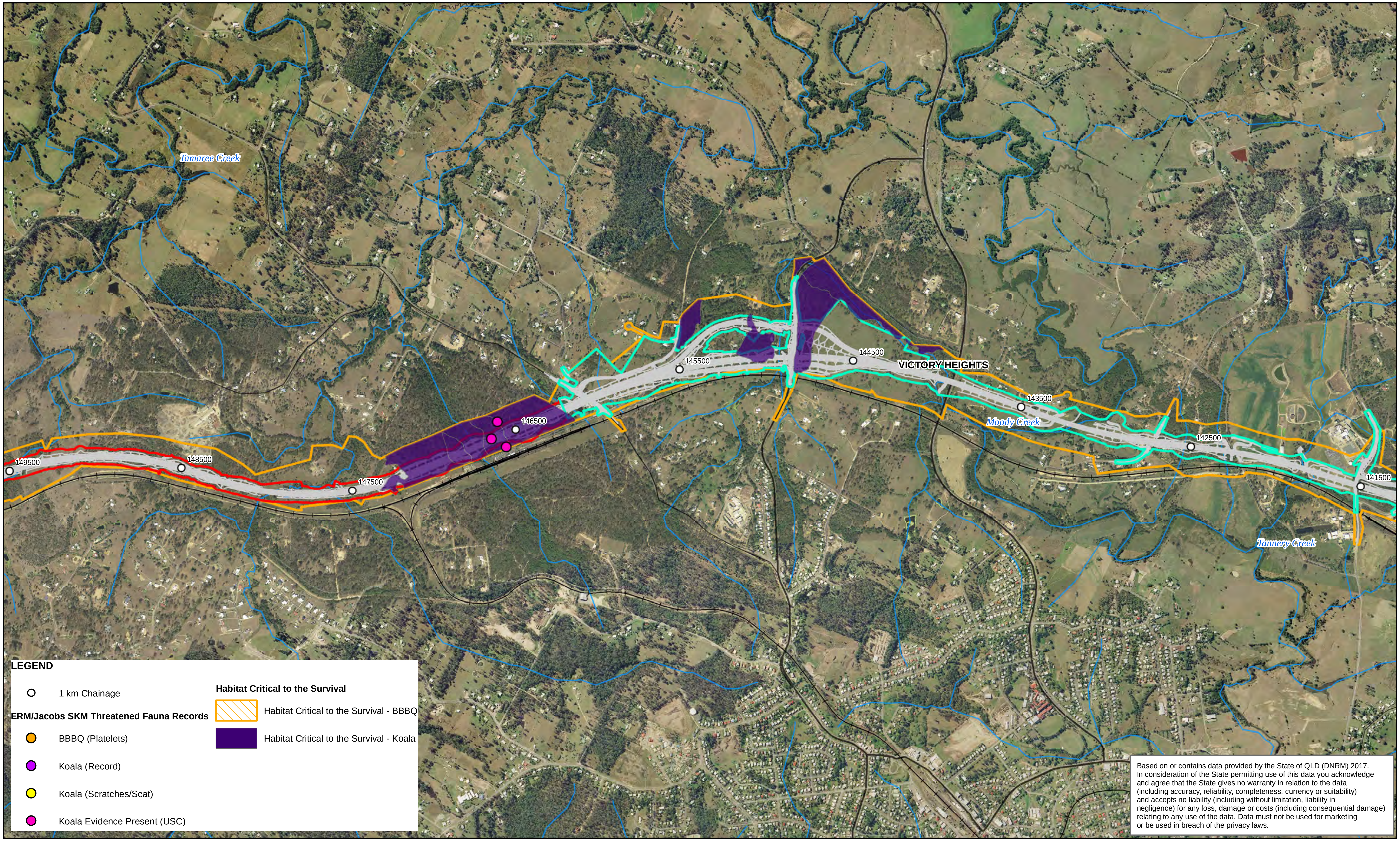
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick



Paper Size A3

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- Town
- Railway
- Secondary Road
- Local Connector Road
- Street/Local Road
- Watercourses
- Protected Areas
- Survey Area

Project Area

- Contract 1
- Contract 2

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
Revision	0
Date	04 Apr 2017

Habitat Critical to the Survival of the Black-breasted Button-quail and Koala

Appendix N
Sheet 3 of 4

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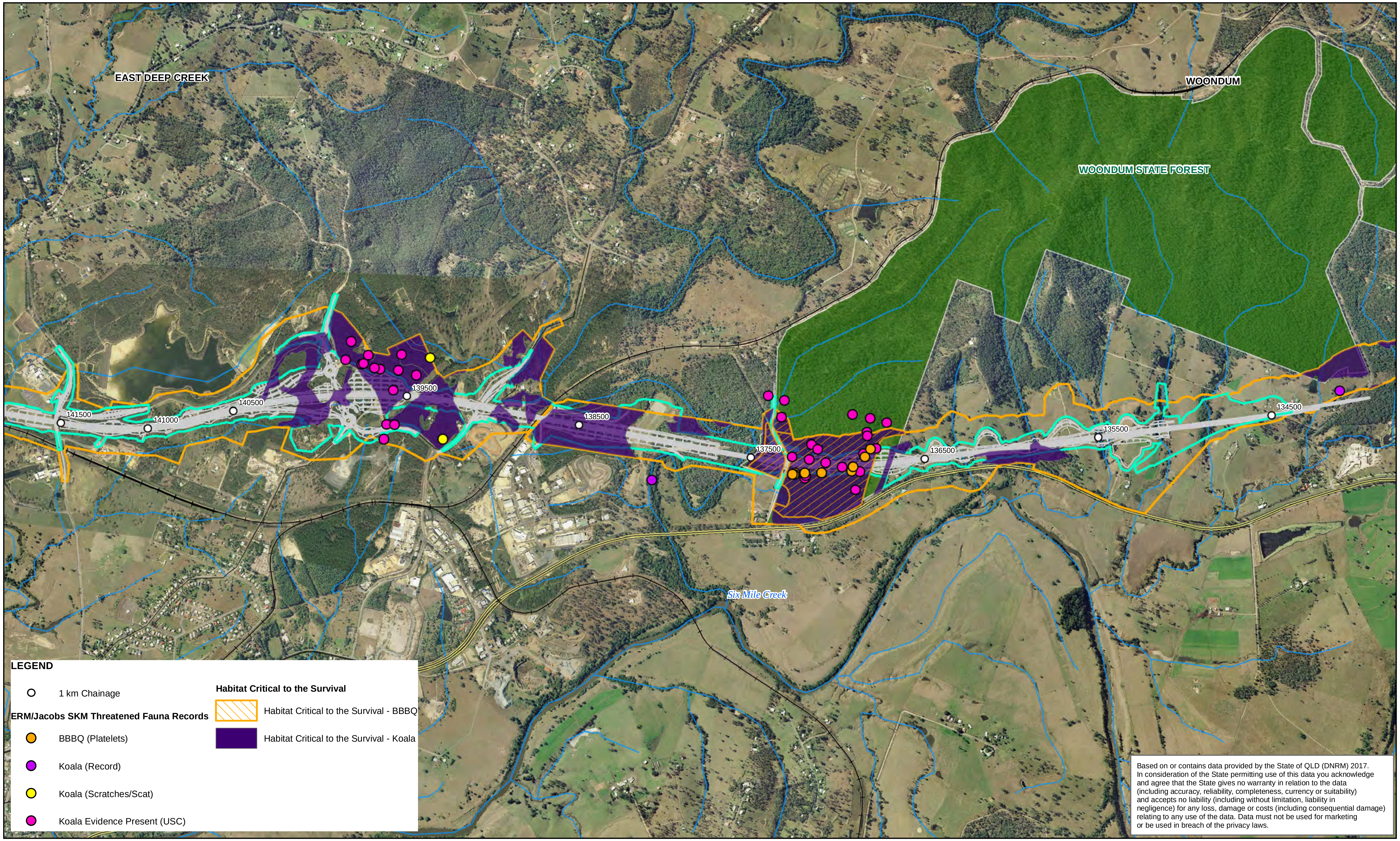
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

Town	Secondary Road	Watercourses	**Project Area**
Railway	Local Connector Road	Protected Areas	Contract 1
Highway	Street/Local Road	Survey Area	Contract 2

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
Revision	0
Date	04 Apr 2017

Habitat Critical to the Survival of the Black-breasted Button-quail and Koala

Appendix N
Sheet 4 of 4

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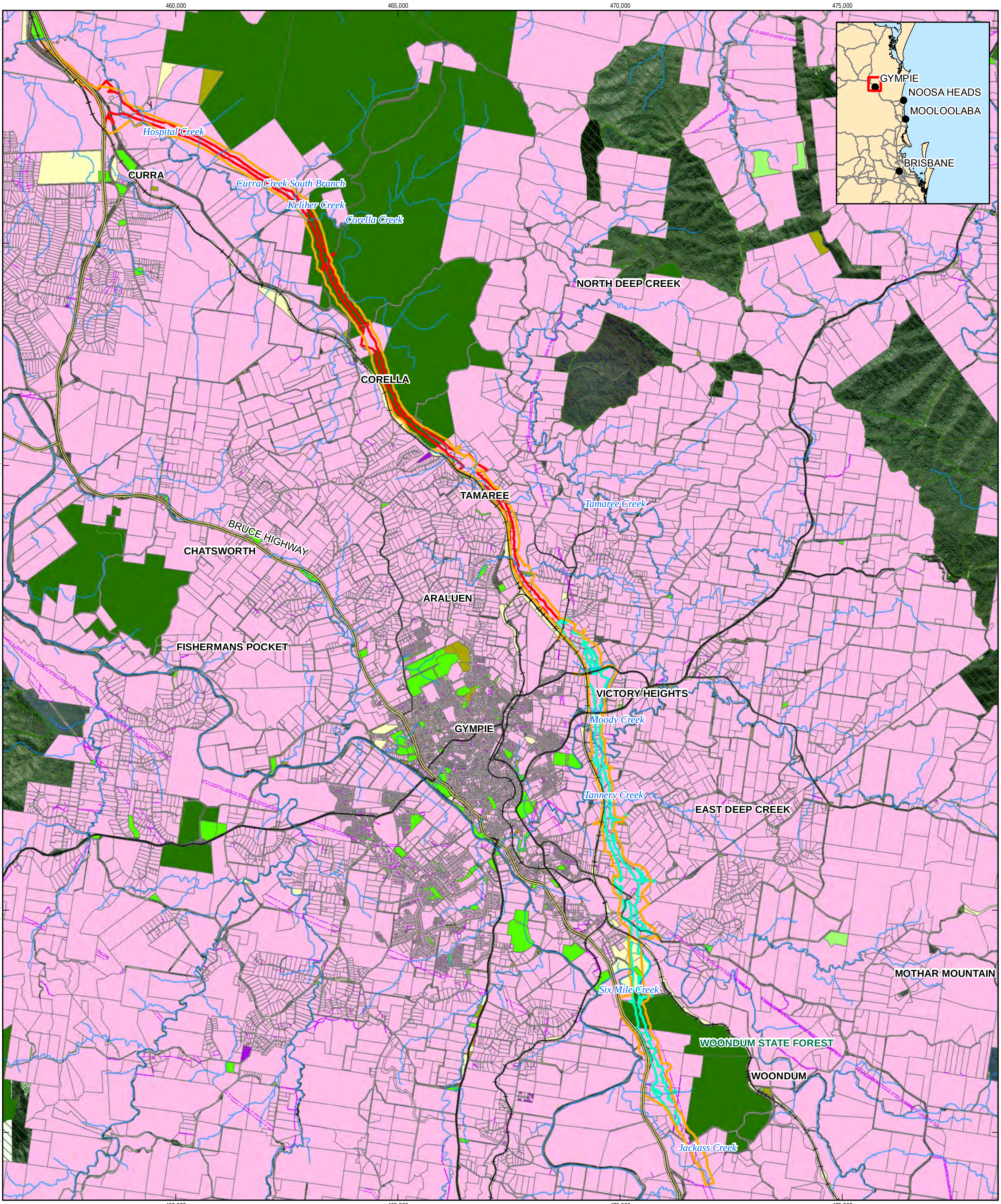
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick

Appendix O – Land Tenure



LEGEND

Town	Secondary Road	Contract 1	Covenant	Lands Lease	Railway
Watercourse	Local Connector Road	Contract 2	Easement	Main Road	Reserve
Railway	Street/Local Road	**Land Tenure**	Freehold	National Park	State Forest
Highway	Survey Area	Below the Depth Plans	Housing Land	Profit à Prendre	State Land

1:80,000 @ A3

0 0.5 1 2 3

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number	41-29914
Revision	0
Date	24 Mar 2017

Land Tenure

Appendix O

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: GA: Town (2014); TMR: Aerial Imagery (2016), Survey Area (2016); DNRM: Land Tenure (2015), Railway, Watercourse (2014), Road (2016). GHD: Project Area (March 2017). Created by: SC

Appendix P – Additional Works Code of Compliance

Department of Transport and Main Roads

Bruce Highway Cooroy to Curra
(Section D: Woondum to Curra)
Job No. 232/10A/7, Invitation No. WBYD-1335

Additional Works Code of Compliance

April 2017

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Appendices

1. Introduction

1.1 Background

The Department of Transport and Main Roads (TMR) are proposing to upgrade 26 km of the existing Bruce Highway, including a bypass to the east of Gympie, Queensland. This package of works is termed the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) project (herein referred to as 'the project').

This Additional Works Code of Compliance (herein referred to as the 'Code') is referred to as a mitigation measure within the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral documentation submitted to the Commonwealth Department of the Environment and Energy (DEE) to manage vegetation and therefore potential habitat for matters of National environmental significance (MNES) outside the nominated project area.

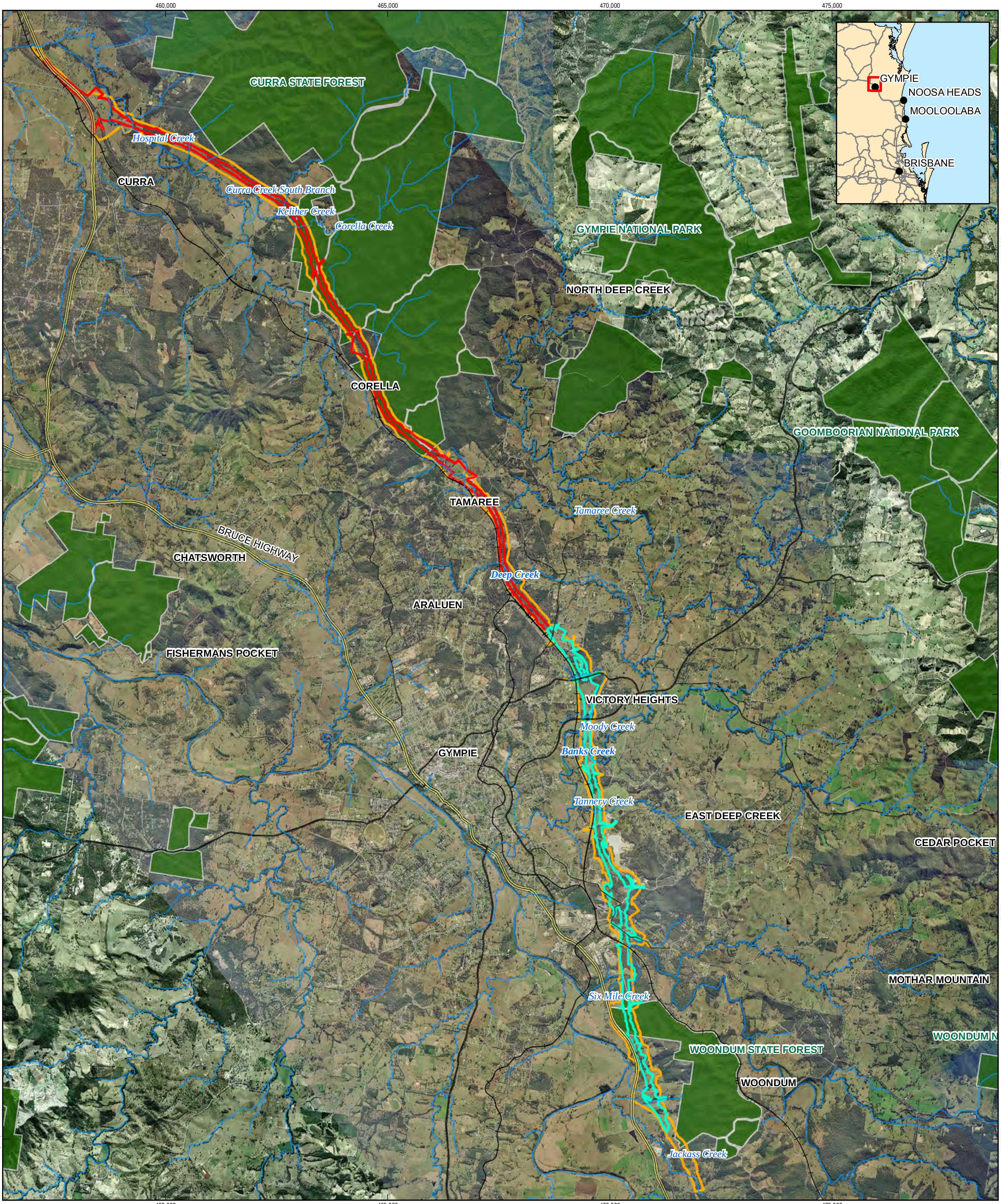
As part of the baseline and targeted ecological studies undertaken to support the EPBC Act referral, habitat mapping for each MNES anticipated to be impacted by the project has been developed across a 'survey area'. Habitat loss (in hectares) as a result of the project is nominated in the EPBC Act referral documentation. This habitat loss is based on a complete clearing extent within the 'project area' and the anticipated total loss of MNES habitats resulting from vegetation clearing will likely form a condition of the project EPBC Act approval, and also be included within the construction contract. For the purposes of general understanding of the terms 'project area' and 'survey area', these are described in the following sections and represented on Figure 1.

1.1.1 Project area

The 'project area' is approximately 430 ha and has been developed based on the following:

- The bottom of embankments (i.e. volume of earthern material that is placed and compacted for the purpose of raising the grade of the roadway above the level of the existing surrounding ground level) plus 25 metres to be cleared of vegetation to provide adequate room for haul routes, light vehicle access, drainage structures, stockpiles and temporary and permanent sediment basins.
- The top of cuttings (i.e. where soil or rock material from a hill or mountain is cut) plus 15 metres to be cleared of vegetation to provide adequate room for drainage structures and light vehicle access tracks.
- Where cuttings are required to be installed on a wider slope, or spoil areas required to dispose of material, additional areas within the footprint has been provided.
- Proposed site office locations as identified in the constructability review.
- Incorporation of areas of cleared agricultural land owned by TMR adjacent to the construction area for the purposes of site laydown, site offices etc.

The project area has formed the basis for all technical environmental studies undertaken to date and has been refined during the Detailed Design phase to avoid or minimise impacts to MNES where possible (refer to Figure 1). It is noted that the project area may not include all additional temporary or permanent vegetation clearing due to the uncertainty around the locations of these items at the detailed design phase.



LEGEND

Town	Secondary Road	**Project Area**
Watercourse	Local Connector Road	Contract 1
Railway	Street/Local Road	Contract 2
Highway	Survey Area	Protected Areas

Based on or contains data provided by the State of QLD (DNRM) 2016. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Department of Transport and Main Roads
Bruce Highway – Cooroy to Curra
(Section D: Woondum to Curra)

Job Number 41-29914
Revision 0
Date 12 Apr 2017

Locality Plan

Figure 1

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3033_MNES_Fig01_A3_Rev0.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: GA: Town (2014); TMR: Aerial Imagery (2016), Survey Area (2016); DNRM: Railway, Watercourse (2014), Road (2016). GHD: Project Area (March 2017). Created by: SC

1.1.2 Survey area

A 'survey area' was established during the Business Case phase of the project for the purposes of conducting terrestrial flora, terrestrial fauna and aquatic ecology surveys (refer to Figure 1). The survey area was selected to gain an appreciation of ecological values that are present within and immediately adjacent to the project area; for example, fauna species that may transition through the project area and vegetation communities that may be fragmented. The survey area was defined by the project area (developed during the Business Case phase as of January 2015) which includes the extent of the cut/fill batters, plus a buffer of approximately 50 – 100 m around the alignment, with some broader areas on surrounding properties, as well as upstream and downstream extents within waterways or within adjacent habitats. As a result, of the project area being refined further during the Detailed Design phase some areas of the project area are outside the survey area. However, these areas include only previously cleared agricultural or grazing land due to their useability for construction related infrastructure (i.e. site laydown, site offies etc.).

1.2 Previous works

As part of the previous sections of the broader Bruce Highway Cooroy to Curra upgrade, TMR have referred the various stages of the project under the EPBC Act and undertaken works in accordance with the conditions of approval. Approval conditions for the Bruce Highway Cooroy to Curra (Section C: Traveston to Woondum) set limits of clearing and confined the works area to the project area identified within the EPBC Act referral documentation. However, during the construction phase of this project, the Construction Contractor required additional areas of vegetation to be cleared outside of the project area nominated in the EPBC Act referral documentation. The additional vegetation clearing was required as part of the construction works and included necessary ancillary infrastructure such as, private property access realignments, public utility and plant, rural and fauna fencing, temporary access tracks and water storage facilities. As these works were located outside of the areas approved under the EPBC Act referral documentation, addendums to the original EPBC Act referral were required prior to works commencing on these activities. Consequentially, project timeframes were affected due to the submission of an addendum. The aim of this Code, as described below is to minimise the potential for current project timeframes to be impacted.

1.3 Aim of the code

This Code aims to ensure that vegetation clearing required outside the project area is undertaken in a manner that is compliant with the mitigation measures detailed in the EPBC Act referral documentation, and avoids the requirement to develop and submit addendums to DEE. In this regard, the Code will:

- Maintain the limits of vegetation clearing for certain habitat types (e.g. vegetation with MNES habitat value) to within the limits nominated within the conditions of approval gained for the project.
- Not result in additional significant impacts to MNES.
- Not conflict with existing approvals under State legislation for the clearing of vegetation outside of the approved project area.
- Provide clarification to the Construction Contractor of the required procedures including guidelines to assess and determine if vegetation clearing can proceed outside of the project area.

Vegetation within the survey area which supports habitat values for MNES impacted by the project are included on Figure 2. This mapping was completed as an outcome of previously completed ecological surveys and has been included in this Code for reference. This mapped MNES habitat includes the following species and vegetation communities:

- Black-breasted button-quail (*Turnix melanogaster*)
- Koala (*Phascolarctos cinereus*)
- Lowland Rainforest of Subtropical Australia Threatened Ecological Community (TEC)
- *Macrozamia pauli-guilielmi* (pineapple zamia)
- Grey-headed flying-fox (*Pteropus poliocephalus*)
- Greater glider (*Petauroides volans*).

1.4 Compliance with other documentation

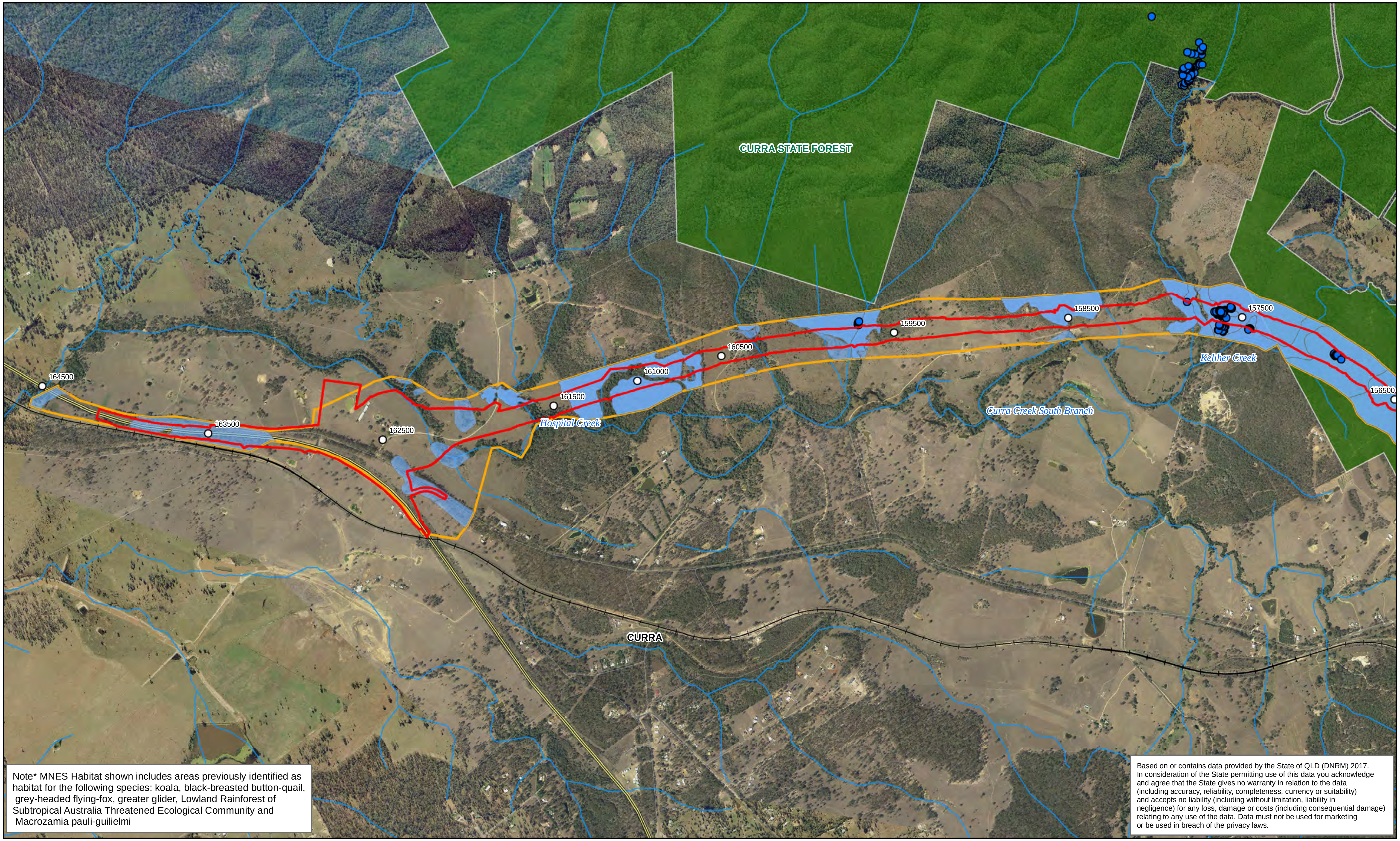
The Code aims to facilitate vegetation clearing to enable the development of temporary and permanent works in accordance with the EPBC Act referral documentation. For the purposes of this document, vegetation clearing pertains only to native vegetation species protected under the Queensland *Nature Conservation Act 1992* and the EPBC Act (including threatened and least concern native species); which is defined as removing, cutting down, ringbarking, pushing over, poisoning or destroying native vegetation in any way, including by burning, flooding or draining (as per the Queensland *Vegetation Management Act 1999*).

Although this Code has been developed for the purposes of avoiding or mitigating impacts to MNES, the following environmental approvals, permits and licenses are relevant to vegetation clearing and may require consideration prior to and/or during the clearing:

- Development permit for operational works for constructing or raising waterway barrier works under the *Fisheries Act 1994*
- Water licence to take or interfere with water under the *Water Act 2000*
- Requirements under the *Environmental Offsets Act 2014* and Queensland offsets framework, in particular for State significant biodiversity values
- A Clearing Permit and Impact Management Plan for clearing conservation significant flora species under the *Nature Conservation Act 1992*
- A 'high risk' Species Management Program (SMP – high risk) under the *Nature Conservation Act 1992*
- A 'low risk' SMP (SMP – low risk) under the *Nature Conservation Act 1992*
- General environmental duty to minimise environmental harm under the *Environmental Protection Act 1994*
- Responsibilities to manage contaminated land under the *Environmental Protection Act 1994*
- Cultural heritage management requirements under the *Aboriginal Cultural Heritage Act 2003.*

1.5 Scope and limitations

This report has been prepared by GHD for TMR and may only be used and relied on by TMR and the nominated Construction Contractor for the purpose agreed between GHD and TMR; and between TMR and their nominated Construction Contractor, as set out in this report. GHD otherwise disclaims responsibility to any person other than TMR arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. Targeted surveys within the survey area were undertaken between 2015 and 2017; TMR will confirm the currency of MNES mapping included in Figure 2 prior to construction commencing.



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- 1 km Chainage
- Town
- Macrozamia
- Railway
- Highway
- Street/Local Road
- Watercourses
- Protected Areas
- MNES Habitat
- Survey Area

Project Area

- Contract 1
- Contract 2

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Habitat values for MNES within the survey area

Job Number	41-29914
Revision	0
Date	21 Apr 2017

Figure 2
Sheet 1 of 4

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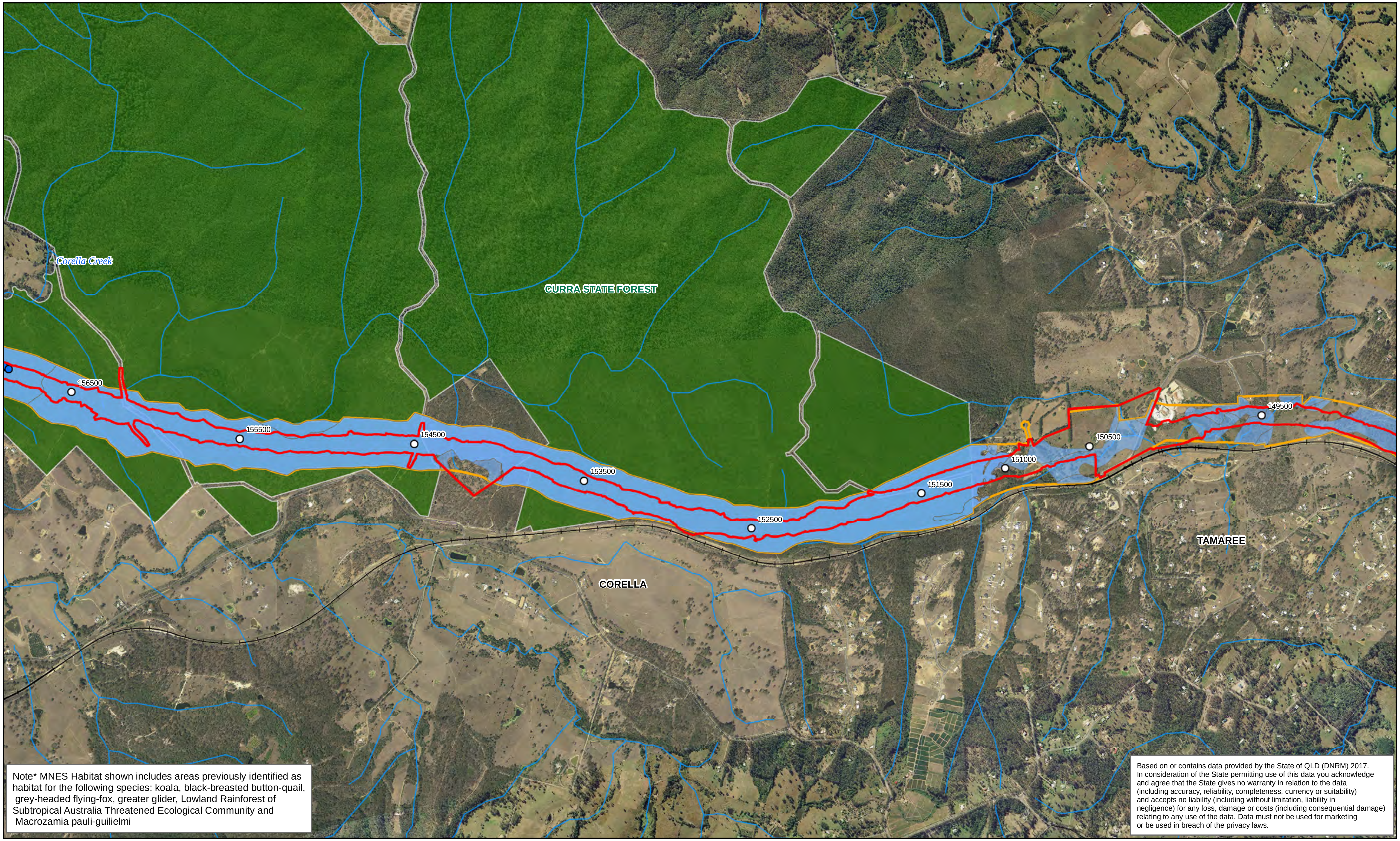
6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

LEGEND

- 1 km Chainage
- Town
- Macrozamia
- Railway
- Local Connector Road
- Street/Local Road
- Watercourses
- Protected Areas
- MNES Habitat
- Survey Area

Project Area

- Contract 1
- Contract 2

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Job Number	41-29914
Revision	0
Date	21 Apr 2017

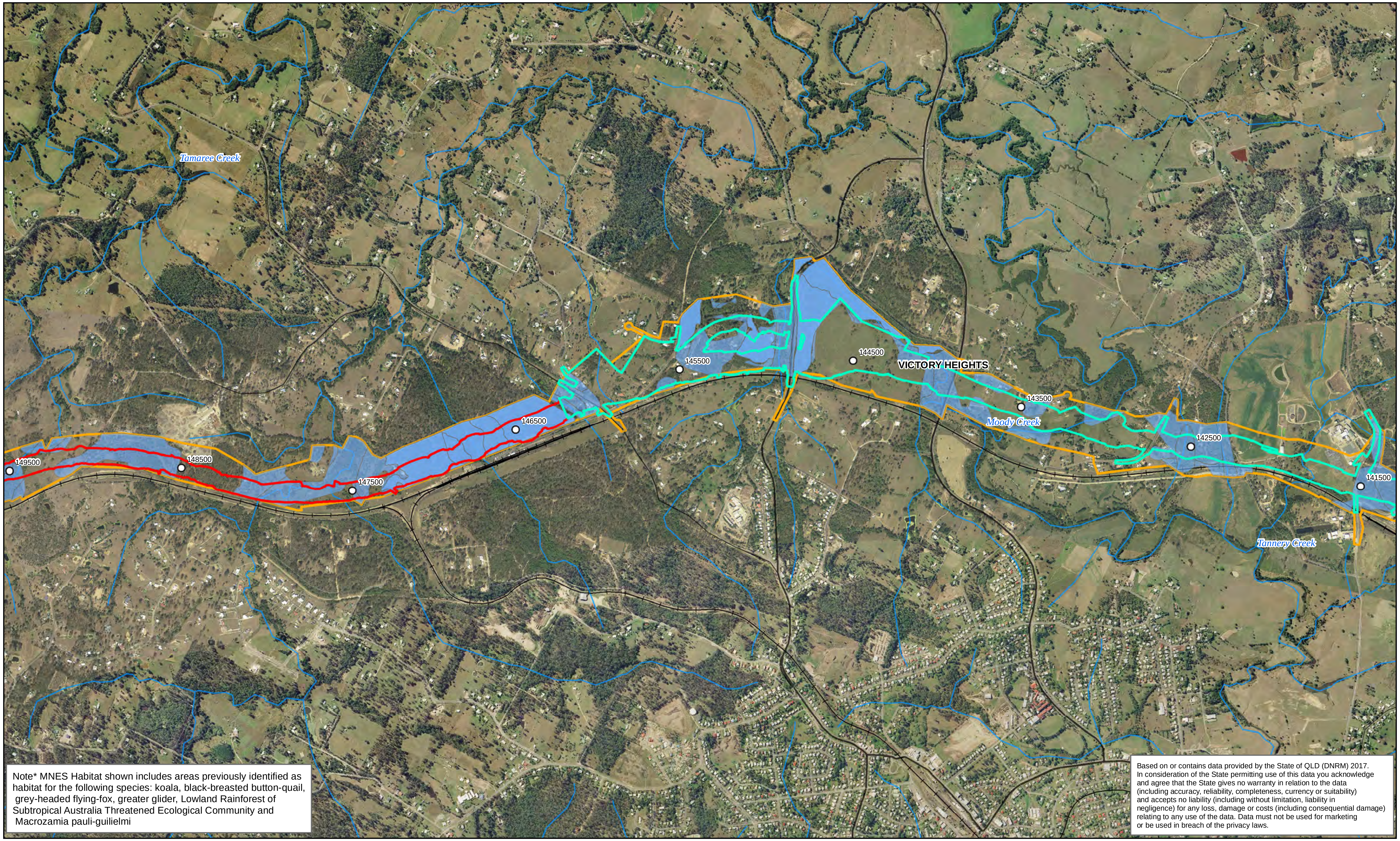
Habitat values for MNES within the survey area

Figure 2
Sheet 2 of 4

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3051_CodeofCompliance_Fig02_A3_RevA.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick



Note* MNES Habitat shown includes areas previously identified as habitat for the following species: koala, black-breasted button-quail, grey-headed flying-fox, greater glider, Lowland Rainforest of Subtropical Australia Threatened Ecological Community and Macrozamia pauli-guilielmi

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

1 km Chainage	Railway	Local Connector Road	Protected Areas	**Project Area**
Town	Secondary Road	Street/Local Road	MNES Habitat	Contract 1
Macrozamia		Watercourses	Survey Area	Contract 2

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Habitat values for MNES within the survey area

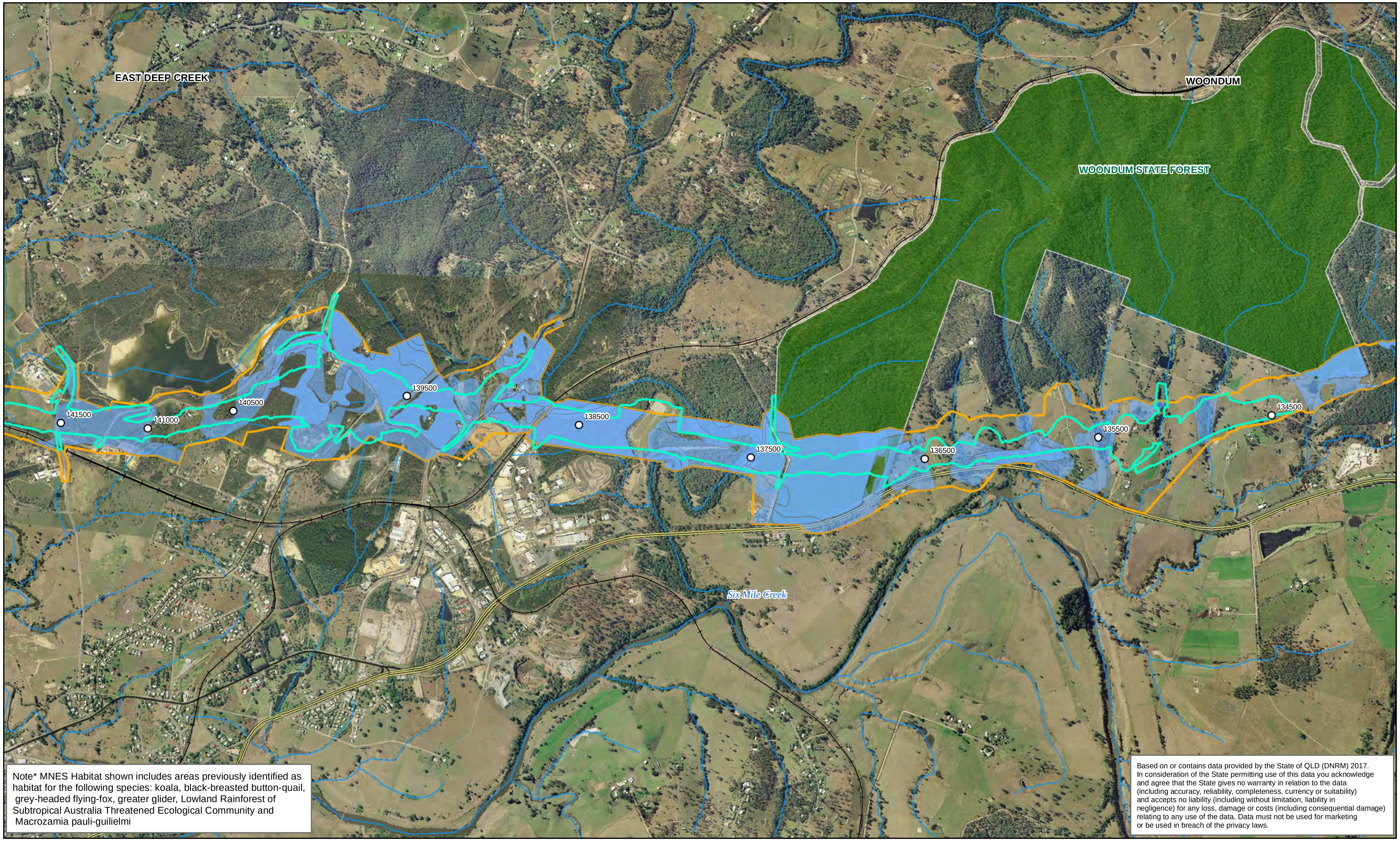
Job Number	41-29914
Revision	0
Date	21 Apr 2017

Figure 2
Sheet 3 of 4

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3051_CodeofCompliance_Fig02_A3_RevA.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia **T** 61 7 5413 8100 **F** 61 7 5413 8199 **E** bta01mail@ghd.com **W** www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick



Note* MNES Habitat shown includes areas previously identified as habitat for the following species: koala, black-breasted button-quail, grey-headed flying-fox, greater glider, Lowland Rainforest of Subtropical Australia Threatened Ecological Community and Macrozamia pauli-guilielmi

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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- 1 km Chainage
- Town
- Macrozamia
- Railway
- Highway
- Secondary Road
- Local Connector Road
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- Watercourses
- Protected Areas
- MNES Habitat
- Survey Area

Project Area

- Contract 1
- Contract 2

GHD

Department of Transport and Main Roads
Bruce Highway Cooroy to Curra
(Section D: Woodnum to Curra)

Habitat values for MNES within the survey area

Job Number	41-29914
Revision	0
Date	21 Apr 2017

Figure 2
Sheet 4 of 4

G:\41\29914\GIS\Maps\MXD\Environmental\41_29914_3051_CodeofCompliance_Fig02_A3_RevA.mxd

6 Innovation Parkway Birtinya QLD 4575 Australia T 61 7 5413 8100 F 61 7 5413 8199 E bta01mail@ghd.com W www.ghd.com

Data source: DNRM: Rail (2014), Roads (2016), Towns (2015); TMR: Imagery, Project Area, Survey Area, Chainage (2016), ERM/Jacobs SKM Threatened Fauna Records, High Value habitat (2016). GHD: Fauna Connectivity Structures (2016). USC: Koala Evidence Present (2016), Project Area (March 2017) Road Design (November 2016). Created by:schadwick

2. Clearing requirements

2.1 General vegetation clearing

Vegetation clearing within the project area is anticipated to be undertaken in the following stages:

- Clearing for pioneering works including but not limited to: erection of fencing such as boundary fencing, general construction access, additional geotechnical investigations and establishment of erosion and sediment controls (including sediment basins).
- Bulk vegetation clearing in accordance with staging requirements and zones as specified in the contract documentation. Bulk vegetation clearing will occur within the project area only.

Clearing within the project area will be managed in accordance with the contract documentation prepared for the project.

The majority of construction activities have been allowed for within the project area however, it is anticipated that some unavoidable vegetation clearing may be required for the following activities outside the project area, to assist in the delivery of the project:

- Relocation or augmentation to public utility and plant
- Temporary access tracks to water sources, spoil locations and other construction-related storage areas
- Property access realignments
- Boundary and fauna exclusion fencing
- Additional drainage and earthworks
- Unforeseen other construction related activities.

When considering vegetation clearing, the Construction Contractor must apply a hierarchy of mitigation measures such that avoidance is considered in the first instance. Where avoidance of vegetation clearing is not achievable, the Construction Contractor will be required to comply with this Code, to minimise the vegetation clearing.

2.1.1 Clearing outside the project area

All clearing outside of the project area, must be undertaken in accordance with the following steps:

- **Step 1** – If area to be cleared is located within the survey area, confirm whether this area has been previously mapped as supporting MNES habitat (refer to mapping included in Figure 2). Undertake ecological assessment of vegetation to be cleared to confirm if habitat values for previously identified or newly listed MNES are present. The ecological assessment is to be undertaken by a suitably qualified and experienced person/s and be in accordance with all relevant guidelines and procedures.
- **Step 2** – Where no habitat values for MNES are present, undertake works in accordance with mitigation measures outlined in Table 1 of this Code and any Commonwealth or State approval and permits gained for the project. Approval from the Contract Administrator is required prior to vegetation clearing outside the project area.
- **Step 3** – In instances where the ecological investigations identifies that the vegetation provides habitat for MNES, upon which the project is having a significant impact, the

clearing must not commence until the Contract Administrator has accepted the clearing. The Contract Administrator will determine whether the clearing is in accordance with approved disturbance limits set for the species in the EPBC Act approval documentation.

- **Step 4** – In instances where ecological investigations identify that the vegetation provides habitat for MNES, upon which the project is not having a significant impact, a self-assessment will be undertaken to confirm if the clearing will result in a significant impact. The results of the significant impact assessment are to be provided to the Contract Administrator. The Contract Administrator will not approve works that are deemed to have a significant impact on MNES.
- **Step 5** – Where it is necessary to undertake clearing activities within vegetation containing habitat values for MNES and the Contract Administrator has approved the clearing, the vegetation clearing must be undertaken in accordance with Table 1 of this Code.

Table 1 Mitigation measures required during vegetation clearing outside of project area

Phase	Management actions
Planning phase of works	Preference must be given to locating all works in previously cleared areas and outside of areas with mapped MNES habitat values (refer to Figure 2).
	Under this Code, the clearing of vegetation shall: • Be limited to the extent necessary for the works • Not exceed the limits of clearing specified in the EPBC Act referral documentation for each applicable MNES, upon which the project is anticipated to have a significant impact • Be re-vegetated in accordance with TMR's Main Roads Technical Specification (MRTS) 16 – Landscape and Revegetation Works and associated annexure • Not occur in a wetland • Not occur within 10 metres of the defining bank of a watercourse, unless access across the watercourse is required
	Under this Code, clearing for access tracks shall: • Be no wider than the width required for the type of vehicle for which the access track is required • Constructed in a manner in which watercourse bank erosion is minimised • Be at right angles to the water flow • Comply with all State legislation for waterway crossings/barriers
	Clearing undertaken using this Code shall not result in significant impacts to species previously assessed under the EPBC Act referral documentation as not having a significant impact.
	The Construction Contractor is to provide a plan of proposed works to the Contract Administrator for approval prior to the commencement of any vegetation clearing works.
	A flora survey is to be undertaken by the Construction Contractor for conservation significant flora species by a suitably qualified person in accordance with the *Flora Survey Guidelines – Protected Plants, 2016* (EHP, 2016) or current version.

Phase	Management actions
	No clearing of conservation significant flora species (i.e. listed under the State's NC Act) is permitted where found. Additional clearing permits are required to be obtained by the Construction Contractor where conservation significant flora species are required to be cleared outside the project area. Where a conservation significant flora species is recorded during the pre-clearance surveys the Construction Contractor is to notify the Contract Administrator.
	No clearing of *Macrozamia pauli-guilielmi* is permitted under this Code. No vegetation clearing within 100 m of *Macrozamia pauli-guilielmi* or within the offset site (i.e. receiving site) is permitted under this Code.
	No clearing of riparian vegetation at Six Mile Creek, Deep Creek and Curra Creek is permitted under this Code.
	No-go zones are to be clearly set out and marked prior to construction activities commencing, in accordance with Annexure MRTS51.1 – Environmental Management. Nomination of no-go zones is required in consultation with the terrestrial fauna specialist and are to be shown on relevant design plans produced by the Construction Contractor. The nomination of no-go zones are to be submitted to and deemed suitable by the Contract Administrator. No works are to be undertaken in these areas, nor are these areas to be used as storage of materials/plant.
	Annexure MRTS51.1 – Environmental Management requires the Construction Contractor to develop a clear staged approach to vegetation clearing prior to the commencement of works. The staging of works will need to be deemed suitable by the Contract Administrator prior to commencement.
	Erosion and sediment control plans are to be prepared for the clearing area and submitted and deemed suitable by the Contract Administrator prior commencement of vegetation clearing works.
	The Construction Contractor is required to identify all Commonwealth and State legislative approval requirements and identify additional approvals required to facilitate the vegetation clearing including, but not limited to: • Species Management Program – high risk • Species Management Program – low risk • Clearing Permit under the NC Act • Waterway Barrier Works Approvals • Licence to interfere with the flow of a watercourse

Phase	Management actions
Pre-clearing phase	The Construction Contractor is required to undertake a pre-clearing weed survey documenting areas of existing weed infestation and identifying treatment and management requirements in accordance with Annexure MRTS51.1 – Environmental Management.
	A terrestrial fauna specialist approved by the Department of Environment and Heritage Protection (EHP) shall be appointed by the Construction Contractor prior to construction commencing. A licensed fauna spotter catcher is required to be present during any woody vegetation clearing issued under the *Nature Conservation (Administration) Regulation 2006* and shall be responsible for the management of the handling, capture and release of native fauna in accordance with either the SMP – low risk or the SMP – high risk, dependant on the species listing under the *Nature Conservation (Administration) Regulation 2006*.
	Prior to vegetation clearing, the terrestrial fauna specialist will undertake a pre-clearing survey to identify and mark habitat features (i.e. hollow bearing logs, hollow bearing trees). The terrestrial fauna specialist will also be required to identify the fauna species likely or known to be present. Results of the pre-clearance survey are to be reported by the Construction Contractor in the monthly report to the Contract Administrator, prior to clearing commencing in an area.
	Hollow timber, woody debris and bush rock suitable for fauna habitat are to be relocated to retained habitat areas outside/adjacent to the clearing area.
	The terrestrial fauna specialist is required to undertake an immediate pre-clearance survey a maximum of 24 hours ahead of vegetation clearing, to search habitat features previously marked for fauna and/or breeding activity. The terrestrial fauna specialist shall undertake a daytime canopy search of the clearing area to identify any vegetation with koalas and adjacent vegetation with overlapping crowns. Should a koala be present, suspension of clearing works will occur for the koala to move away from the project area on its own accord, which may include delay overnight. A two stage approach to clearing will be implemented where hollow bearing trees have been identified. Non-hollow bearing trees will be cleared before hollow bearing trees to allow fauna an opportunity to move away and allow time to concentrate rescue efforts on the trees that are most likely to be inhabited. Hollow bearing trees will be felled after a minimum 24 hr delay after clearing of non-habitat trees. The terrestrial fauna specialist will be on site for all clearing works, including clearing of hollow bearing trees. Individual hollows of felled hollow bearing trees will be inspected using a torch or similar by the terrestrial fauna specialist and the relevant fauna contingency actions initiated. Once the trees are deemed clear by the terrestrial fauna specialist further processing can occur.

Phase	Management actions
	Sequential vegetation clearing is to be applied onsite. Vegetation clearing is to occur from disturbed areas and clear towards areas of vegetation to be retained.
	All dewatering activities are to be supervised by the Construction Contractor’s aquatic fauna specialist and in accordance with the approved Dewatering Plan in the SMP – high risk.
	An aquatic fauna specialist is required to undertake pre-clearance surveys 14 days prior to any dewatering activities required (including dams, ponds etc.) to identify whether any potential platypus burrows or turtle nesting sites are present within the area to be impacted. EHP is required to be notified of the location of any potential platypus burrows or turtle nesting sites. Where a burrow or nest is identified, the aquatic fauna specialist is required to seek advice from EHP on the required actions to undertake prior to the disturbance of any burrows or nests. The aquatic fauna specialist will be required to prepare a report following the dewatering activities. This report is to be provided to the Contract Administrator within the Construction Contractors monthly report.
Vegetation clearing phase	The Construction Contractor is to complete an environmental induction for all site personnel to outline responsibilities in relation to MNES, the use of no-go zones and staged clearing requirements, as defined in MRTS51 – Environmental Management. This induction is to also outline the procedures to follow in the event of injured wildlife occurring within the survey area (refer to the SMP – high risk).
	Hygiene declaration forms are to be prepared by the Construction Contractor for all plant/vehicles working within the area.
	The Construction Contractor is to maintain the flow of waterways (mapped on the Queensland waterways for waterway barrier works GIS layer) in accordance with relevant waterway barrier works codes or approvals gained for the works.
	The use of herbicides and growth retardants to control vegetation, as well as fire retardants and insecticides are to be restricted over and adjacent to dams, drainage lines and waterways due to the potential indirect impacts on MNES and other threatened fauna.
	If there is more than one vegetation clearing machine operating during vegetation clearing, a terrestrial fauna specialist is required to accompany each vegetation clearing machine.
	Grubbing and removal of ground cover and understorey is to be delayed until immediately prior to earthworks occurring.

Phase	Management actions
	Cleared native vegetation is to be mulched and reused onsite during rehabilitation and stabilisation activities where possible. Should the mulch be required to be stockpiled, the material shall be stockpiled in a manner where endemic seeds remain viable and weeds are treated to minimise the spread of weeds.
Post clearing	Permanent revegetation onsite shall occur progressively as soon as practicable once earthworks are complete, in accordance with MRTS16 – General Requirements Landscape and Revegetation Works and associated annexures.
	Rehabilitation/revegetation of temporarily disturbed areas is to be undertaken as quickly as possible.
	The terrestrial fauna specialist is to prepare and submit a post-clearing report. The Construction Contractor is required to provide the post-clearing report to the Construction Administrator within the monthly report following completion of clearing each stage.
	The Construction Contractor is to complete reporting requirements as per Section 3 of this Code.

3. Reporting requirements

3.1 Construction Contractor reporting

The reporting requirements for clearing vegetation outside of the project area are required on a monthly basis to the Contract Administrator in accordance with the contract documentation (Clause 7 of MRTS51 – Environmental Management). A checklist has been developed and shall be utilised by the Construction Contractor when undertaking an assessment of vegetation clearing outside the project area (refer to Appendix A).

3.2 Specialist reporting

In addition to the Construction Contractor's reporting requirements, the terrestrial fauna specialist (fauna spotter catcher) and an aquatic fauna specialist are required to provide the following information for each area of vegetation cleared:

- Results of the pre-clearance survey are to be included in the Construction Contractor's monthly report to the Contract Administrator, prior to clearing commencing in an area.
- A post-clearing report to the Construction Administrator within the Construction Contractor's monthly report, following completion of clearing each stage.
- The aquatic fauna specialist will be required to prepare a report following dewatering activities. This report is to be provided to the Contract Administrator within the Construction Contractor's monthly report.

3.3 TMR reporting

For clearing works within the project area, TMR will be responsible for reporting to DEE the amount of vegetation cleared with habitat for MNES.

For clearing works outside the project area, TMR will be responsible for reporting to DEE all additional ecological investigations undertaken, the outcomes of the ecological investigations and amount of vegetation cleared with habitat for MNES. TMR will include any instances of observed MNES. Reports are to be submitted to DEE annually.

Appendix A - Additional Works Code of Compliance Checklist

Additional Works Code of Compliance - Checklist

Date:

Site location: (attach plan of proposed works)	
Purpose, justification of proposed works: (including consideration of possible avoidance alternatives)	
Private property owner/ TMR consent:	
Area of vegetation to be cleared:	

Planning Phase

Aspect		Description	Proposed control measures
Desktop assessment	Regional ecosystem		
	Previous recorded MNES/ State listed species		
	Waterway present (stream order) (risk to fisheries interests i.e. green/amber/red/purple)		
Field assessment	Regional ecosystem verification		
	Suitable habitat for MNES/ State listed species		
	Habitat features present (i.e. Hollow bearing trees / vine thickets / roosting habitat)		

Aspect		Description	Proposed control measures
	Presence of weeds	Yes/ No – please outline species	
	Are *Macrozamia pauli-guilielmi* present?	Yes/ No – please outline	
	Is a significant impact assessment required?	Yes/ No – please outline	
Terrestrial fauna specialist	Is a pre-clearing inspection required	Yes/ No – please outline	
Aquatic fauna specialist	Is dewatering required?	Yes/ No – please outline	
Erosion and sediment control	Is erosion and sediment control	Yes/ No – please outline Attach erosion and sediment control plan	
No-go zones	Are no-go zones required?	Yes/ No – please outline	

Aspect		Description	Proposed control measures
Access track		Yes/ No – please outline	
State approvals to be adhered to	List approvals	Yes/ No – please outline	
Mitigation measures employed	Documented evidence that the works comply with the relevant mitigation measures within the Code		
Revegetation works required (include activity timeframes)		Yes/ No – please outline	

Sign off by Contract Administrator

Date of contract notice:	
Contract notice number:	
Comments:	

Pre-clearing and Clearing Phases

Action	**Required (Yes/ No/ N/A)**	**Completed**		**Comments**
		Date	**Signature**	
Weed control measures employed:				
No-go zones established:				
Erosion and sediment control measures utilised:				

Inspection by terrestrial fauna specialist				
Dewatering by aquatic fauna specialist:				
Vegetation clearing completed including cleared dimensions of all disturbance footprints:				
Should the disturbance trigger rehabilitation works, the Construction Contractor must provide photo evidence of topsoiling and planting, including an indicative monitoring timeframe, within 30 days of the rehabilitation activity commencing.				

Specialist Reporting

Report	Required (Yes/ No/ N/A)	Date submitted to Contract Administrator
Pre-clearance survey		
Post-clearing report (including photos, as cleared dimensions of all disturbance footprints under the Code)		
Report by aquatic fauna specialist		

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