APPENDIX D UPDATED BDAR

Hills of Gold Wind Farm

Biodiversity Development Assessment Report

FINAL REPORT Version 9

Prepared for Hills of Gold Wind Farm Pty Limited

23 March 2022

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- NSW Department of Primary Industries for access to indicative mapping of freshwater threatened species and fish populations.

Biosis staff involved in this project were:

- Mark Venosta, Ian Smales and Felicity Williams (technical bird and bat inputs)
- Lauren Harely (GIS and mapping)

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Forward, certification and declarations

Biosis commenced control of this document and assessment in September 2021. Prior to Biosis taking custodianship, earlier drafts of this updated Biodiversity Development Assessment Report (updated BDAR) were prepared by Arup.

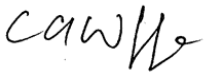
Prior to submission of the original Biodiversity Development Assessment Report (original BDAR) with the Project Environmental Impact Statement (EIS), Arup acted as lead biodiversity consultant and Accredited BAM Assessor (Matt Davis BAAS18090) for the project. Biosis undertook the fauna component of the field surveys, provided field support for flora surveys and vegetation mapping of the transmission line corridor, haul route and other ancillary investigation areas, and provided input into the fauna components of the BDAR only at this point.

Following Matt Davis' departure from Arup, Biosis assumed the role of finalising this updated BDAR. As such the role of Accredited BAM Assessor has been split between Matt Davis (BAAS18090) for development of the original BDAR, and Callan Wharfe (BAAS18138) and Mitch Palmer (BAAS17051) for updates undertaken in developing this updated BDAR, including aligning the BDAR with BAM 2020 requirements as part of the Response to Submission and Amendment Report process.

We certify that this report has been prepared on the basis of the requirements of, and information provided under, the Biodiversity Assessment Method (DPIE 2020) and s6.15 of the *Biodiversity Conservation Act 2016*.

In preparing this assessment we have acted in accordance with the Accredited BAM Assessor Code of Conduct.

We declare that we have considered the circumstances and there is no actual, perceived or potential conflict of interest.

Signature: Callan Wharfe 

Date: 23 March 2022

BAM Assessor Accreditation Number: BAAS181338

Signature: Mitch Palmer

Date: 23 March 2022

BAM Assessor Accreditation Number: BAAS17051

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Glossary

AGL	Above ground level
Amendment Report	The Amendment Report prepared for the Project following exhibition of the EIS.
Assessment Area	Is the Assessment area for the proposal and includes the development footprint plus a 1500m landscape assessment buffer
BAM	Biodiversity Assessment Method 2020
BBAMP	Bird and Bat Adaptive Management Plan
BC Act	*Biodiversity Conservation Act 2016*
BCD	Biodiversity Conservation Division
BDAR	Biodiversity Development Assessment Report
BoM	Bureau of Meteorology
BOS	Biodiversity Offsets Scheme
BVM	Biodiversity Values Map
Development Corridor	The development corridor is the broader investigation area used to inform the design layout and impact mitigation. The development corridor has the same meaning as 'subject land' as defined by the BAM, and has undergone ground-validated assessment as described in this BDAR. Figure 2 provides an overview of this area.
Development footprint	Is the area in which physical disturbance has been assessed within the Subject land to determine direct and indirect impacts as a result of the proposed Project. It includes permanent and temporary development footprint.
DNG	Derived Native Grassland
DPIE	Department of Planning, Industry and Environment
EES	Environment, Energy and Science Group in the Department of Planning, Industry and Environment
EIS	The Environmental Impact Statement prepared and exhibited for the Project dated 18 October 2020.
EMS	Environmental Management Strategy
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
GDEs	Groundwater Dependent Ecosystems
IBRA	Interim Biogeographic Regionalisation for Australia
Landscape assessment buffer	The development footprint plus a 1500m buffer.

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LGAs	Local Government Areas
OEH	Office of Environment and Heritage
Permanent development footprint	This is the area of land that will be subject to permanent alteration as a result of installation and operation of Project infrastructure
PCT	Plant Community Type
RTS	The Response to Submissions Report prepared for the Project.
SEAR's	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
Subject land	The area to which the BAM has been applied, assessed and studied
TEC	Threatened Ecological Community
Temporary Development Footprint	This is the area of land that will be temporarily disturbed during construction of the project, and rehabilitated following construction in order to minimise permanent impacts to biodiversity. Mitigation measures in these areas are to include revegetation, spreading mulched or cleared vegetation and installing native grass seed using locally occurring species.
WTG	Wind turbine generator

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Executive summary

Project description

Hills of Gold Wind Farm (HOGWF or the Proponent, previously Wind Energy Partners), a 100% owned subsidiary of ENGIE Australia, proposes to develop a wind farm on the ridgeline between Hanging Rock and Crawney Pass, approximately 60 km southeast of Tamworth (the project).

The project is State Significant Development and will be assessed under Part 4 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act). A referral under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) was submitted to the Commonwealth Department of Agriculture, Water, and the Environment (DAWE). The Commonwealth Minister for the Environment declared the project to be a controlled project which requires assessment under the provisions of the EPBC Act. This means it is being bilaterally assessed under State and Commonwealth legislation in accordance with the *NSW Bilateral Agreement relating to environmental assessment 2015*.

The Project would have a capacity to generate approximately 390 megawatts (MW) of electricity that would be supplied to the National Grid.

The project will consist of the following:

- Up to 65 wind turbine generators (WTGs), each with:
  - A generating capacity of approximately 6 MW.
  - Three blades mounted to a rotor hub. In turn the hub will be mounted on a tubular steel tower. This will provide a total height from the tip of the blade to the ground of 230 metres.
  - A gearbox and generator assembly housed in a nacelle.
  - Adjacent hardstand areas for use as crane pads and laydown areas. These will be initially used to help build the WTGs. They will remain in place to allow for ongoing maintenance.
- Decommissioning of three operational meteorological monitoring masts and the installation of up to five temporary and five permanent masts to monitor the power of the wind. Up to five of the 10 masts will be permanently installed near one of the WTGs, within the subject land. The other five will be temporarily installed at the location of one of the WTGs and removed after initial testing. All 10 masts will be approximately 150 metres tall; equivalent to the hub height of the final selected WTG model. The exact number and location of the up to 10 masts will be confirmed during detailed design.
- A 330 kilovolt (kV) electrical substation located centrally within the project site. The substation will include transformers, insulators, switchyard, and other ancillary equipment.
- An operations and maintenance facility.
- A battery energy storage system capable of storing up to 400 mega-watthours (MWh).
- Aboveground and underground 33kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation. The cables will follow site access tracks where practicable.
- A 330kV high-voltage overhead transmission line to connect the onsite substation to the existing 330kV TransGrid Liddell to Tamworth overhead transmission line network. The connection point will be approximately 21 km west of the substation.
- A switching station will also be built at the connection point.

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- A network of internal private service and access road network that would total a distance of 40 km. The road network will connect the WTGs and other project infrastructure to the public road network.
- Various local road upgrades and waterway crossings as needed to deliver, install and maintain the project.

The final project layout, project infrastructure configuration, and development footprint presented in the Response to Submissions (RTS) and Amendment Report for the Project were developed in consultation with project ecologists and the Proponent, and have been further refined in response to the issues raised in submissions, with a strong focus on further minimising the project's overall biodiversity impact. In summary, the refinements and amendments made to the Project in consultation with ecologists since the original BDAR was prepared include:

- Reducing the number of WTGs from 97 (initial pre-EIS design), to 70 for EIS submission, and further to 65 (current design) to reduce biodiversity impacts following further detailed investigations.
- Optimising wind farm, transmission line and access road layouts to further avoid ecologically sensitive areas based on additional surveys and improved mapping.
- Defining construction and engineering methods to reduce the construction program and amount of earthworks.
- Mapping and prioritising the use of existing access tracks to reduce the amount of vegetation clearance.
- Opting to use the transmission line corridor with the lowest ecological value of the seven options investigated in 2018.
- Undertaking a focussed study on potential ecological impacts along the transmission line corridor associated with the spanning of deep valleys by overhead power cables as part of the ongoing detailed design of the transmission line.

More detail on the amended design and its impact on the assessment of biodiversity impacts is provided below.

Amended design and addressing submissions

The following design amendments were made following exhibition of the EIS between December 2020 and January 2021 (Table 1). The reduced impact of these changes has been assessed in this updated Biodiversity Development Assessment Report (BDAR). The locations of the amened designs and a summary of the reduction in impacts are presented in Figure 1 below.

Table 1 Design amendments and impact / benefit

Project Amendment	Description	Impact/benefit
Development footprint revision	Exhibited project footprint (EIS) comprised: • Permanent Development Footprint: approximately 242 ha • Temporary Development Footprint: approximately 271 ha • Total development footprint approximately 513 ha. Design revisions have resulted in the	Substantial reduction in direct impacts to biodiversity values have been realised through detailed design revision and footprint/infrastructure amendments. This is combined with a material reduction in the indirect impacts arising from the removal and relocation of turbines as well as a reduction in bulk earthworks and associated project infrastructure.

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Project Amendment	Description	Impact/benefit
	amended project footprint now comprising: • Permanent Development Footprint: approximately 100ha • Temporary Development Footprint: approximately 200 ha • Total development footprint approximately 300 ha	
Removal of WP1	WP1 was the closest turbine to the Crawney Pass National Park and its removal reduces biodiversity impacts, native vegetation removal and the requirement for bulk earthworks. The road required to access the turbine has also been removed, further benefitting biodiversity values in that location.	WP1 was considered a Moderate Risk turbine and its removal benefits locally occurring threatened and non-threatened fauna species including microbats, Koala, Greater Glider, as well as to approximately 2ha of high condition PCT 1194 vegetation. Removal of this turbine location from the project design has the direct benefit of reducing native vegetation removal, but also reduces potential connectivity impacts as the turbine was acting as an outlier on the south-western extent of the array, and the turbines now occur in a more linear arrangement in that location.
Removal of WP19	WP19 has been removed reducing impacts to biodiversity values in the centre of the wind farm. Its removal will reduce the earthworks and vegetation clearance needed to install the turbine, supporting hardstand area and access road.	The removal of WP19 results in an increase separation gap from 1 – 1.5km between turbines in this location, to approximately 2.1km between turbine WP18 and turbines WP20-22 reducing habitat connectivity impacts in an areas of the wind farm where moderate condition habitats occur on either side of the ridgeline. The removal of WP19 also allows for an approximate 600 metre reduction of the intrusion into intact vegetation to the south of the development footprint.
Removal of WP23, 27 and 31	WP23, 27 and 31 have all been removed to reduce risk of direct and indirect impact biodiversity values including potential microbat breeding habitat, modelled potential owls breeding habitat, and intact vegetation. The removal of these turbines will reduce significant bulk earth works associated with hardstands and associated roads, and reduces the area of impact from the southern-most portion of the wind farm by 400 – 500m at each turbine location.	All three of these turbines were assessed as high risk turbines (four assessed in total) in relation to potential impacts to biodiversity values. WP23 was considered high risk due to its occurrence as southern outlier in high condition intact native vegetation considered likely to support habitat for numerous threatened species, WP27 was located in close proximity to confirmed potential microbat breeding habitat, and WP31 occurred in proximity to modelled potential large forest owl breeding habitat. The removal of these three turbines will substantially benefit biodiversity values utilising

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Project Amendment	Description	Impact/benefit
		the habitats along this southern portion of the wind farm, both directly though a reduction in vegetation removal, and indirectly through a reduction in potential collision risk, breeding habitat disturbance, and connectivity impacts.
Reorientation of WP2 hardstand	The hardstand for WP2 has been reorientated such that it now occurs largely on exotic grassland.	This reorientation complements the reduction of impacts associated with the removal of WTG 1 and reduces impacts to high condition PCT 1194 by another 0.3 ha (on top of the 1 ha reduction highlighted above from the removal of WTG 1).
Relocation of WP47	WP47 has been relocated 209 metres north east of the exhibited location. This is to reduce the extent of vegetation clearance in this location.	The relocation of WTG 47 increases buffer distance from retained native vegetation on the escarpment and reduces native vegetation clearing. This reduces impacts to biodiversity values.
Relocation of WP50	WP50 was been moved approximately 130m to the north-east to avoid indirect impacts to conformed microbat potential breeding habitat.	WTG 50 was originally assessed as a high risk turbine. The relocation of WTG 50 avoids indirect impacts to the confirmed microbat potential breeding habitat that occurs to the south-west of the turbine and hardstand location. The turbine, turbine blade and zone of disturbance are now all located well outside the 100 m BAM prescribed microbat breeding habitat buffer to further reduce potential collision risks, and potential vibration impacts during construction.
Monitoring Masts at WTG Location prior to WTG Installation	Decommissioning of three current monitoring masts and installation of up to 10 additional monitoring masts for power testing (five previously proposed in the EIS, and five additional as part of this Amendment Report). The new monitoring masts will be located close to a turbine location with a maximum height of approximately 150 m AGL, equivalent to the hub height of the installed turbines. The additional five masts proposed will be temporary and placed on the same location as a turbine prior to its installation and removed shortly before turbine installation.	Up to 10 temporary monitoring masts are now proposed with the exact number and location being confirmed at the detailed design stage. No additional impacts will result, as the 5 new proposed monitoring masts will be located within assessed turbine footprints. The exact number and location will be defined at the detailed design stage.
Transmission Line realignment	The transmission line north of WP12 and to the east of WP2 has been realigned. This will reduce the vegetation clearance.	Relocation of approximately 3 km of the transmission line corridor in this area has reduced impacts to patches of high condition

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Project Amendment	Description	Impact/benefit
	Further analysis of opportunity to reduce clearing of native vegetation where overhead clearance is expected to be sufficient to avoid impacts.	native vegetation and relocated the footprint predominantly in areas of exotic grassland, further to the south and closer to the turbines. This design revision has resulted in materially reduced direct impacts to native vegetation and habits, including mapped habitat for Koala and Spotted-tailed Quoll.
Removal of transmission vegetation	Portions of the vegetation previously assessed to be removed for transmission line have been reassessed in a targeted study by AECOM to identify native vegetation that will remain un-impacted due to the spanning of valleys from the overhead power lines, remaining well over the height of the mature vegetation.	A reduction in the total clearing footprint will ensure an overall reduction in direct impacts to native vegetation. Portions of the vegetation previously assessed to be removed within the transmission line easement have been confirmed as able to remain based on further detailed design following a targeted study by AECOM (2021) to identify native vegetation that will remain un-impacted due to the height of the overhead power lines where they span across valleys. The lines in these areas have now been confirmed to remain well over the height of the mature vegetation, enabling the vegetation to be retained and further reducing biodiversity impacts.
Traffic Access to Project Area	All Project traffic will access the Project Area via Morrisons Gap Road only. The Head of Peel Road will not be used for Project related construction and operational traffic and will be for emergency use only. As a result, road upgrades previously proposed along the Crawney Road / Head of Peel access route ('Southern Route') will not be undertaken	Reduction in number of waterway crossings and impacts to native vegetation and fauna habitat, clearing that would otherwise have been required, through removing access along Head of the Peel Road.
Removal and realignment of internal road networks	Removal of the internal road from the development site near southern end of Head of Peel Road into western area of the Project Site. Sections of track between WP16 to WP17, WP17 to WP18, WP46 to WP47 and WP66 to WP67 and have been reassessed to avoid biodiversity impact and following contractor input on reducing earthworks and required width of footprint.	Sections of access track between WTG 16 to WTG 17, WTG 17 to WTG 18, WTG 46 to WTG 47 and WTG 66 to WTG 67 have been refined to avoid biodiversity impacts and following contractor input on reducing earthworks and required width of footprint. Removal of internal roads no longer required as a result of the turbine removals outlined above will directly and indirectly benefit previously impacted biodiversity values due to reductions in vegetation clearing, and bulk earthworks and resulting fragmentation of vegetation and habitats.
Key Intersection, Devils Elbow and Morrison	The proposed road upgrades at Devils Elbow and the Barry Road/Morrison Gap	Impacts associated with the exhibited project footprint in the EIS at Devils Elbow comprised

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Project Amendment	Description	Impact/benefit
Gap Road design update	Road intersection have been modified. Proposed upgrades would require vegetation clearing with the Devils Elbow footprint approximately 2.5 ha and the Barry Road/Morrison Gap Road proposed footprint is approximately 2.4 ha.	approximately 17ha of native vegetation which is generally in high condition. Substantial design revisions and a new bypass have reduced the impact assessed in this location down to 2.5 ha of native vegetation, leading to direct and indirect benefits to previously impacted vegetation and habitats in this area (refer Plate 1 below). This includes Box Gum Woodland Critically Endangered Ecological Community and habitat for threatened fauna species. Previously exhibited impacts considered a number of design options of which only one was intended to be constructed. The final route selected presented the lowest impact option and was further refined to avoid impacts.
Transport Route Updates	The transport route for OSOM from the Port of Newcastle to the Project Area has been amended by the following: • Removal of the tower route option via Tamworth; • Removal of the Head of Peel Road route ('Southern Route') (as stated above) and associated alternate routes through Nundle including Happy Valley Road, Jenkins St, Gill St, Innes St; • Inclusion of route optionality in Muswellbrook; • Two additional laybys for OSOM traffic on Lindsay Gap Road and Morrisons Gap Road to allow existing road users to pass slower moving Project traffic.	Overall, the refined transport route represents a reduction in biodiversity impacts with the remaining impacts fully assessed in the updated BDAR.
Ancillary Infrastructure Amendments	As a result of the removal of the Head of Peel Road access to the Project Area, the construction laydown area and batching plant at the top of the Head of Peel Road access route has been deleted. The laydown area / batch plant has been relocated to the footprint of the BESS / substation and O&M facility.	Changes to the location of temporary concrete batching plant locations, optionality for a new O&M location, alternate construction compound and additional met masts have overall, resulted in a reduction to previously presented impacts on biodiversity values.
	Substation, BESS and O&M configuration has been amended following further substation design works	
	Option to relocate O&M to WP56 based on feedback in the Hazards and Risk	

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Project Amendment	Description	Impact/benefit
	Report	
	Laydown Area and Concrete Batching Plant optionality for all laydown areas with the exception of laydowns along Morrisons Gap Road to host concrete batching plants (total number of batching plants for the Project will not increase and will remain as two).	
	An additional temporary construction compounds are proposed adjacent to WTG 56 and at the eastern (downslope) extent of the Devils Elbow bypass in an existing cleared pullover bay. No impacts to vegetation will occur at the evils Elbow compound.	

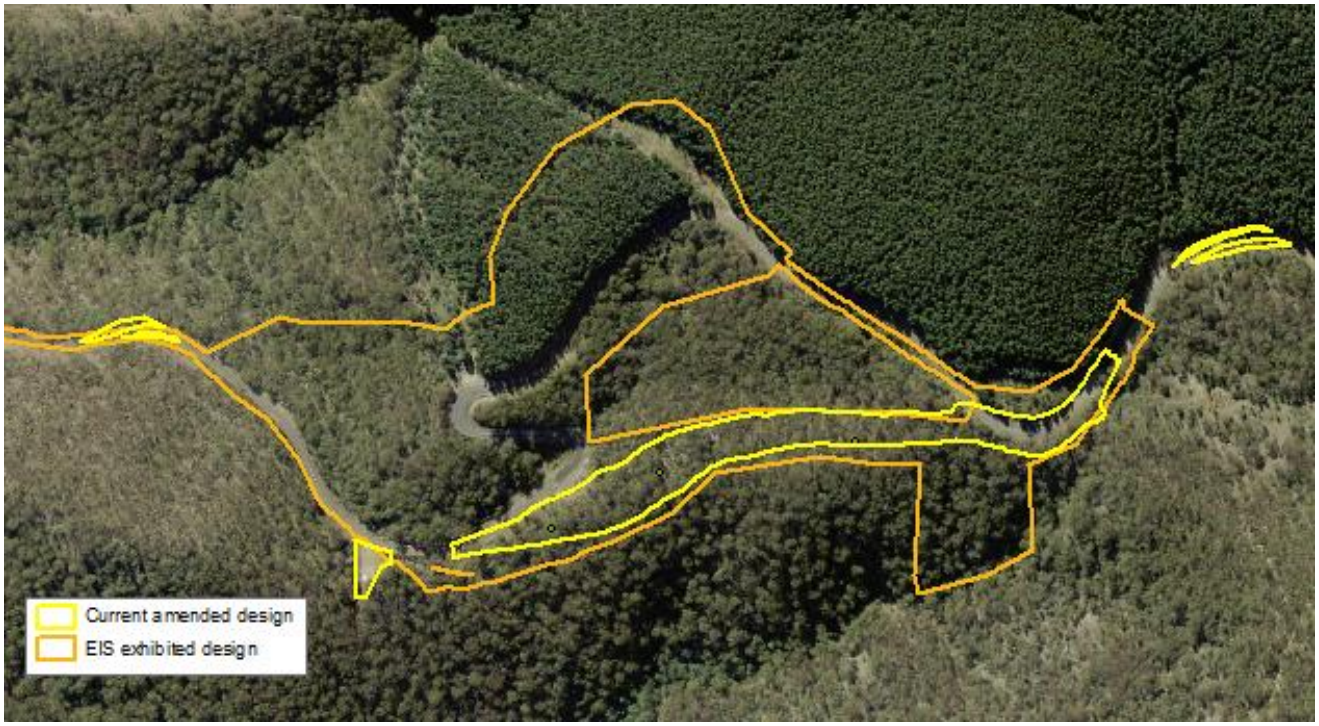

Plate 1 Devils Elbow bypass engineering design for the current and EIS exhibited impact assessment

The following table highlights the impact revised assessment has had on Native Vegetation.

Table 2 Revised direct vegetation impacts

Vegetation condition class	2020 BDAR Area (ha)	Updated BDAR Area (ha)	% Reduction	% of mapped vegetation
Planted or urban vegetation	7.39	0.24	97	0.08

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Vegetation condition class	2020 BDAR Area (ha)	Updated BDAR Area (ha)	% Reduction	% of mapped vegetation
Exotic grassland	272.36	164.48	40	55.35
Derived Native Grasslands	30.91	29.06	6	9.78
Native vegetation – Low condition	37.11	19.28	48	6.49
Native vegetation – Moderate condition	73.8	46.18	37	15.54
Native vegetation – High condition	64.88	37.92	42	12.76
TOTAL	**486.45**	**297.15**	**39**	**100%**

The project amendments have significantly reduced the impacts to vegetation as a result of clearing by a total of 39%, with a reduction of 42% occurring in areas of high condition native vegetation. As a result, a total of 72.41 hectares of native vegetation (varying in condition from low to high) will no longer be impacted by the Project.

Table 3 demonstrates the reduction in residual impacts required to be offset under the Biodiversity Offset Strategy to ensure no net loss to biodiversity.

Table 3 Reductions in project refinements

Relevant matter	Details	2020 BDAR Direct impacts	2021 Updated BDAR Direct impacts	Change in direct impacts
Native vegetation communities and ecosystem credit species habitats.	Direct loss of native vegetation communities associated with site clearing	207.7 ha	132.43 ha	-75.27 ha
Threatened ecological communities	Direct loss of Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	57.43 ha	23.36 ha	-34.07 ha
	Direct loss of White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	13.33 ha	6.07 ha	-7.26 ha
Habitat for threatened fauna species – species credit species	Large-eared Pied Bat*	61.08 ha	19.68 ha foraging habitat 0 ha breeding habit	-41.4 ha
	Eastern Cave Bat*	62.49 ha	19.68 ha foraging habitat 0 ha breeding habitat	-42.81 ha
	Large Bent-winged Bat*	23.12 ha	0 ha (breeding habitat)	-23.12 ha
	Little Bent-winged Bat*	23.12 ha	0 ha (breeding habitat)	-23.12 ha

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Relevant matter	Details	2020 BDAR Direct impacts	2021 Updated BDAR Direct impacts	Change in direct impacts
	Southern Myotis	2.21 ha	3.97 ha	1.76 ha
	Eastern Pygmy-possum	30.42 ha	18.14 ha	-12.28 ha
	Koala	50.76 ha	36.44 ha	-14.32 ha
	Squirrel Glider	26.20 ha	16.06 ha	-10.14 ha
	Booroolong Frog	1.59 ha	0.64 ha	-0.95 ha
	Border Thick-tailed Gecko	0.17 ha	0.17 ha	0 ha
	Powerful Owl	Assessed as not present as none were observed during surveys	1.99 ha based on assumed presence	No change. However, based the conservative assumption that this species is present despite not being located during surveys, 1.99 ha of potential habitat will be impacted.
	Sooty Owl	As above	As above	As above
	Barking Owl	As above	As above	As above
	Masked Owl	As above	As above	As above
Total Change				-275.88 ha

As a result targeted field survey, significant refinement has been achieved for previously assumed potential roosting / breeding habitat locations for cave dwelling bats including the threatened Eastern Cave Bat, Large Bent-winged Bat, Little Bent-winged Bat and Large-eared Pied Bat within and surrounding the development footprint. The former conclusion of a potential significant impact to Large-eared Pied Bat has been updated to unlikely based on a lack of optimal breeding habitat and removal and relocation of high risk turbines. Further information is provided in Section 8.8.

The Proponent intends to implement best practice processes for minimising these direct impacts noted above, including:

- Pre-clearing protocols, including pre-clearing inspections, establishment of exclusion zones and on-ground identification of specific habitat features to be retained and/ or relocated.
- Vegetation clearing protocols will be implemented including staged habitat removal, fauna handling and unexpected threatened species finds procedures for species (including of wombats, Koala, and other fauna) and any specified seasonal limits on clearing activities.
- A Biodiversity Management Plan will be implemented including the following specific requirements to minimise and manage any risk of fauna injury mortality during construction:

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- Strategies for fauna management during construction including any identification roles, responsibilities and contingency measures such as temporary stop works and engagement of fauna specialist.
- Requirements for temporary deterrent fencing, signage and/or requirements to modify driver behaviour and regular visual inspections to minimise the risk of fauna injury / mortality (particularly Koala and Spotted Tailed Quoll) due to vehicle strike or entrapment in deep excavations, with details to be developed during the preparation of the BMP.
- Opportunity for egress to any species that may become trapped in any open excavation in the form of graded exits or tools to support climbing out.
- Opportunities for the salvage and re-use of important habitat features, including tree-hollows and bush rock, are to be identified and detailed procedures for the implementation of these activities are to be adopted.

- A Bird and Bat Adaptive Management Plan will be developed and implemented for the monitoring of threatened or at risk species subject to adverse operational impacts. A framework for key components of this plan is provided in Section 8.10.2.

This amended BDAR has been prepared in accordance with the requirements of the *Biodiversity Conservation Act 2016* (NSW, BC Act) and the NSW Biodiversity Assessment Method (BAM, DPIE 2020). This BDAR was originally prepared in accordance with the BAM 2017 (OEH 2017) method, however as the final submission will occur after October 22, 2021 all amendments have been prepared to comply with BAM 2020 requirements.

Consultation was carried out with the Biodiversity Conservation Division (BCD) of DPIE and NSW National Parks and Wildlife Service (NPWS) before preparing the original BDAR. Consultation has continued since public exhibition of the original BDAR and EIS. BCD was consulted on this amended BDAR on the 3 February 2021 and 27 May 2021. This amended BDAR was also shared with BCD and NPWS prior to formal lodgement.

Following the Response to Submissions, further consultation with BCD and NPWS occurred on the 27 February and 11 March to discuss points raised in Response to Submissions, and discuss the aspects surrounding the development of the more detailed frameworks for the Bird and Bat Adaptive Management Plan.

A single development footprint has been assessed that covers the wind farm infrastructure, internal roads, transmission line easement, access tracks, and transport haul route.

The development footprint includes the construction and operational footprints, including temporary and permanent footprints. A wider 1500 metre landscape buffer was added to the development footprint to assess landscape impacts, as required under the BAM. The development footprint plus the buffer is referred to in this BDAR as the "assessment area".

The following biodiversity values were identified in the subject land through a desktop study and targeted field investigations.

Topography

- The topography includes a range of plateaus, ridgelines, and escarpments. The ridgetop where the WTGs will be installed is relatively flat.

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Vegetation

- The majority (55.5 % or 164.72 ha) of the mapped vegetation within the development footprint is composed of exotic grassland or planted/urban vegetation, with 44.5 % of the mapped vegetation being classified as native vegetation.
- The 132.43 ha of mapped native vegetation within the development footprint, occurs across 17 separate PCTs with varying levels of disturbance and condition, stratified into 43 vegetation zones.
- The mapped native vegetation (132.43 ha) represents 0.61 % of the approximate 21,540 ha contained within the assessment area.

Communities and species

- A total of 24 Plant Community Types (PCTs) were identified and mapped within the subject land, of these PCTs 16 will be impacted by the project.
- Two State-listed Threatened Ecological Communities (TECs) were identified and mapped within the development footprint, White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box Gum Woodland, Critically Endangered) (6.07ha) and Ribbon Gum - Mountain Gum - Snow Gum Grassy Forest/Woodland (Endangered) (23.36ha).
- One nationally-listed Critically Endangered Ecological Community (CEEC) was identified and mapped, within the development footprint, White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box Gum Woodland) (6.07ha).
- 12 state-listed fauna BAM species credit species were recorded or assumed to be present, two birds, eight mammals, one amphibian, and one reptile.
- Five nationally-listed threatened fauna either occur or are highly likely to occur, Koala, Large-eared Pied Bat, Greater Glider, Spotted-tailed Quoll and Booroolong Frog.
- No migratory fauna flightpaths or routes were observed or mapped throughout the assessment area.
- Nankeen Kestrel, Brown Goshawk and Wedge-tailed Eagles are present onsite, and while not listed these species, are protected and considered subject to potential collision risk.

The mitigation approach was to firstly avoid and minimise impacts through design phase refinements. However, there will be certain unavoidable impacts if the project is built. Therefore, mitigation measures have been identified to minimise the Project's biodiversity impacts. This includes (adaptive) management and monitoring measures. It also includes the use of biodiversity offsets to ensure no net loss of biodiversity.

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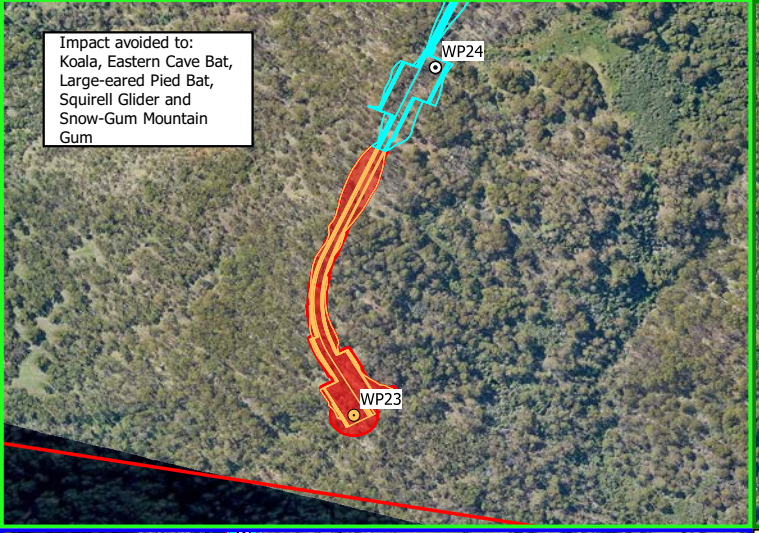

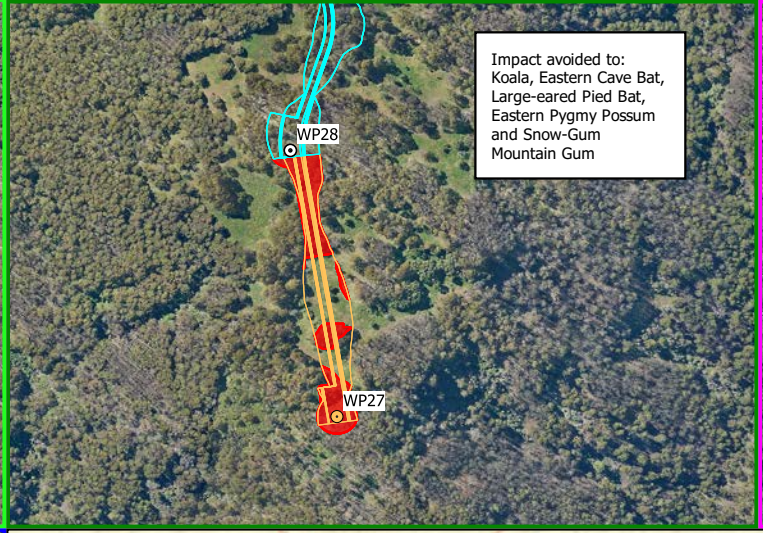

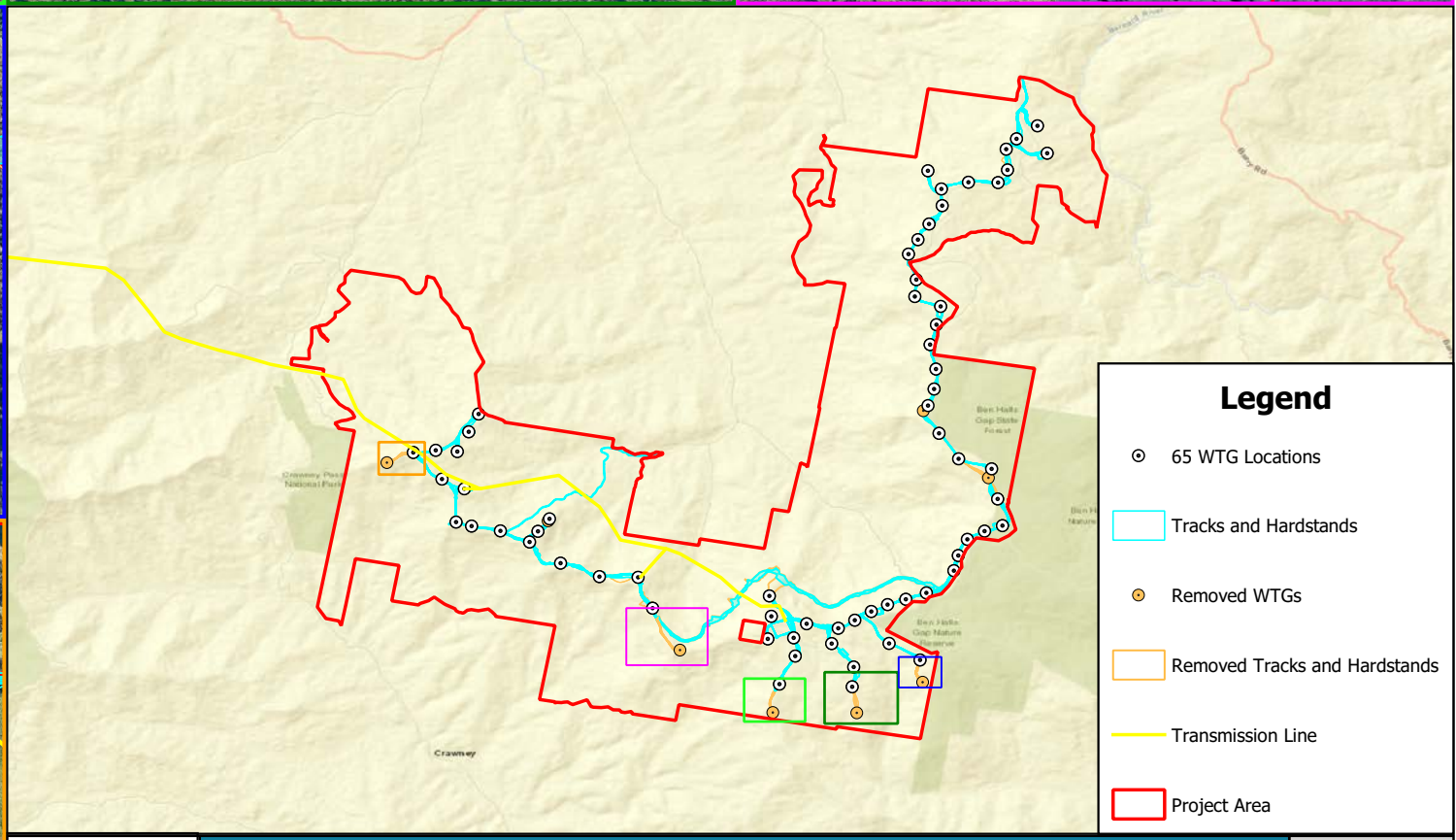

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0 3 6 km

Coordinate System: WGS 84 EPSG 4326

Removal of Five Wind Turbines

M01

Date: 07/09/2021

Version: 1

Prepared by: LE
Reviewed by: JC

Hills of Gold Wind Farm

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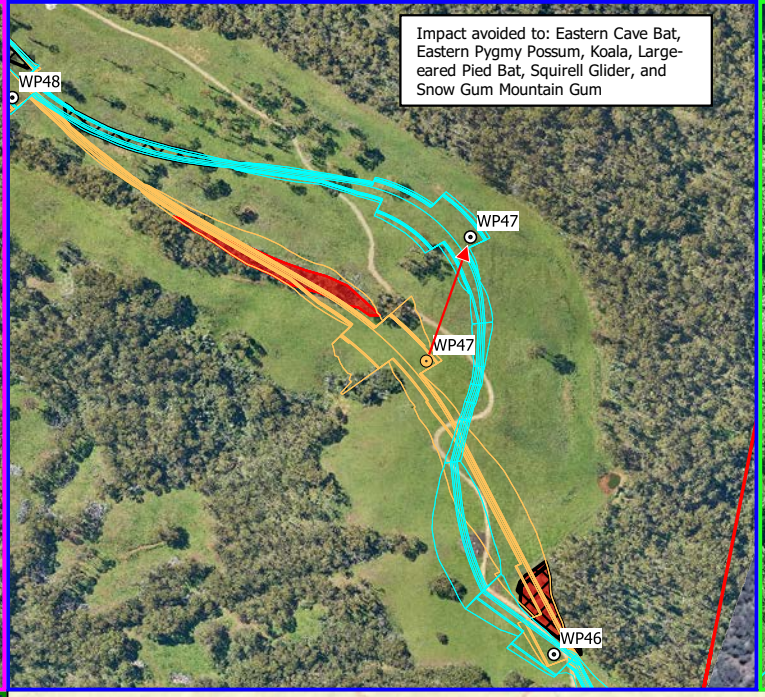

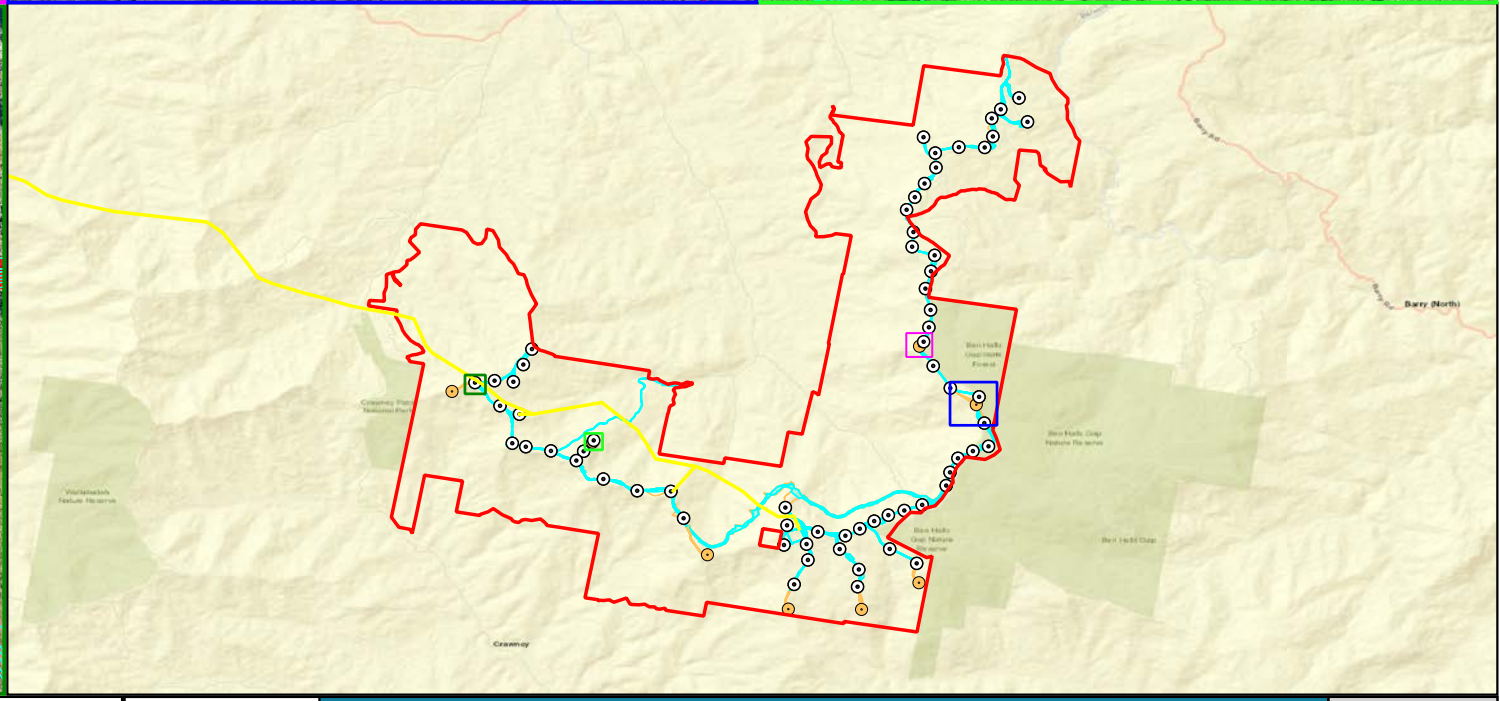

Legend

- 65 WTG Locations
- Removed WTGs
- Transmission Line
- Tracks and Hardstands
- Removed Tracks and Hardstands
- Project Area
- Species

N

Turbine Relocations

0 2.5 5 km

Coordinate System: WGS 84 EPSG 4326

Date: 07/09/2021

Version: 1

Prepared by: LE
Reviewed by: JC

Hills of Gold Wind Farm

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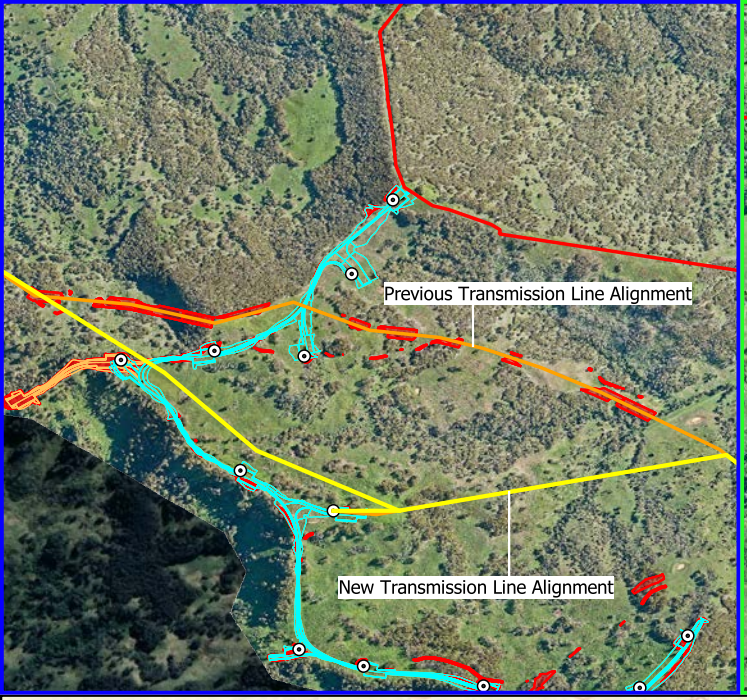

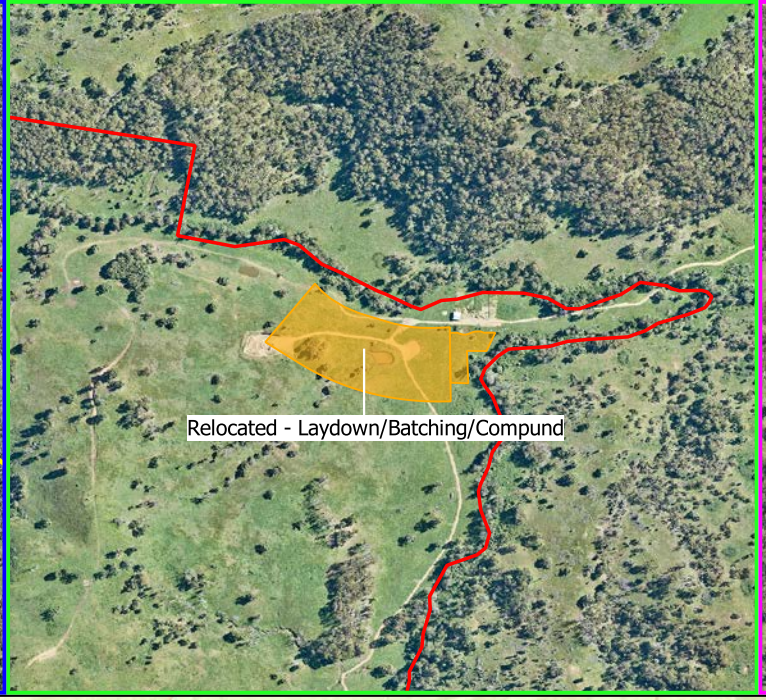

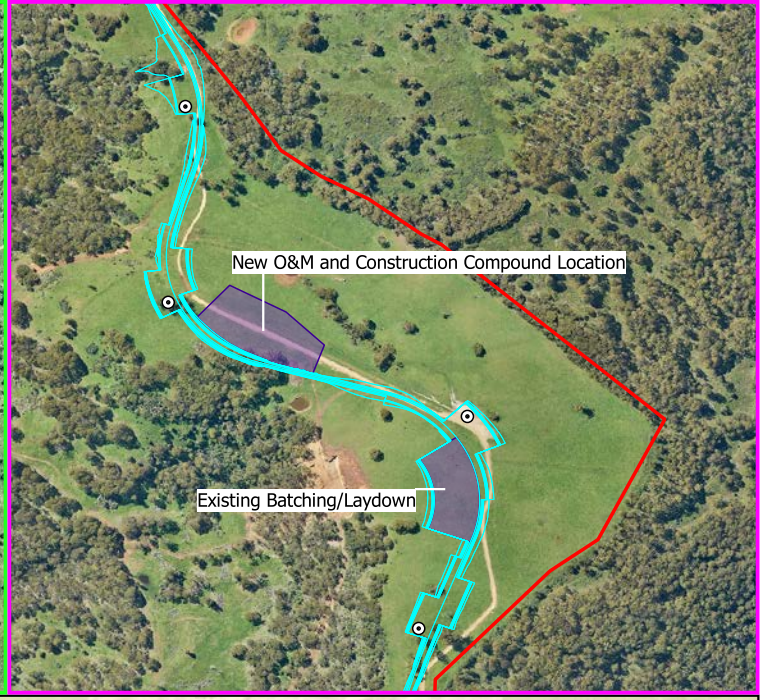

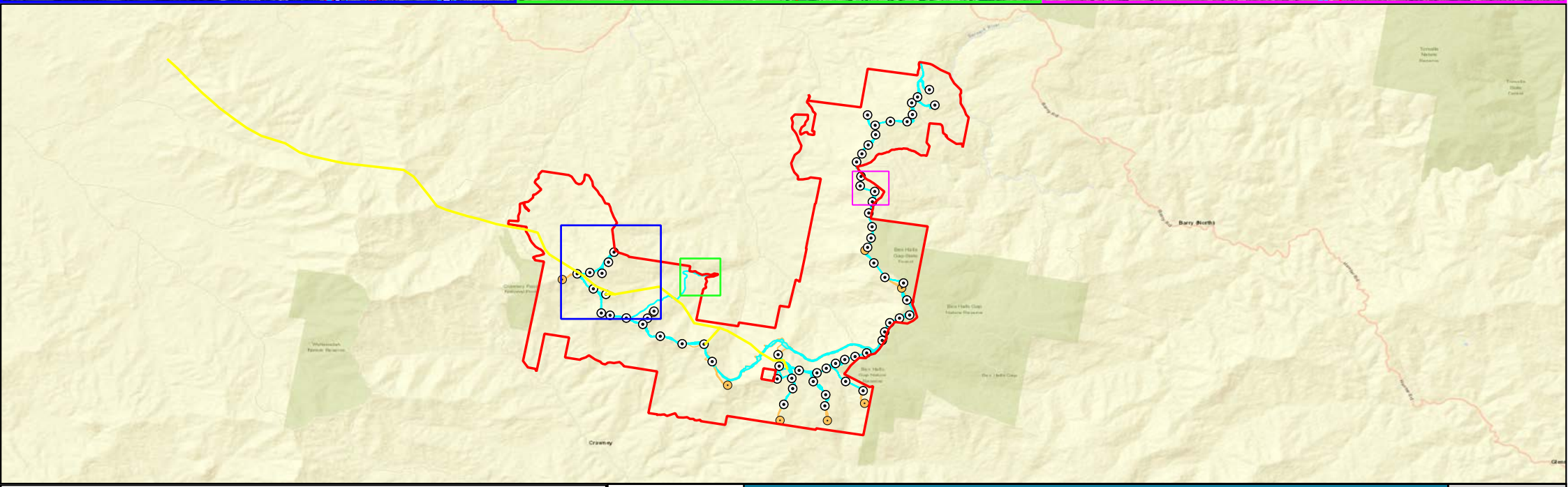

Legend

- 65 WTG Locations
- Tracks and Hardstands
- Removed WTGs
- Removed Tracks and Hardstands
- Transmission Line
- Previous Transmission Line Alignment
- Project Area
- Removed Ancillary Infrastructure
- Species

N

0 2.5 5 km

Coordinate System: WGS 84 EPSG 4326

Ancillary Infrastructure Amendments

Date: 07/09/2021

Version: 1

Prepared by: LE
Reviewed by: JC

Hills of Gold Wind Farm

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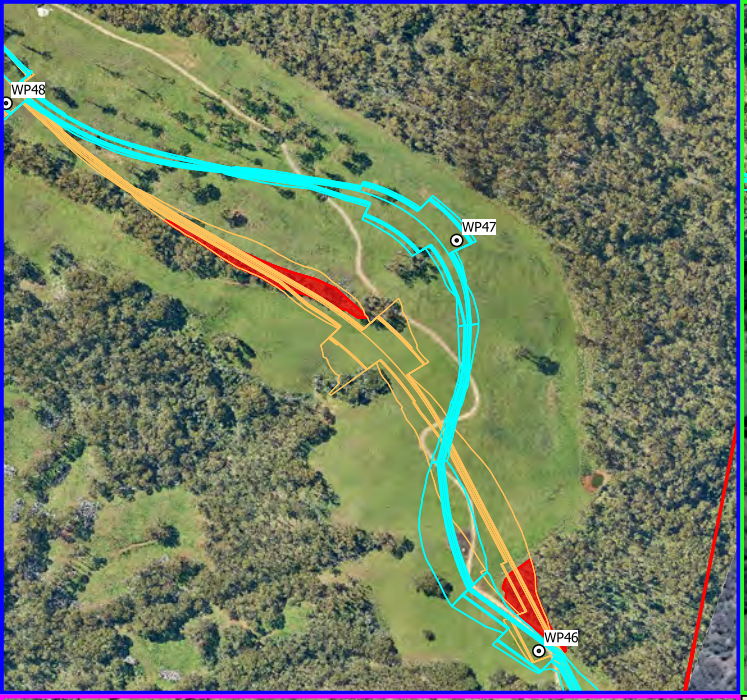
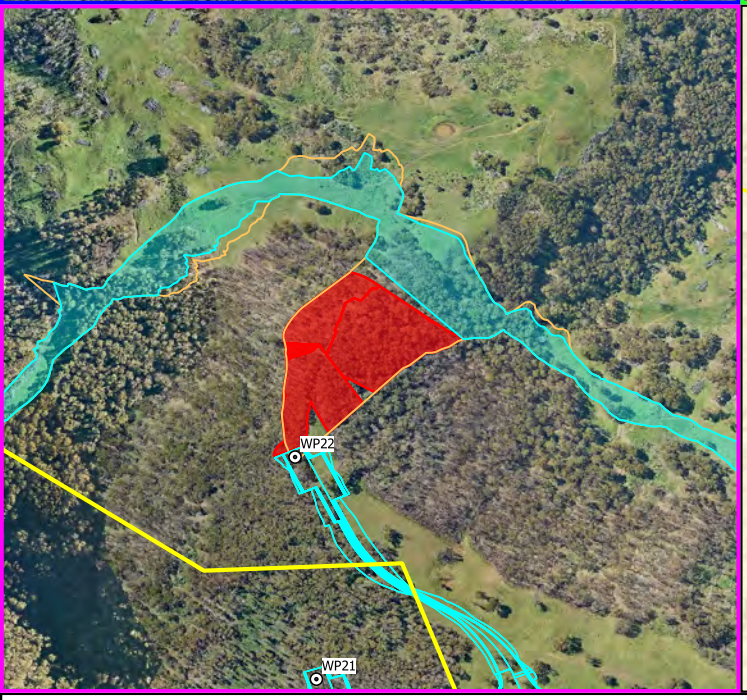
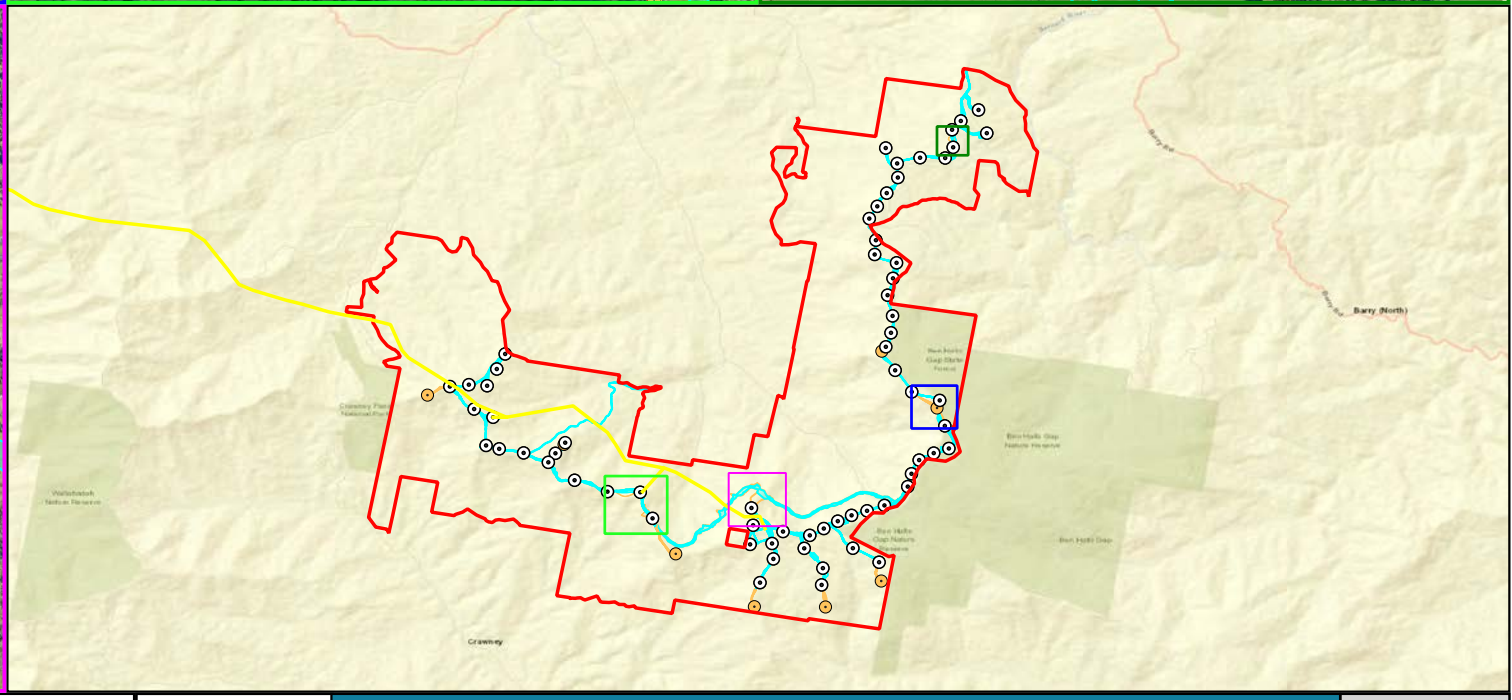
M03

SOMEVA RENEWABLES







Legend

- 65 WTG Locations
- Removed WTGs
- Transmission Line
- Tracks and Hardstands
- Removed Tracks and Hardstands
- Project Area
- Species Avoided

N

0 2.5 5 km

Coordinate System: WGS 84 EPSG 4326

Internal Road Changes

Date: 07/09/2021

Version: 1

Prepared by: LE
Reviewed by: JC

Hills of Gold Wind Farm

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M04

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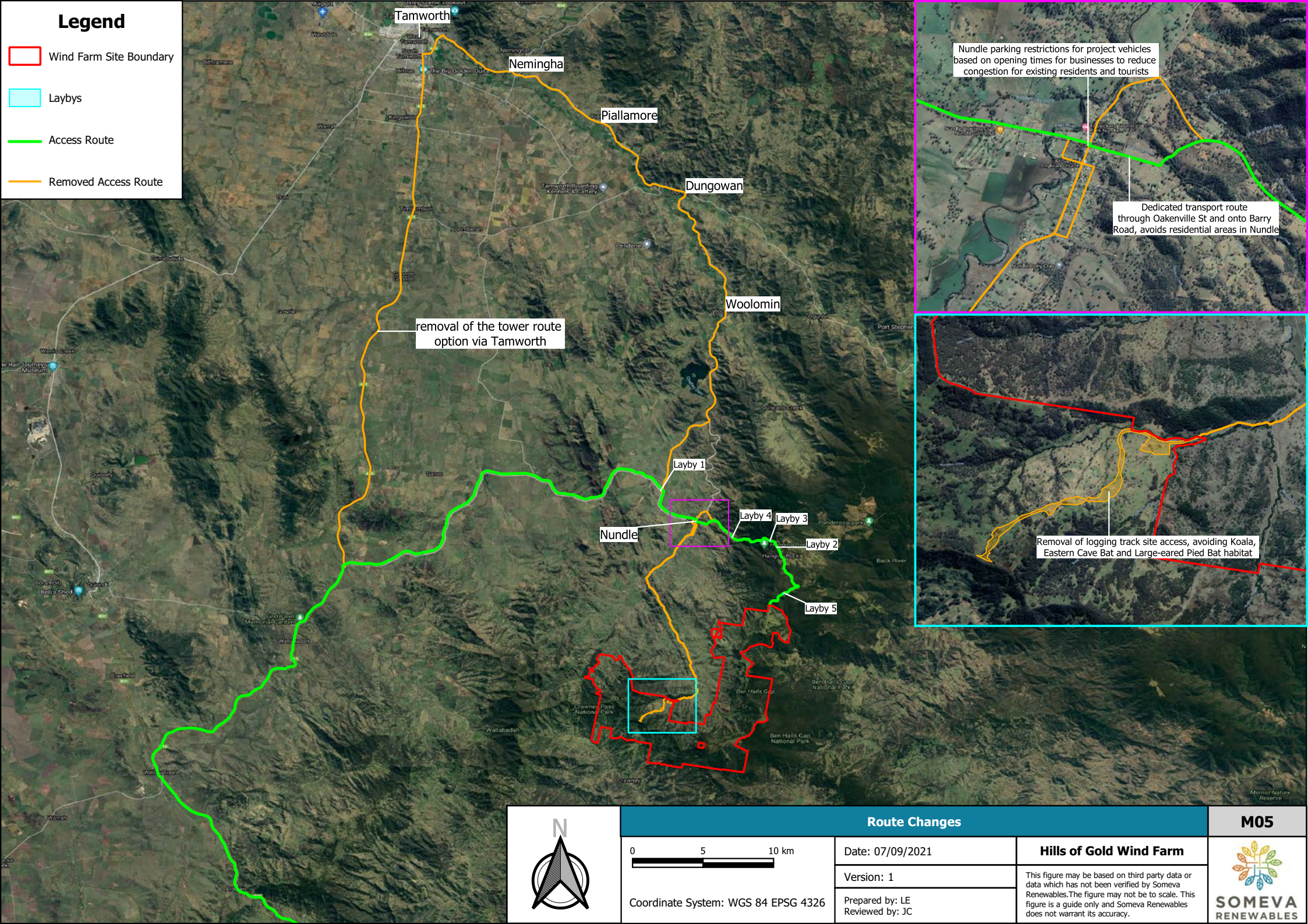

Route Changes

M05

Date: 07/09/2021

Version: 1

Prepared by: LE
Reviewed by: JC

Hills of Gold Wind Farm

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SOMEVA RENEWABLES

Key Updates to BDAR

Additional assessment

The following additional field surveys, desktop assessment and detailed analysis were completed following finalisation of the original BDAR to further assess the impacts of the Project, including the proposed amendments outlined in the Amendment Report as part of updating the BDAR in relation to the submission comments:

- An additional 24 BAM plot were collected in March 2021. This included collection of data to support the design refinements proposed to the of Devils Elbow bypass and Morrison Gap Road, upgrades as well as additional data to enable improved calculation of vegetation integrity across the development footprint.
- Additional geomorphological assessment was carried to assess the potential for microbat roosts and breeding habitat. In addition, a microbat cave roost inspection was carried out between 29 March 2021 and 1 April 2021. All high priority areas that were identified via desktop as having a sudden changes in elevation (ie potential large caves, and clifflines) were able to be visually inspected from the nearest accessible point.
- Based on feedback that the surveys carried out as part of the original BDAR, which did not identify any large forest owls (Barking Owl, Powerful Owl, Sooty Owl and Masked Owl), may not have been sufficient to fully exclude the possibility that large forest owls may utilise the Project Area, further large forest owl habitat suitability mapping and assessment was carried out. This assessment conservatively assumed the presence of large forest owls and assessed the updated Project on this basis.
- Serious and irreversible impact (SAII) assessments were completed for both the Box Gum Woodland TEC and microbat species. However, the subsequent design refinements made to the Project mean that an SAII assessment for microbats is no longer required.
- An assessment of the prescribed impacts of the updated Project was undertaken in accordance with the BAM, as well as further detailed assessment of indirect impacts to threatened species was completed.
- A qualitative risk assessment was also completed for impacts associated with potential bird and bat turbine blade strike, as well as a turbine specific risk assessment. Additional operational mitigation measures have been provided to manage potential impacts from turbines.
- Further detail has been provided around the BBAMP proposed to be developed, and implemented over the life of the project.

Residual impacts and their significance

The amended assessment confirms that there is the ability to avoid and minimise impacts through best practise and recognised mitigation measures to mitigate or offset impacts. While there will be an overall ecological impact in delivering the Project, the residual impacts has been minimised through the amendments made to the Project which were strongly focused on further reducing impacts to biodiversity values. Further reduction of impacts will sought throughout the detailed design phase and construction and operational impacts will be minimised through the preparation and implementation of a Construction Biodiversity Management Plan and an Operational Bird and Bat Adaptive Management Plan.

SAII to cave dwelling microbats and their potential breeding habitat have been avoided through the removal and relocation of specific turbines from the project footprint. The potential for SAII to Box Gum Woodland CEEC remains, but have been further minimised through project design, and it is considered that the current

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level of proposed impact is a worst case and can be mitigated against, and reduced during future design stages.

Potential significant impacts to EPBC Act listed Koala and Spotted-tailed Quoll are considered likely to occur as a result of the Project, however significant impacts to all other EPBC Act listed entities have been avoided including Box Gum Woodland CEEC, Large-eared Pied Bat and Booroolong Frog. Impacts to Koala and Spotted-tailed Quoll have been minimised through project design amendments reducing direct impacts to Koala habitat by approximately 14 hectares and to Spotted-tailed Quoll by approximately 40-50 hectares (with the species being associated with all areas of moderate and high condition native vegetation in the development footprint). Impacts will be further minimised through construction and operational mitigation measures targeting these species and through the establishment of local offsets aimed to increase local habitat connectivity between the existing reserve network. Despite the efforts made to reduce impacts, the residual impacts to both species have been conservatively considered significant in accordance with the EPBC Act significant impact guidelines, and as such the species will require direct offsets in accordance with the EPBC Act Offsets Policy (Commonwealth of Australia 2016), secured via the NSW BOS. Required offsets are expected to be achieved via a combination of establishment of local Biodiversity Stewardship Sites and the securing of biodiversity credits.

Residual impacts will be offset in accordance with the NSW Biodiversity Offset Scheme. Once these offsets are applied, no net loss to biodiversity is expected as a result of the Project. In addition, investigation into the establishment of local offset sites as Biodiversity Stewardship Sites has commenced and yielded a number of viable opportunities. Key to establishing local offsets is the aim of improving biodiversity values, and in particular habitat connectivity, at the local scale to mitigate the Project's impacts and improve biodiversity values in the locality. In particular, the potential to create Biodiversity Stewardship Sites on land surrounding the Project to provide a wildlife corridor between Ben Halls Gap Nature Reserve and Crawney Pass / Wallabadah Nature Reserve has been investigated. There have been seven (7) neighbouring landowners identified who could potentially host a biodiversity stewardship site to deliver the wildlife corridor. The Proponent is seeking to enter into agreements with these neighbouring landowners to secure the potential wildlife corridor. Subject to these agreements being successfully concluded and Biodiversity Stewardship Sites established in accordance with legislative requirements, the Proponent commits to delivering a wildlife corridor between Ben Halls Gap Nature Reserve and Crawney Pass / Wallabadah Nature Reserve as part of the biodiversity offsets required for the Project.

As identified in Section 8.5 of the revised BDAR, there has been an overall reduction in prescribed impacts as a result of the amended Project.

Biodiversity, Conservation and Science Directorate (BCS) - Request for additional information February - March 2022

Following submission of the Amended BDAR with the project's Amendments Report, further information on a number of key items was requested by BCS and NPWS. These items have been addressed in the current version of the BDAR, and where and how each RFI item has been addressed is detailed in Table 4 below.

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Table 4 Summary of RFI comments and where/how they are addressed

Item	Agency	Summary of Agency comments	How / where addressed
1	BCS	Not all components of the BAM assessment were included in the BDAR i.e. No % cleared for PCTs provided.	Noted. No further action required.
2	BCS	The methodology used to determine non-native vegetation must be clearly articulated, however was considered adequate.	Noted. No further action required.
3	BCS	The selection of PCTs has not been adequately justified, and further justification should be provided in the BDAR for the selection of all PCTs.	Further justification on why PCTs were selected has been provided. Refer to additional comparison tables providing "Similar PCTs" and "Justification of Best Fit" included for each PCT in Appendix B.
4	BCS	Inclusion of vegetation plots located outside the project footprint must be justified.	Additional justification on the comparison between plots outside of the footprint in relation to the impacted vegetation zones has been added. Additional justification provided in Section 4.1.4 and Table 21.
5	BCS	Separate BOAMs cases are needed for each IBRA subregion. BOAMs cases to be split between IBRA sub-regions, with separate cases for each subregion.	The BAM-C for the project has been updated and split by IBRA region/subregion. A small number of species previously assessed as not relevant to the project, but not detailed in Table 31 and Appendix C, are now included.
6	BCS	Vegetation condition classes be reviewed to ensure that they accurately reflect vegetation integrity scores.	More information around the use of benchmark data artificially increasing VI scores, and how this relates to the ground-validated condition states used to determine vegetation zones has been provided. Additional justification provided in Section 4.2.4.
7	BCS	Permanent and temporary impacts for each vegetation category is adequate.	Noted. No further action required
8	BCS	Ecosystem species have been included in discussions regarding species credit species.	Noted. No further action required
9	BCS	Inconsistencies exist between the field data and the data in the BAM calculator. Explanations be provided for differences in plot data between spreadsheets.	Spreadsheet 1 (as referred to in the RFI document) is an Arup document and Biosis cannot comment on the accuracy of the data included. Since January 2021 Biosis has completed a QA on the floristic plot data and has updated any inconsistencies and/or errors that may have occurred prior to that date. This has included minor adjustments to the location of some BAM plot points that were inaccurately located due to GPS error in the field, for example to move the point

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Item	Agency	Summary of Agency comments	How / where addressed
			back under the canopy of the vegetation patch the plot occurred within. Further to the above, discrepancies have now been noted in the large tree count data in Biosis' BAM plot data. The error has been traced back to an issue with the GIS data processing model either creating duplicate values or summing values for >80cm DBH or 50-79cm DBH, depending on the way the data was captured in the field. These issues have now been corrected, without changing the VI scores for any vegetation zones where this error had occurred. Updated data include in the BAM-C and Appendix H
10	BCS	All SAII have been adequately addressed. No further action necessary.	Noted. No further action required.
11	BCS	The potential impact to fauna relating to turbine placement has not been adequately addressed. Discussion regarding the potential for the displacement of home ranges, or the sterilisation of suitable habitat through fauna avoiding turbines, thus disrupting movement patterns is required. Justification be provided for the distance between turbines along ridge lines.	Additional justification and assessment provided in Sections 5.4.2 (Table 44), 8.3.4 and 8.3.5. Section 5.4.2 (Table 44) addresses animal behaviour including forage flight characteristics. Section 8.3.3 "Turbine risk assessment" has been updated to consider the barriers to movement and potential collision with turbine blades on a turbine by turbine basis. Table 67 "Qualitative risk assessment for turbines for full 70 turbine layout" provides barrier effect risk. Section 8.3.4 "Barrier Effect Risk Assessment" and Section 8.3.5 "Summary of collision risks and indirect impacts" have been updated with specific regard to potential barrier impacts to threatened species and the risks associated with displacement of home ranges, or the sterilisation of suitable habitat through fauna avoiding turbines, thus disrupting movement patterns. Table 70 provides an updated qualitative risk assessment for potential barrier effect impacts to birds and bats within identified turbine clusters. It has been concluded that "All known or predicted bird and bat species within the subject land have low or negligible risk associated with barrier effects or avoidance behaviour resulting from aerial fauna flying near/within the zone of disturbance or from habitat sterilisation surrounding the operational wind turbines". However, where individual spacing and potential zone of disturbance overlap or become in close proximity to each other, this represents identified turbines clusters that may have a slight increase in an inherent risk associated

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Item	Agency	Summary of Agency comments	How / where addressed
			with barrier effects or altered flight behaviour in that area. Additional assessments were undertaken with additional technical input from Biosis' acknowledged avian and microbat ecologist and highly experienced wind farm ecologist Ian Smales and Mark Venosta (see Section 1.9.2 for credentials).
12	BCS	Prescribed impacts relating to wind farms have not been adequately addressed. Options to compensate for unavoidable prescribed impacts, the decision pathway and justification for suggested credit numbers or other compensatory actions, should be clearly documented.	Additional justification and information around residual prescribed impacts and compensatory measures has been provided in Section 8.3.5 "Summary of collision risks and indirect impacts" and 8.10.2 "Bird and Bat Adaptive Management Plan (BBAMP)".
13	BCS	Direct impacts on cave bat roosts needs to be clarified. Additional input be sought from an acknowledged bat ecologist. Monitoring of bats take place prior to construction adjacent to geological features with high bat activity at "fly-out" times to determine if further investigation is warranted to identify potential roost sit.	Additional considerations included in Section 5.4.2 Microbats (at the end of section) based on input from highly experienced wind farm ecologist and Biosis' senior microbat ecologist Mark Venosta (see Section 1.9.2 for credentials). Additional monitoring of bat activity near geological features that may potentially provide roost habitat has been included in Section 8.10.1.
14	BCS	Indirect impacts on microbats have not been adequately addressed. Full details of trigger points and mitigation measures be addressed and presented prior to a final determination of the project rather than in a post-consent BBAMP. Data from ongoing bird and bat monitoring surveys be provided to DPIE annually as well as made publicly available on the project's website.	Additional justification and information provided in Section 8.10.2, which includes detailed commitments made by the proponent to a mitigation strategy, to be finalised during the preparation of the BBAMP, and includes trigger points and proposed mitigation measures. Section 8.10.2, contains an overview of the proposed BBAMP, and includes the following: • Framework and objectives. • Baseline information. • Trigger-level and unacceptable impacts for further investigation and adaptive management. • Monitor and report on the effectiveness of impacts and trigger levels. • Operational mitigation measures. • Residual prescribed impacts and compensatory measures. • Compliance management and summary. • Monitoring and adaptive management triggers for barrier effect impacts.
15	BCS	Additional assessment of a locally important population of the Greater Glider has been provided. No significant impact is likely on the local population of Greater Glider. No further	Noted, but refer to point 18.

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Item	Agency	Summary of Agency comments	How / where addressed
		action necessary	
16	BCS	Species polygons for some species credit species are unacceptable. Species polygons for Powerful, Barking and Masked Owls are to be reconfigured. Species polygon for Koala, Eastern Pygmy Possum, Squirrel Glider are to be reconfigured to include all suitable habitat.	Additional information has been provided in Section 5.5. Habitat polygons have been developed based on a combination of targeted field surveys, ground-validated habitat assessments, and species' habitat requirements based on published literature and the TBDC. Preparing species polygons in this manner was undertaken to ensure the use of information available for each species, such as PCT associations, habitat parameters where they can be justified based on BioNet or published, peer-reviewed literature, habitat assessments, and targeted surveys, to ensure species polygons are as accurate and meaningful as possible. The approach was undertaken considering Section 6.1.1.2 of the BAM, which specifies that: *'An assessor may use additional information about a threatened species, in BioNet (e.g. the profile of a threatened species) or published, peer reviewed literature, when assessing the habitat suitability of a site'* Koala, Eastern Pygmy Possum, and Squirrel Glider species polygons, were developed based on a combination of on-ground fauna habitat assessment undertaken across the entire wind farm corridor, and the results of targeted surveys undertaken for all three of these species, with reference to BioNet and literature. Owl species polygons were developed using a combination of the Large Forest Owl Recovery Plan (DEC 2006), BioNet and peer reviewed literature.
17	BCS	Stewardship sites should consider proximity to turbine influence.	Acknowledged and included in Section 9.1.3.
18	BCS	Additional information is required for Matters of National Environmental Significance. A credit requirement for the Greater Glider should be calculated under advice from the Commonwealth Department of Agriculture, Water and the Environment.	No further guidance has been provided on this issue, other than the project is not expected to have a significant impact to this species (Item 15). As such no species specific offsets are considered necessary, and any offsetting of impacts to the species' habitat will be included with the project's ecosystem credit offsets and establishment of local Biodiversity Stewardship Sites.
19	NPWS	It is unknown how the proposed adaptive management will mitigate impacts once the turbines are constructed. What options are there for the proposed adaptive management measures once the turbines are in place? A key question is whether a moderate level of risk to threatened species is	Additional justification and information provided in Section 8.10.2, which includes detailed commitments made by the proponent to a mitigation strategy, to be finalised during the preparation of the BBAMP, and includes trigger points and proposed mitigation measures to reduce potential operation impacts associated

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Item	Agency	Summary of Agency comments	How / where addressed
		acceptable adjacent to high quality habitat on national park? For these reasons and for potential impacts on NPWS operations, NPWS recommends the removal from the proposal of all turbines adjacent to Ben Halls Gap Nature Reserve.	with the turbines, with particular consideration of turbines adjacent to the Nature Reserve. Section 8.3.3 "Turbine risk assessment" has been updated to consider the barriers to movement and potential collision with turbine blades on a turbine by turbine basis. Table 67 "Qualitative risk assessment for turbines for full 70 turbine layout" provides barrier effect risk. Section 8.3.4 "Barrier Effect Risk Assessment" and Section 8.3.5 "Summary of collision risks and indirect impacts" have been updated with specific regard to potential barrier impacts to threatened species and the risks associated with displacement of home ranges, or the sterilisation of suitable habitat through fauna avoiding turbines, thus disrupting movement patterns. Table 70 provides an updated qualitative risk assessment for potential barrier effect impacts to birds and bats within identified turbine clusters. Each of these assessments gives particular consideration of turbines adjacent to the Nature Reserve.
20	NPWS	BDAR Tables 56 & 59 regarding potential impacts of blade-strike on local populations of several species, lists the risk as moderate but describes impacts as short term. Given that the potential risks of collision will exist for the duration of the project's operation, the impacts are likely to be ongoing and hardly short term.	Terminology used in tables in Section 8.3.1 and 8.3.2 have been updated.
21	NPWS	Proposed ongoing monitoring of impacts and adaptive management is commended. However it's difficult to understand how adaptive management can be implemented once the turbines are constructed -- there is little indication of what this might comprise "after the event" and after its impact.	Additional justification and information provided in Section 8.10.2 and information relating to items 14 and 19 of this table.
22	NPWS	BDAR's mitigation measures include "appropriate setbacks" required from NP estate "where practical", which have not been clearly identified and do not appear to be in place for the turbines immediately adjacent to BHGNR. Also the 30m "minimum safe distance" from nearest vegetation canopy to mitigate blade-strike risks to protected fauna appears inadequate, and inconsistent with the above and other considerations including precedents set for other windfarms which involved more extensive set-backs.	Additional justification for turbine placement along the ridgeline adjacent to Ben Halls Gap Nature Reserve is provided in Section 7.1.1. Details are provided around the different considerations resulting in the current placement of the turbines including wind energy generation, minimisation of biodiversity impacts, residual impacts and potential increases to impacts resulting from changes to layout in that location.

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Item	Agency	Summary of Agency comments	How / where addressed
23	NPWS	Proponent would be willing to consider a contribution to wild dog/fox baiting programs if required, and this is both welcomed and recommended.	Additional proposed mitigation measures and information provided in Section 8.9 "Mitigation and Managing Impacts", Table 82, B11 as well as Section 8.10.1 "Biodiversity Management Plan". The proponent has committed to ongoing consultation and participation with NPWS and LLS on their annual vertebrate pest baiting programs including a financial contribution capped at $5k per annum to cover any additional costs of aerial baiting programs as a result of rotary aircraft (as opposed to fixed wing) being required to improve safe operating practice.
24	NPWS	Impacts to Sphagnum Moss and potential TEC listing. Inappropriate fire regimes are regarded as a key threatening process, which has implications for turbines' potential to impact NPWS and other aerial fire management operations.	Additional information provided in Section 4.3.3, Section 8.5and Section 8.9 including that the bushfire strategy developed for the project will include measures to minimise risk of bushfire to the Sphagnum Moss TEC, including: • Increase the accessibility of the ridgeline to fire fighters and improve strategic fire advantages that already exist. • Access to water will be maintained such that existing water resources will remain available at all times to support firefighting activities. • Extension of the strategic fire zone from NHPNR. • Upgrades to the access road network to RFS fire trail standards. • Increased water storage. Further information is updated in projects commitments for bushfire responses provided in the RFI.

Table 5 Summary of RFI comments in repsonse to the BBAMP framework

Item	Agency	Summary of Agency comments	How / where addressed
1	BCS	The BBAMP framework could be improved by including objectives to avoid and mitigate impacts to biodiversity during the operation of the wind farm. Where impacts cannot be avoided or mitigated, offsets for these residual impacts will be required.	Updates have been provided throughout Section 8.10.2.
2	BCS	Biodiversity credit quanta for bird and bat strikes be reviewed and fully justified: • Credit quanta should be calculated according to the conservation status of the individual species impacted.	Additional detail has been provided in Section 8.10.2. in terms of credit generation, the commitment has been made for "the amount of credits required to be offset would be calculated by the number of actual and modelled impacts in the preceding 12 months, accounting for scavenger impacts, to individual species

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Item	Agency	Summary of Agency comments	How / where addressed
		• Calculation of credits should be done every twelve months as part of the annual review. • Offsets should be calculated based on the maximum estimated number of fatalities for the preceding twelve months.	in a given year, multiplied by the biodiversity risk weighting (BRW) for the relevant species". This method is commensurate with the Equation 3 (Section 10.1.3) of the BAM for calculating species credit requirements for flora species assessed by a count of the number of individuals, which is aligned with the calculation of offsets required for impacts to individual bird and bat strikes. This differs from the approach put forward by BCS, however Biosis believes it captures the relevance of a current threatened listing for a species, and is in accordance with the expectations of BAM implementation for prescribed impacts (Section 8.6 of the BAM).
3	BCS	Actual strike rates be used as triggers rather than percentages of individual species' populations. Additional triggers for corrective action are identified which are focused on actual strikes rates which have been extrapolated and analysed during annual reporting. A detailed monitoring plan will need to be provided to BCS for endorsement should percentage of population number triggers be pursued.	These suggestions have been noted and updated throughout Section 8.10.2, however Biosis has maintained the option for calculation of impacts (and associated triggers) at the population scale, as if this can be determined it will provided more ecologically meaningful targets and ongoing assessment of impacts.
4	BCS	More detail to be included on how turbine risk ratings are to be determined.	Updates have been provided throughout Section 8.10.2 with links to relevant sections of the BDAR to which this refers including Section 8.3.3 Turbine risk assessment.
5	BCS	The Tier 1 alert for non-threatened 'at-risk' species and low risk species should be changed to a trigger of two or more carcasses, feather spots or injured individuals of a single species, found under or close to a wind turbine during any mortality search or incidentally by wind farm personnel. The Tier 2 impact trigger for all non-threatened species should be more than four carcasses, feather spots, or injured individuals of a single species, found under or close to a wind turbine within a two-month cycle.	These suggestions have been noted and updated in Section 8.10.2.
6	BCS	Lists of threatened and non-threatened at-risk species be included in the BBMAP framework.	Updates have been provided throughout Section 8.10.2 with links to relevant tables within the BDAR Table 61 and Table 65.
7	BCS	Mitigation implementation protocols be included in the BBAMP framework.	Updates have been provided throughout Section 8.10.2.
8	BCS	Monitoring of all turbines following their commissioning be conducted over	Updates have been provided in Section 8.10.2, including monthly monitoring for

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Item	Agency	Summary of Agency comments	How / where addressed
		twelve months, ensuring all seasons are covered. Monthly carcass searches of turbines should be conducted for the first five years of operation, using trained dogs for at least the first two years. The monitoring program be reviewed at two years.	the first six months following commissioning of turbines, however this must include the first spring/summer season following commissioning of turbines, and therefore may be extended in duration, including follow up pulse searches.
9	BCS	The BBAMP framework should include clear links between tiers, triggers, and actions.	Updates have been provided throughout Section 8.10.2.

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Environmental assessment requirements

The below table lists the Secretary's environmental assessment requirements (SEARs) relevant to biodiversity and where they are addressed in this report.

Table 6 SEARs relevant to biodiversity

SEARs No.	Secretary's requirement	Where addressed
Key issues – Biodiversity (1)	The EIS must assess biodiversity values and the likely biodiversity impacts of the development including impacts associated with transport route road upgrades in accordance with the *Biodiversity Conservation Act 2016* (NSW), including a detailed description of the proposed regime for minimising, managing and reporting on the biodiversity impacts of the development over time, and a strategy to offset any residual impacts of the development in accordance with the *Biodiversity Conservation Act 2016* (NSW).	All sections of this BDAR.
Key issues – Biodiversity (2)	The EIS must assess the impact of the development on the National Estate in accordance with the Guidelines for Development Adjoining Land and Water Managed by DECCW (OEH, 2010).	Section 4, 5, 7 and 8 of this BDAR.
Key issues – Biodiversity (3)	The EIS must assess the impact of the project on birds and bats from blade strikes, low air pressure zones at the blade tips (barotrauma), and alteration to movement patterns resulting from the turbines and considering cumulative effects of other wind farms in the vicinity.	Section 4, 5, 7 and 8 of this BDAR.

Relevant agency SEARs requirements are also provided in Table 7.

Table 7 Agency SEARs requirements relevant to the project

Assessment requirements	How addressed
DPI Fisheries	
Assess the impact of the design, construction and operation of waterway crossings on access roads across the site in accordance with NSW Fisheries (2013) Fisheries Policy and Guidelines Fish Habitat Conservation and Management (2013 update) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings.	Section 8.4 and 8.5 of the BDAR.
Department of Planning, Industry and Environment	
Biodiversity impacts related to the proposed development are to be assessed in accordance with Section 7.9 of the Biodiversity Conservation Act 2017 the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method, unless OEH and DPIE determine that the proposed development is not likely to have any significant impacts on biodiversity values.	Addressed throughout this document.

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Assessment requirements	How addressed
The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method.	Section 7, 8 and 9 of this BDAR.
The BDAR must include details of the measures proposed to address the offset obligation as follows. • The total number and classes of biodiversity credits required to be retired for the development/project. • The number and classes of like-for-like biodiversity credits proposed to be retired. • The number and classes of biodiversity credits proposed to be retired in accordance with the variation rules. • Any proposal to fund a biodiversity conservation action. • Any proposal to conduct ecological rehabilitation (if a mining project). • Any proposal to make a payment to the Biodiversity Conservation Fund. If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	Section 9 of this BDAR.
The BDAR must be submitted with all spatial data associated with the survey and assessment as per Appendix M of the BAM.	All data will be provided upon submission to DPIE.
The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2020 under s6.10 of the *Biodiversity Conservation Act 2016*.	Section 1 of this BDAR.
The EIS must map the following features relevant to water and soils including: • Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method). • Wetlands as described in s4.2 of the Biodiversity Assessment Method.	Section 3 of this BDAR.
Fauna survey is to be conducted in native vegetation adjacent to the development site, including Ben Halls Gap Nature Reserve and Ben Halls Gap State Forest.	Section 4 and 5 of this BDAR.
Assessment of impact is to include all components of the proposal, including any road/track widening to enable transport of turbines to the site.	Sections 4, 5, 7 and 8 of this BDAR.
Hollow-bearing trees are to be quantified on the development site and in adjacent native vegetation.	Sections 4 and 5 of this BDAR.
A candidate list of species that may use the development site as a flyway or migration route must be included in the EIS, including: (a) resident threatened aerial species (b) resident raptor species (c) nomadic and migratory species that are likely to fly over the project area.	Section 5 and 7 of this BDAR. Appendix D of this BDAR.
Bird and bat flight paths are to be identified and assessed. Maps of habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site are to be included in the EIS.	Section 5, 7 and 8.5.8 of this BDAR. Appendix D of this BDAR.
The cumulative effect of wind farms in the broader area should be considered in relation to migratory birds.	Section 8.5 and 8.9 of this BDAR.
Copies of all raw data sheets for flora and fauna studies are to be included in the EIS or provided to OEH.	To be provided.
ArcGIS compatible spatial data is to be provided including (but not limited to) vegetation	To be provided

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Assessment requirements	How addressed
mapping, plot locations, transect locations and the locations of turbines and other infrastructure.	

On the 23 December 2019, the DAWE determined the project was a controlled action under section 75 of the EPBC Act. Controlling provisions for the proposed action are listed threatened species and communities (section 18 and 18A) and listed migratory species (section 20 and 20A). Table 8 details the specific assessment requirements identified by DAWE for these matters.

Table 8 DAWE assessment requirements for the proposal.

DAWE requirement	Assessment requirements	How addressed
General (5)	The Environmental Impact Statement (EIS) must address all matters outlined in Schedule 4 of the EPBC Regulations and all the matters outlined below in relation to the controlling provisions.	This BDAR.
General (10)(a)	The EIS must include an assessment of the relevant impacts of the action on the matters protected by the controlling provisions, including: • A description and detailed assessment of the nature and extent of the likely direct, indirect, and consequential impacts, including short term and long-term relevant impacts.	Section 6 of this BDAR.
General (10)(b)	• A statement whether any relevant impacts are likely to be unknown, unpredictable, or irreversible.	Section 6, 7 and 8 of this BDAR.
General (10)(c)	• Analysis of the significance of relevant impacts.	Section 6 of this BDAR.
General (10)(d)	• Any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	To be provided.
General (11)(a)	For each of the relevant matters protected that are likely to be significantly impacted by the action, the EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action including: • A description and an assessment of the expected or predicted effectiveness.	Section 6, 7 and 8 of this BDAR.
General (11)(b)	• Any statutory policy basis for the mitigation measures.	Section 6, 7 and 8 of this BDAR.
General (11)(c)	• The cost of the mitigation measures.	Detailed costs to be prepared as part of future design phases.
General (11)(d)	• An outline of an environmental management plan that sets out the framework for continuing management, mitigation, and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing.	Section 6, 7 and 8 of this BDAR.
General (11)(e)	• The name of the agency responsible for endorsing or approving each mitigation measures or monitoring program.	NSW DPIE and DAWE.

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DAWE requirement	Assessment requirements	How addressed
General (12)	Where a significant residual adverse impact to a relevant protected matter is considered likely, the EIS must provide information on the proposed offset strategy, including discussion of the conservation benefit associated with the proposed offset strategy.	Section 9 of this BDAR. Offsets to be delivered under the NSW BOS.
General (13)	For each of the relevant matters likely to be impacted by the action, the EIS must provide reference to and consideration of, relevant Commonwealth guidelines and policy statements including any: • Conservation advice or recovery plan for the species or community. • Relevant threat abatement plan for a process that threatens the species or community. • Wildlife conservation plan for the species. • Any strategic assessment.	Section 6 of this BDAR.
Key Issues – Biodiversity (1)	The EIS must identify each EPBC Act listed threatened species and community and migratory species likely to be impacted by the action. For any species and communities that are likely to be impacted, the Proponent must provide a description of the nature, quantum, and consequences of the impacts. For species and communities potentially located in the project area or in the vicinity that are not likely to be impacted, provide evidence why they are not likely to be impacted.	Section 5 and 6 of this BDAR.
Key Issues – Biodiversity (2)(a)	For each of the EPBC Act listed threatened species and communities and migratory species likely to be impacted by the action, the EIS must provide a separate: • Description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations and habitat critical for survival), with consideration of and reference to any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans.	Section 5 and 6 of this BDAR.
Key Issues – Biodiversity (2)(b)	• Details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements.	Section 5 and 6 of this BDAR.
Key Issues – Biodiversity (2)(c)	• Description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action.	Section 7 of this BDAR
Key Issues – Biodiversity (2)(d)	• Identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are considered.	Section 6 of this BDAR.
Key Issues – Biodiversity (2)(e)	• Description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established.	Section 9 of this BDAR.
Key Issues – Biodiversity (2)(f)	• Details of how the current published NSW Biodiversity Assessment Methodology has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts.	Section 4, 5, 6 and 7 of this BDAR.

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DAWE requirement	Assessment requirements	How addressed
Key Issues – Biodiversity (2)(g)	• Details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the NSW biodiversity Assessment Methodology and/ or mapping and descriptions of the extent and condition of the relevant habitat and/ or threatened communities occur on proposed offset sites. [Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action and deliver an overall conservation outcome that improves or maintains the viability of the MNES i.e. 'like for like'. Like-for-like includes protection of native vegetation that is the same ecological community or habitat being impacted (preferably in the same region where the impact occurs), or funding to provide a direct benefit to the matter being impacted e.g. threat abatement, breeding and propagation programs or other relevant conservation measures.]	Section 9 of this BDAR.
Key Issues – Biodiversity (2)(h)	• Any significant residual impacts not addressed by the NSW Biodiversity Assessment Methodology may need to be addressed in accordance with the EPBC Act Environmental Offsets Policy.	Section 9 of this BDAR.

The following table summarises key submission issues raised by agencies and organisations and where they have been addressed in the amended BDAR.

Table 9 Biodiversity-related submission comments

Issue raised	Project response
BCS (Biodiversity, Conservation and Science Directorate	
Given the nature of the project, the Proponent may wish to stage construction.	• Section 1.6 of the Updated BDAR provides a description of the proposed project staging.
Not all components of the BAM assessment were included in the BDAR. The BDAR should be updated to fulfil the requirements of the BAM as described in Appendix L of the BAM.	• Section 1.9 includes an update to report structure and overall BAM assessment.
The field data sheets should be provided as an appendix to the BDAR for a more complete BAM assessment.	• Appendix H includes the field data hat was collected electronically.
The method used to determine non-native vegetation must be clearly articulated. Justification for areas of non-native vegetation must be clearly provided in the BDAR. The selection of PCTs has not been adequately justified. Justification should be provided in the BDAR for the selection of all PCTs. All vegetation zones must be clearly mapped. Inclusion of vegetation plots located outside the project footprint must be justified. Where vegetation plots are not located in the project footprint, justification must be	• Section 4.1.3 provides criteria used to assign PCTs, vegetation condition class, and determination of non-native vegetation. • PCT justification, based on plot data, descriptions and photographs are provided in Appendix B. • Section 4.1.4 provides information about the existing and additional 24 BAM plots and justification for existing plots being located outside of Development Footprint (but within representative vegetation zones). Plot data was interrogated and used to justify PCT selection.

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Issue raised	Project response
provided, including evidence that the plot is in the correct PCT and vegetation zone, and that the plot data are consistent with other plot data collected in that vegetation zone.	• Figure 7 provides vegetation zone mapping. • Section 4.2 Vegetation Communities has been updated.
Permanent and temporary impacts for each vegetation category should be presented. A table should be created that states the permanent and temporary impacts for each vegetation category: exotic grassland, planted vegetation, cleared land and each PCT to clearly reconcile impacts across the development footprint.	• Table 25 summarises the PCTs, vegetation zones, extent, integrity score, and associated TECs for the total combined development footprint. This data has been used to reassess the project's overall impacts. • Table 10 provides a summary of permanent and temporary impacts of the project.
Ecosystem species have been included in discussions regarding species credit species. Table 21 of the BDAR should contain only species credit species.	• Table has been updated.
Inconsistencies exist between the field data and the data in the BAM calculator. Ensure that all data entered in the BAM-C is consistent with the field data.	• The BAM Calculator has been revised and submitted with this updated BDAR.
Serious and Irreversible Impacts (SAII) have not been addressed. A standalone section addressing serious and irreversible impacts as required by sections 9.1.2 and 9.1.3 of the BAM for all listed entities known or likely to occur in the assessment area is required.	• Section 8.6 has been updated and provides a summary of the detailed assessment. Appendix E provides detailed SAII assessments.
The potential impact to fauna relating to turbine placement has not been adequately addressed. The potential impacts of turbine spacing should be addressed as prescribed impacts.	• Section 8.3.2, 8.3.3 and 8.5 have been updated to include a qualitative risk assessment of turbine strike and to address impacts prescribed by the BAM.
Prescribed impacts relating to wind farms have not been adequately addressed: • Further assessment of the potential for blade strike on fauna, particularly microbats, is required. • Proposed mitigation measures for prescribed impacts such as blade strike and barotrauma should be presented in the BDAR. • Options to compensate for unavoidable prescribed impacts, and the decision pathway and justification for suggested credit numbers or other compensatory actions, should be clearly documented in the BDAR.	• Section 8.3.2 and Section 8.3.3 have been updated to include a qualitative risk assessment of turbine bird and bat strike. • Section 8.5 has been included to assess prescribed impacts. • Section 8.9 describes mitigation measures for prescribed and indirect fauna impacts. • Local offset feasibly has been assessed through in a biodiversity offset strategy including a combination of field surveys and desktop analysis or target properties. Information on the estimated available local credits is provided in Section 9.1.2. This is expected to provide further options to compensate for unavoidable impacts.
Direct impacts on cave bat roosts needs to be clarified. Justification is required for the placement of turbines within cave bat roosting habitat buffers.	• The project will not result in any direct impacts to cave bat roosts, nor will any project infrastructure occur within cave bat roosting habitat buffers, based on both field assessment and design revisions. • Section 5.4.2 includes the detailed findings of additional desktop assessment, ground-truthing surveys, and geomorphological assessment of

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Issue raised	Project response
	potential microbat roots surrounding the development footprint. • Figure 15 provides the updated mapped microbat roosting habitat areas. • Appendix E provides details associated with assessments undertaken in accordance with serious and irreversible impact assessment, providing further assessment of impacts to cave roosting bats. • Section 8.5 provides an assessment of the prescribed impacts of the project to bats. • Appendix F includes advice regarding the presence of geological features of significance within the assessment area and in the broader landscape. Section 3.1.6 summarises this information.
Indirect impacts on microbats have not been adequately addressed. Further study to determine the size, extent and nature of the local bat population is required.	• Section 5.4.2 includes updated additional assessment of the microbat local microbat population. • Section 8.3.1 includes a qualitative risk assessment for indirect impacts to the local microbat population. • Section 8.5 has been included to assess prescribed impacts, many of which are indirect impacts to microbats. • Section 8.9 describes mitigation measures for prescribed and indirect fauna impacts. Appendix E provides details associated with assessments undertaken in accordance with serious and irreversible impact assessment, providing further assessment of impacts to cave roosting bats.
Additional assessment of a locally important population of the greater glider is required. Further justification should be provided as to why the local population of the greater glider is not considered an important population.	• Section 8.8.5 and Table 80 includes an updated EPBC Act significant impact assessment for Greater Glider and provides evidence population does not constitute an important population.
The surveys completed for large forest owls are inadequate. Either additional surveys for large forest owls (equating to that required for a 90 percent probability of detection) be conducted, or an expert report be obtained, to confirm the presence or absence of large forest owls.	• Out of abundant caution, Large forest owls (Barking Owl, Powerful owl, Sooty owl and Masked owl) have been assumed to be present (even though none have been identified in the extensive surveys completed to date) because further survey was not able to be completed. • The approach to mapping breeding habitat species credit polygons is provided in Section 5.5. • Figure 21 provides updated habitat mapping. • Table 65 provides a qualitative risk assessment for potential blade strike to birds including assessed owl species. • It should be noted that WP31 previously intersected with what has now been modelled to be owl breeding habitat, and was subsequently removed from the design.

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Issue raised	Project response
NPWS	
In response to Appendix D, p. 3 | 1.5 km buffer around footprint includes a significant portion of both BHGNR and CPNP, yet very few survey points were undertaken within this buffer, and only 100 metres into BHGNR. NPWS recommends a robust survey be conducted within the 1.5 km buffer.	• The 1.5 km buffer exists only for assessment of landscape context and connectivity around the development footprint. It is a standard requirement of the BAM, and only requires desktop analysis and mapping of specific landscape features. There is no requirement to undertake detailed survey within the 1.5 km buffer under the BAM. • Ecological surveys were carried out within the subject land development footprint and within a 100-metre buffer along the project boundary with Ben Halls Gap Nature Refuge. • The abbreviations, glossary and Section 1.5 have been updated to clarify where field surveys were undertaken and the scope of the desktop searches required within the landscape assessment buffer.
In response to Appendix D, p. 73-74 | Weather conditions at Quirindi Post Office were used. Murrurundi Gap weather conditions are closer to those experienced in the higher parts of the survey area. The difference in temperature between Quirindi and higher elevations should be noted. Sub-zero temperatures are regularly experienced during winter. Why wasn't data from the Meteorological Masts located at the site used? NPWS recommends a more accurate assessment of weather conditions be conducted at higher elevations during the survey.	• Section 4.1.2 has been updated to include climate details at Murrurundi GAP AWS.
In response to Appendix D, Table 21 | Booroolong Frog – known from Barnard River in BHGNP, Wombramurra Creek (close to CPNP) and a tributary to the Isis River in CPNP. NPWS recommends sediment controls to be in place close to origin of potential sediment to prevent soil movement in the landscape and impacting on streams.	• Section 8.8.6 provides a detailed assessment of Booroolong Frog habitat and impacts in accordance with the EPBC Act requirements. • The Proponent will implement an Erosion and Sediment Control Plan in the Construction Environmental Management Plan. This will include identification of sensitive receivers, such as waterways and adjacent protected areas, with measures provided in Table 82 in Section 8.9 of this BDAR. • Significant impacts to EPBC listed Booroolong Frog have been avoided with project design amendments reducing impact to the Booroolong Frog habitat from 1.59ha to 0.64ha.
In response to Appendix D | Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest EEC occurs adjacent to the proposed project. It is vulnerable to sediment entering the streams due to soil disturbance in track construction. This was identified as an issue in meetings with the Proponent and has not been addressed in the BDAR. NPWS recommends incorporating Ben Halls Gap Sphagnum Moss Cool Temperate Rainforest	• Section 4.3 of the Updated BDAR makes reference to the location of the Sphagnum Moss TEC in the adjacent Ben Halls Gap Nature Refuge, however the location of this TEC is not mapped on Figure 9 to protect its location. • Table 82 in Section 8.9 of the Updated BDAR has also been amended to make reference to management of stormwater and runoff on the Sphagnum Moss TEC.

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Issue raised	Project response
EEC in the BDAR assessment, with appropriate mitigating measures.	• An updated assessment of site gradients and risk to this community is updated in the Soil and Water report including project commitments to avoid impact in the EIS (Someva 2021)
Appendix D 5.3.2 | Refers to survey locations being shown on Figure 9. Figure 9 is not included in the document. Supply Figure 9.	• Figure 12 (previously Figure 9) includes all fauna survey locations.
Appendix D | The ridgeline (watershed) is shown in the wrong place. This means O&C and a number of WTGs SW of park drain into park, intersects with headwaters of Brayshaws Creek and Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest EEC. Based on this information, there is potential for sedimentation to impact on these creek lines. With correct information, the project area impacts on the Brayshaws Creek catchment, as discussed with the Proponent prior to release of the EIS. Correct the map and develop mitigating measures to prevent sediment impacting Brayshaws Creek and Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest EEC.	• The ridgeline shown on the site maps and the location maps has not been drawn to represent the boundary of the watershed, rather it shows indicative fauna movement corridors across the ridgeline. The BAM requires fauna corridors to be identified and mapped by the accredited assessor.
Appendix D | Site maps reference DPIE, 2020. This is not included in reference list.	• This reference has been included in the reference list of the Updated BDAR to make reference to the DPIE (2020) Biodiversity Values Map.
Hills of Gold Preservation Inc (HOGPI)	
List significant species in, and protection measures required for Ben Halls Gap Nature Reserve and Crawney Pass National Park. Take into consideration TEC including Ben Halls Gap National Park Sphagnum Moss Cool Temperate Rainforest located adjacent to the project area.	• Section 4.3 of the Updated BDAR makes reference to the location of the Sphagnum Moss TEC in the adjacent Ben Halls Gap Nature Refuge, however the location of this TEC is not mapped on Figure 9 to protect its location. • Table 82 in Section 8.9 of the Updated BDAR has also been amended to make reference to management of stormwater and runoff on the Sphagnum Moss TEC.
Assess and mitigate the cluttering effect on bird and bat strike of the southern cluster of turbines forming three fingers in an overlapping barrier of 27 turbines, placed unusually close together.	• This has been addressed in the updated Section 8.3 and specifically within Table 71.
State the duration of the five field studies in November 2018, August 2019, November 2019, February 2020, and August 2020.	• Section 4.1 details the vegetation and flora survey effort and duration • Section 5.3 details the threatened fauna survey effort and duration.
Provide a more in-depth study of the north eastern section of the wind farm project area. Local knowledge suggests Threatened Fragrant Pepperbush (*Tasmannia glaucifolia*) is extensive between	• Table 33 provides survey efforts for the Fragrant Pepperbush. • It is assessed and acknowledged that the species occurs within eucalypt forest within PCT 934, 931 and

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Issue raised	Project response
the northern project area and Morrisons Gap Road and could potentially be impacted by roadside clearing to enable access.	927. However, no individuals or populations were recorded within the development footprint during field surveys. • Preconstruction surveys will be undertaken to determine whether this is present on any modified final development footprint.
Conduct a thorough search for *Eucalyptus oresbia*, listed as vulnerable in NSW, which has been observed neighbouring the proposed project area, and can sometimes look like Mountain Gum.	• Habitat suitability within subject land for *Eucalyptus oresbia* was assessed. It was concluded that the development footprint is not suitable to support this species due to the lack of 'very steep valleys and deeply incised creek lines with primarily south to southwest exposure' (NSW BioNet, DPIE 2021). Due to this habitat limitation, the species was excluded from assessment under the BAM. • Notwithstanding the habitat suitability constraints, the survey effort employed would have detected *Eucalyptus oresbia*.
The impact on biodiversity and the effect of those impacts on the Peel River (and Chaffey Dam) and the Barnard River and Pages Creek and catchments.	• Section 3.1.3 describes the reduced impact to waterway crossings that has resulted from the project design changes described.
Concerns about the intent to clear some 487 hectares of vegetation – native and introduced – as well as direct and indirect impacts on the nearby Timor Caves and other geological features and also bats which roost in, and in forest around, the caves which they forage in the area proposed for the wind farm. The proximity to caves means clearing and erosion will be part of the impact in the hydrological process associated with caves and karst let alone the loss of flora for all animals and the insects which are the food source of microbats whether they be forest dependant or cave dependant species.	• The project has reduced the impact to vegetation by 39% in this revised design and updated BDAR. This includes a reduction of 42% to high condition native vegetation. A total of 74 ha of native vegetation has been assessed as avoided in this updated layout and BDAR. There is now 132.43 ha of proposed impact to native vegetation, mostly in low to moderate condition. • Section 7 provides detail on the assessment and design process that was included to avoid and minimise impacts on biodiversity, including measures to reduce and avoid all direct impacts on cave bat roosts. • The project will not result in any direct impacts to cave bat roosts and indirect impacts have been minimised through turbine relocation and removal. • Section 5.4.2 includes the detailed findings of additional desktop assessment, ground-truthing surveys, and geomorphological assessment of potential microbat roots surrounding the development footprint. • Sections 5.4.2 and 5.5 includes the updated maps illustrating microbat habitat throughout the project area. • Section 8.3.1 provides a qualitative risk assessment for bat species. • Section 8.5 provides an assessment of the prescribed impacts of the project to bats. • Appendix E provides details associated with assessments undertaken in accordance with serious

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Issue raised	Project response
	and irreversible impact assessment, providing further assessment of impacts to cave roosting bats. • Appendix F includes advice regarding the presence of geological features of significance within the assessment area and in the broader landscape. Section 3.1.6 summarises this information. • Section 8.5 provide additional assessment of the indirect impacts associated with bat strike. • Impacts associated with blade strike will be managed by the preparation and implementation of a Bird and Bat Adaptive Management Plan (BBAMP). The plan will be prepared prior to operation of the wind farm and implemented over the life of the project.
Concern that the study undertaken to collect data on threatened species was only taken over a couple of short periods and is most likely considerably lacking in providing a holistic picture of species and their movements.	• Surveys were undertaken over a total of six separate seasonal survey events between spring 2018 to autumn 2021. This is considered a comprehensive survey effort and sufficient to capture seasonal variation in the biodiversity values present within the project area. • Table 32 provides the survey design employed and survey effort for each candidate species and demonstrates how survey effort is sufficient to meet the requirements of the BAM. Where survey effort was not sufficient and habitat for the species is present on the site, areas of habitat for these species has been mapped.
Tamworth Regional Council	
Lack of information in relation to Collision Risk for Bats and Birds. Appendix D contains data and modelling in relation to the collision risk for birds but does not include any modelling in relation to bats or nocturnal bird species such as owls. The report states that of the fifty-one (51) species of birds present in the development footprint, all of these have the capacity to fly at the same height as the turbine blades but only eighteen (18) bird species were recorded as doing so. The report goes on to state the risk of collision is estimated as being very low. The report includes little evidence to support this conclusion.	• Section 8.3.2 and Section 8.3.3 have been updated to include a qualitative risk assessment of turbine bird strike, including on the assumption that large owl species are present in the Project Area. • Section 8.5 has been included to assess prescribed impacts to bats. • Section 8.9 describes mitigation measures for prescribed and indirect fauna impacts. • Appendix E provides details associated with assessments undertaken in accordance with serious and irreversible impact assessment, providing further assessment of impacts to cave roosting bats.
Section 8.3 does address the potential impact of the wind turbines on threatened bat species within the development footprint and basically concludes that there is limited data on the heights that the bats will fly and forage. It states that the spacing between the turbines (ranging from 300m to 500m) will allow substantial locations for migrating and foraging bats to pass through the landscape. The report provides insufficient data/modelling to support this conclusion.	• Section 8.3 has been updated provide a more detailed assessment of the risk of bat species and each turbine. • Section 8.5 provides prescribed impacts to the bats. • Section 3.1.6 provides an updated area of geological significance for suitable habitat. • Section 8.9 describes mitigation measures for prescribed and indirect fauna impacts. • Appendix E provides details associated with assessments undertaken in accordance with serious

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Issue raised	Project response
	and irreversible impact assessment, providing further assessment of impacts to cave roosting bats.
Lack of information in relation to impact on fauna (particularly aerial fauna) located in the adjoining Ben's Hall Gap Nature Reserve (2,500 Ha) and Crawney National Park (310 hectare). It is strongly recommended that the indirect impacts from the wind turbines be examined within a 10 km buffer from the development footprint.	• Indirect impacts are assessed under chapter 8.3 including updates to chapter 8.3.2 Collision risk (birds). • The Collision Risk Modelling presented in the Updated BDAR and in Appendix D was supported by three seasons of field survey across the subject land.
Like the Biodiversity Offset Strategy, the BDAR states that a BBAMP will not be developed until after the wind farm is approved. It is strongly recommended that a BBAMP be submitted prior to final determination of the project.	• Section 8.10 provides more detail on the contents of a BBAMP including sections on the adaptive management recommendations and further project commitments. The final BBAMP will need to respond to the detailed design layout and operational requirements. • It is standard that a BBAMP is developed once detailed design of the project is further progressed following development consent being granted and prior to any turbines becoming operational.
Council officers have noted during site inspections, the presence of wombat holes across the development site. In this respect Council requires further expert information outlining the assessment of the impact of construction on these mammals and details of the proposed management, protection, and preservation of these mammals during the construction phase of the project.	• Table 82 in Section 8.9 of the Updated BDAR has been updated to make reference to wombat burrows and management as part of the Biodiversity Management Plan. • Section 8.10.1 provides details of occupation surveys for wombats as part of the measures outlined in the Biodiversity Management Plan. This includes: - Pre-clearing protocols, including pre-clearing inspections, establishment of exclusion zones and on-ground identification of specific habitat features to be retained and/ or relocated. - For example, occupation surveys for wombat burrows, application of exclusion measures/ deterrents prior to vegetation clearing/ earthworks, works undertaken in presence of spotter/ catcher.
Australasian Cave and Karst Management Association	
Concerns about the intent to clear some 487 hectares of vegetation – native and introduced – as well as direct and indirect impacts on the nearby Timor Caves and other geological features and also bats which roost in, and in forest around, the caves which they forage in the area proposed for the wind farm. The proximity to caves means clearing and erosion will be part of the impact in the hydrological process associated with caves and karst let alone the loss of flora for all animals and the insects which are the food source of microbats whether they be forest dependant or cave dependant species.	• Section 3.1.6 provides an updated area of geological significance for suitable habitat. • Section 7 provides detail on the assessment and design process that was included to avoid and minimise impacts on biodiversity, including measures to reduce and avoid all direct impacts on cave bat roosts. • Section 8.3 and Section 8.5 provide additional assessment of the indirect impacts associated with bird and bat strike. • Impacts associated with blade strike will be managed by the preparation and implementation of a Bird and Bat Adaptive Management Plan (BBAMP). The plan will be prepared prior to operation of the wind farm.

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Issue raised	Project response
Newcastle and Hunter Valley Speleological Society	
Concern that the study undertaken to collect data on threatened species was only taken over a couple of short periods and is most likely considerably lacking in providing a holistic picture of species and their movements.	• Surveys were undertaken over a total of six separate seasonal survey events between spring 2018 to autumn 2021. This is considered a comprehensive survey effort and sufficient to capture seasonal variation in the biodiversity values present within the project area. • Table 32 provides the survey design employed and survey effort for each candidate species and demonstrates how survey effort is sufficient to meet the requirements of the BAM. Where survey effort was not sufficient and habitat for the species is present on the site, they were assumed to be present and areas of habitat mapped.
Impacts to threatened ecological communities and species with reference to white box-yellow box-Blakely's red gum grassy woodland, koala, large-eared pied and the spotted-tailed quoll.	• Threatened species and ecological communities with the potential to be impacted by the project have been surveyed, identified and mapped in accordance with the NSW BAM and EPBC Act requirements. • Section 8 of this BDAR presents a detailed impact assessment, quantifying direct impacts and describing potential indirect impacts.
Upper Peel Landcare Group, Yass Landcare Guardians and Timor Community	
Concerns about the land clearing needed for the project and the impact this will have on the biodiversity of the area.	• Threatened species and ecological communities with the potential to be impacted by the project have been surveyed, identified and mapped in accordance with the NSW BAM and EPBC Act requirements. • Section 8 of this BDAR presents a detailed impact assessment, quantifying direct impacts and describing potential indirect impacts. • The project has reduced direct clearing impacts by 39% from the exhibited EIS.

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1 Introduction

1.1 Project description

The Project involves the construction, operation and commissioning of a wind farm with up to 65 wind turbine generators (WTG), together with associated and ancillary infrastructure.

The Project consists of the following key permanent components:

- Up to 65 WTGs with a generating capacity of approximately 6MW. Each WTG has:
  - Three blades mounted to a rotor hub on a tubular steel tower, with a combined height of blade and tower limited to a maximum tip height of 230m AGL.
  - A gearbox and generator assembly housed in a nacelle.
  - Adjacent hardstands for use as crane pads and assembly and laydown areas.
- Decommissioning of three operational meteorological monitoring masts and the installation of up to five temporary and five permanent masts to monitor the power of the wind. Up to five of the 10 masts will be permanently installed near one of the WTGs. The other five will be temporarily installed at the location of one of the WTGs and removed after initial testing. All 10 masts will be approximately 150 metres tall; equivalent to the hub height of the installed WTGs. The exact number and location of the 10 masts will be confirmed during detailed design.
- A 330 kilovolt (kV) electrical substation located centrally within the project site. The substation will include transformers, insulators, switchyard, and other ancillary equipment.
- An operations and maintenance facility.
- A battery energy storage system of 100 to 400Mwh.
- Aboveground and underground 33kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substation (following site access tracks where practicable).
- A 330kV high-voltage overhead transmission line to connect the onsite substation to the existing 330kV TransGrid Liddell to Tamworth overhead transmission line network. The connection point will be approximately 21 km west of the substation.
- A switching station to connect the Project to the 330kV TransGrid Liddell to Tamworth line.
- An internal private access road network (up to a combined total length of approximately 40 km) connecting the WTGs and other Project infrastructure to the public road network.
- Upgrades to local roads and waterway crossings, as required for the delivery, installation and maintenance of WTG components and other associated materials and structures.

The following temporary elements will be required during construction of the Project:

- Temporary site buildings and facilities for construction contractors / equipment, including site offices, car parking and amenities for the construction workforce.
- Two temporary concrete batching plants to supply concrete for WTG footings and substation construction works.
- Earthworks, including cut and fill, for constructing access roads, WTG platforms and foundations.

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- Potentially rock crushing facilities for the generation of suitable aggregates for concrete batching or sized rock for access road and hardstand construction.
- Up to eight additional hardstand laydown areas for the temporary storage of construction materials, plant, and equipment construction.

The indicative Project layout for the wind farm infrastructure, including the WTGs, internal access roads and supporting infrastructure are shown in Figure 2 and the biodiversity impacts have been assessed based on this development footprint. In order to facilitate refinement of the layout during the detailed design process, an allowance for micrositing of WTGs and infrastructure within the subject land from the locations identified in the RTS and Amendment Report is proposed, while all other infrastructure may be relocated within the subject land and subject to a modification. Figure 2 shows the layout of all components, and ovides more detail on the wind farm and internal roads layout, as well as the transmission line corridor and construction access tracks.

In addition to the wind farm infrastructure, the Project will require minor upgrades to the highway and local road network to facilitate haulage of the turbine components from Port of Newcastle to the subject land (Figure 3). Some of these works will require modifications to the curve radii of intersections that will involve clearing of vegetation. Where clearing of vegetation is required, these areas along the haul route have also been subject to assessment in this BDAR and form part of the development footprint. This assessment included fieldwork to verify vegetation communities and habitat condition for suitability to support threatened species.

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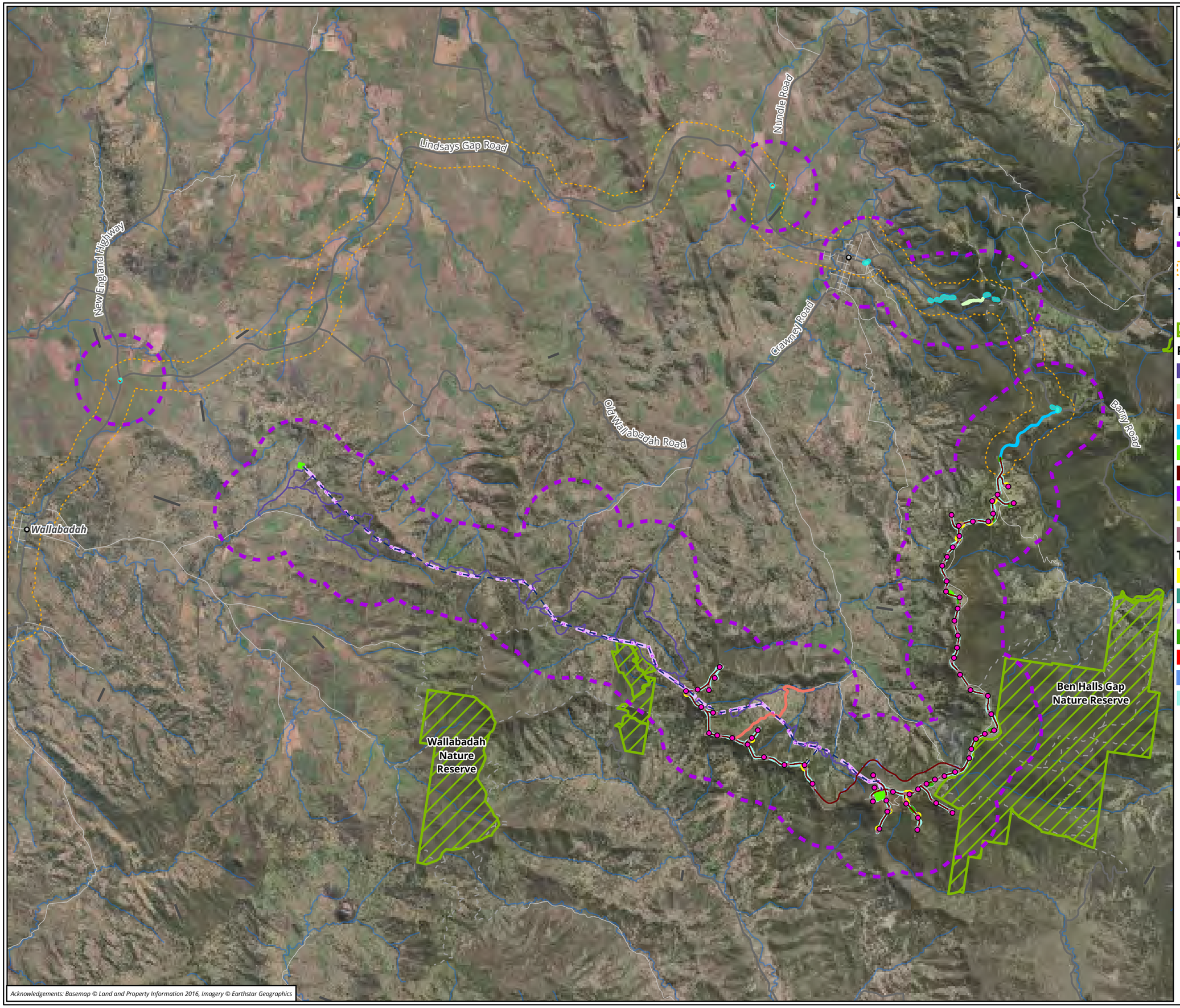

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Legend

- Landscape assessment buffer (study area)
- Transport haul routes
- Transmission line
- Wind turbine locations
- NPWS reserve

Permanent infrastructure

- Access tracks
- Devil's elbow
- Logging track, fire track
- Morrison's gap road
- Ancillary infrastructure
- Roads
- Transmission line structures
- Transport hardstand
- Turbine hardstands

Temporary infrastructure

- Blade laydowns
- T65 WTG Coordinates 35m buffer
- AECOM clearance
- Ancillary infrastructure
- Transport swept path
- Transverse cut fill extents
- Temporary construction footprint

Figure 2 Wind farm and transmission line infrastructure project overview, Page 1

0 1,000 2,000 3,000 4,000

Meters

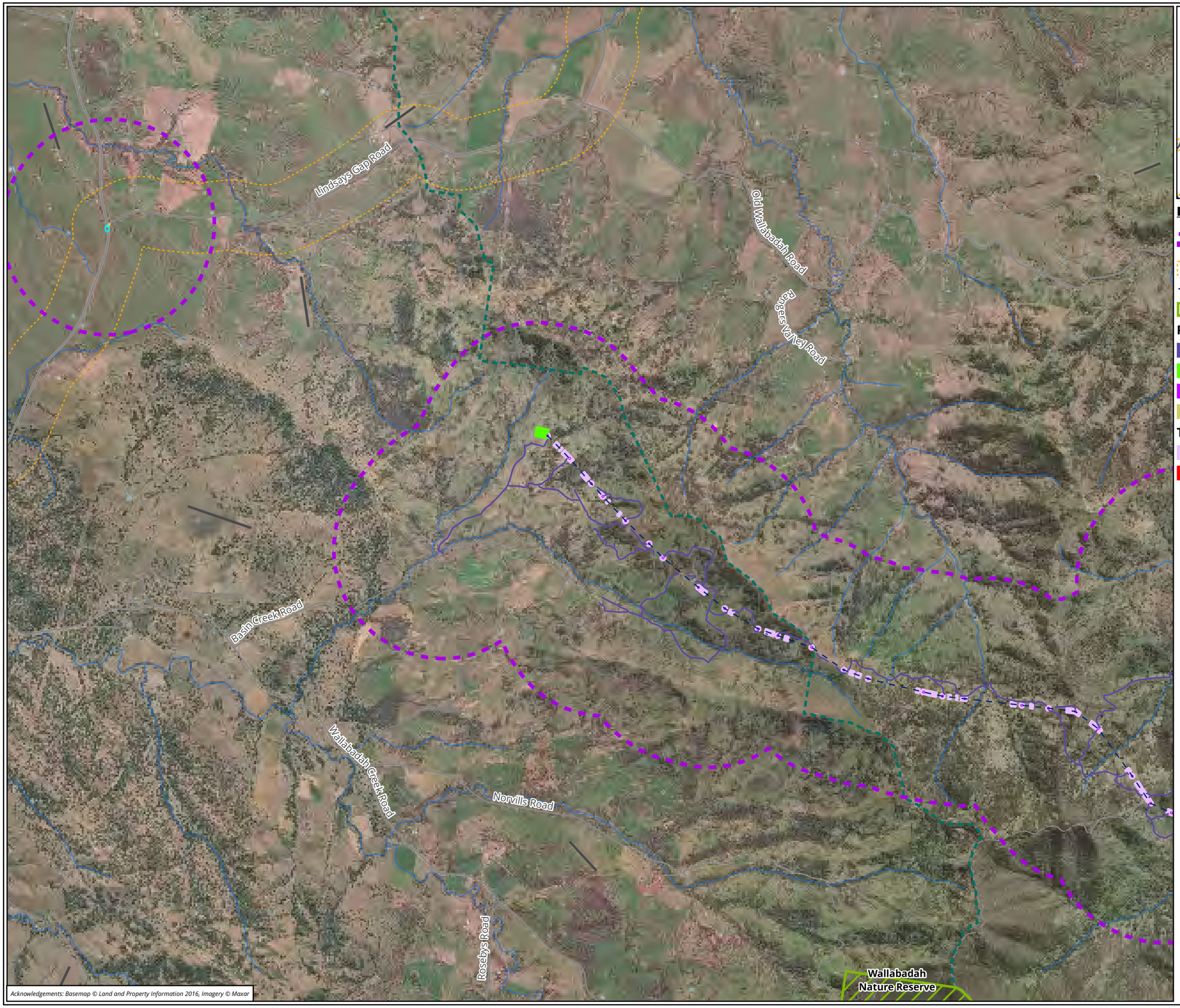
Scale: 1:120,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F2_Overview
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx



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Legend

- Landscape assessment buffer (study area)
- Transport haul routes
- Transmission line
- NPWS reserve

Permanent infrastructure

- Access tracks
- Ancillary infrastructure
- Transmission line structures
- Transport hardstand

Temporary infrastructure

- AECOM clearance
- Transport swept path

Figure 2 Wind farm and transmission line infrastructure project overview, Page 2

0 500 1,000 1,500 2,000

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F2_Overview
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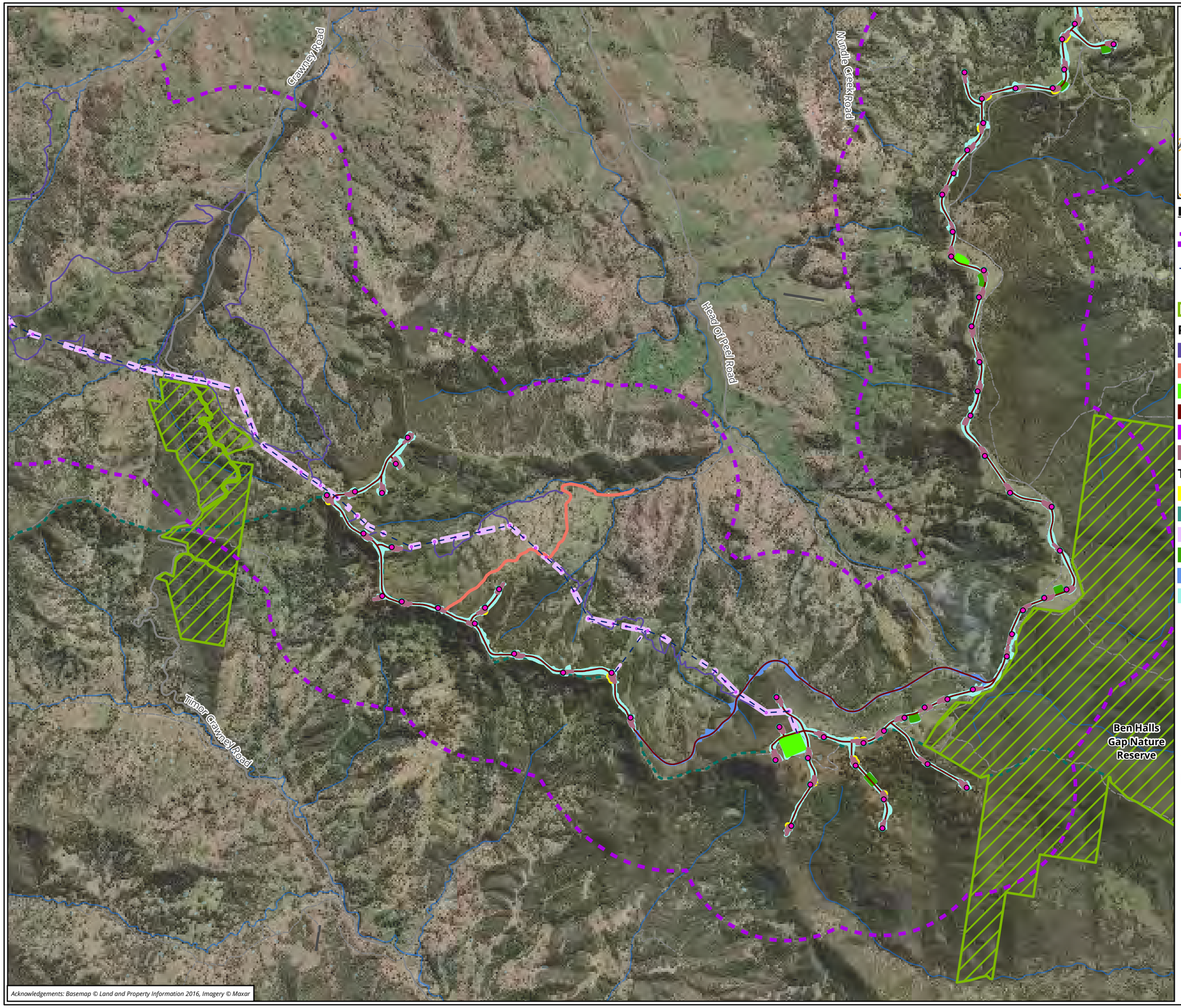

Legend

- Landscape assessment buffer (study area)
- Transmission line
- Wind turbine locations
- NPWS reserve

Permanent infrastructure

- Access tracks
- Logging track, fire track
- Ancillary infrastructure
- Roads
- Transmission line structures
- Turbine hardstands

Temporary infrastructure

- Blade laydowns
- T65 WTG Coordinates 35m buffer
- AECOM clearance
- Ancillary infrastructure
- Transverse cut fill extents
- Temporary construction footprint

Figure 2 Wind farm and transmission line infrastructure project overview, Page 3

0 500 1,000 1,500 2,000

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F2_Overview
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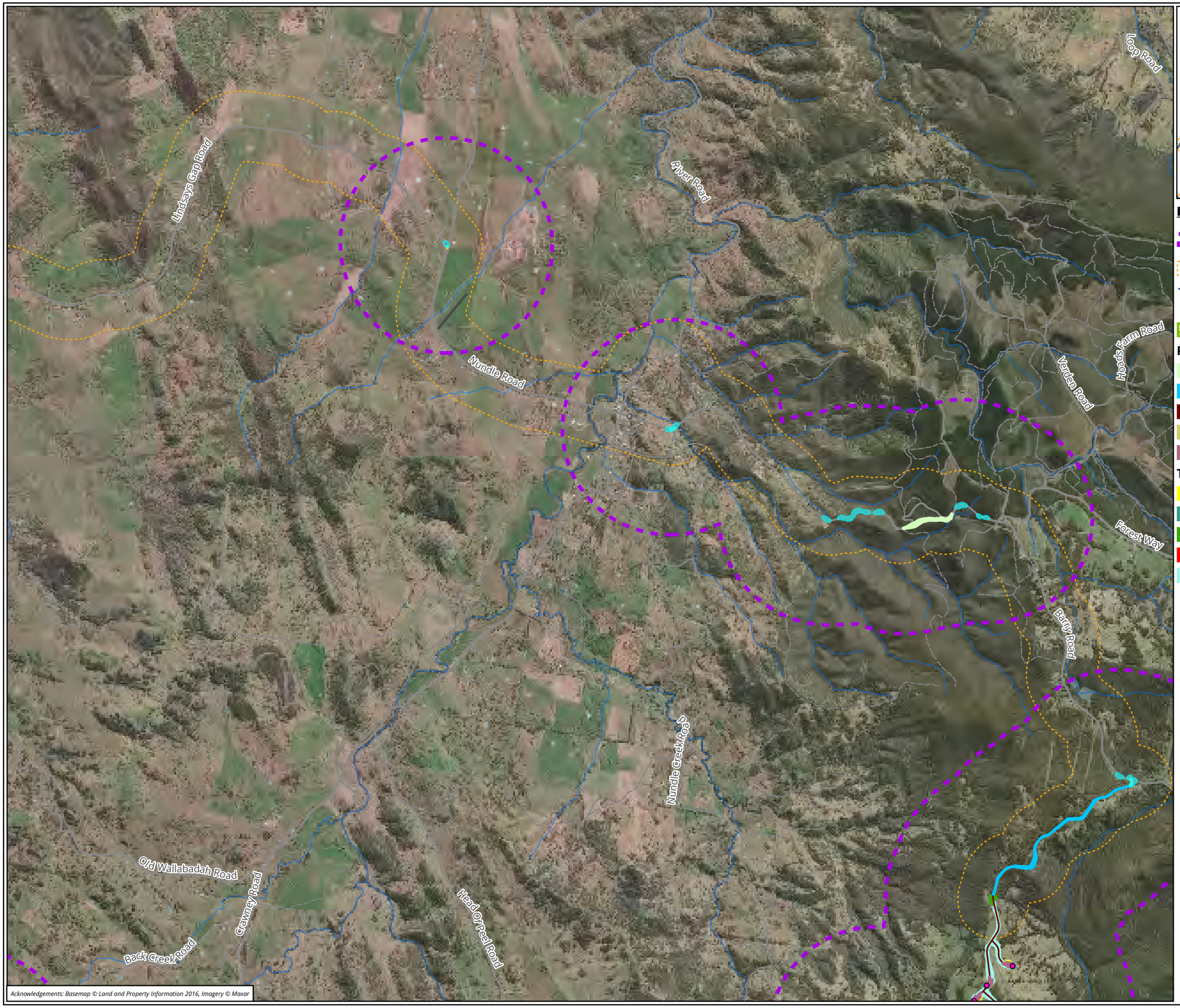

Figure 2 Wind farm and transmission line infrastructure project overview, Page 4

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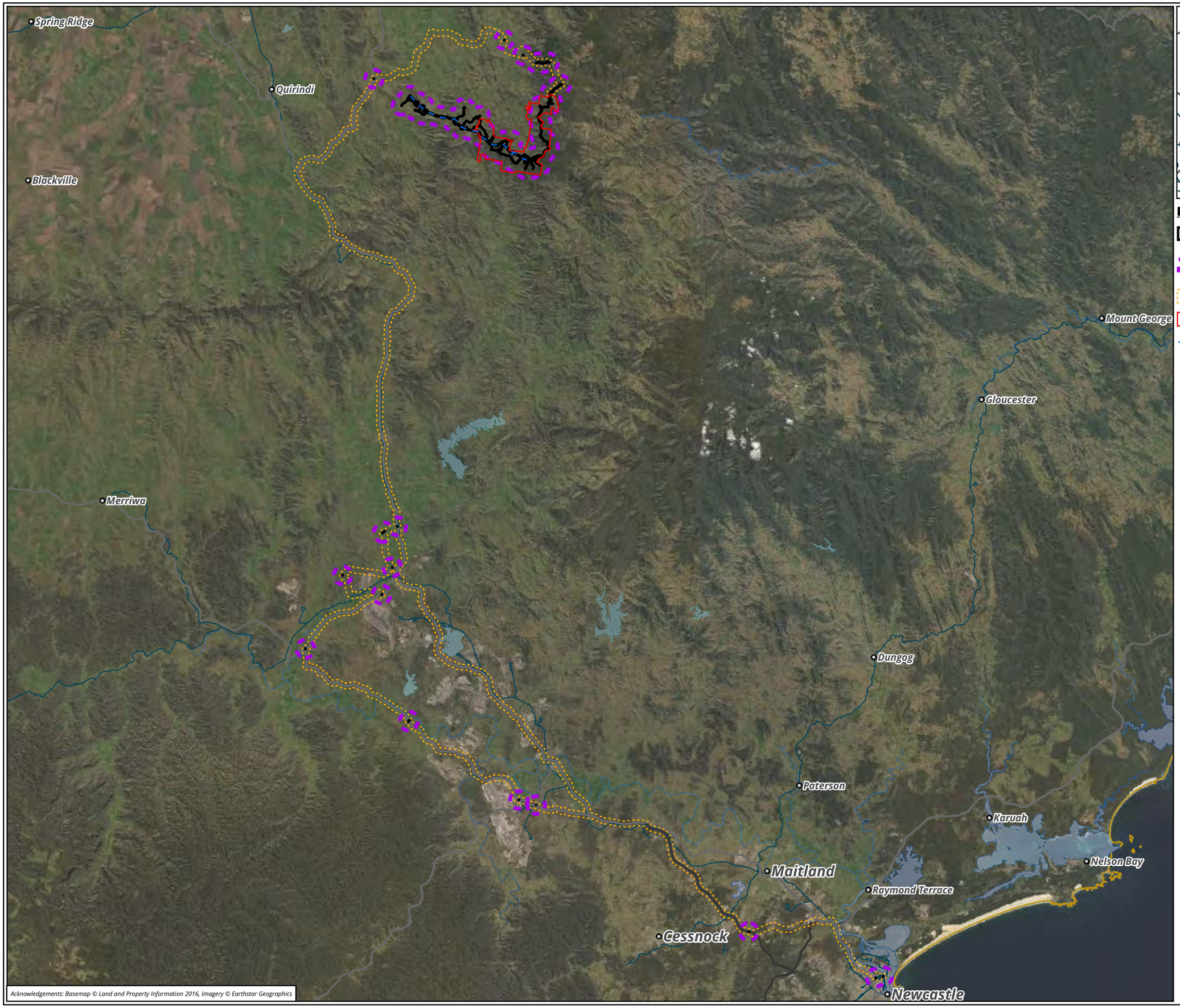
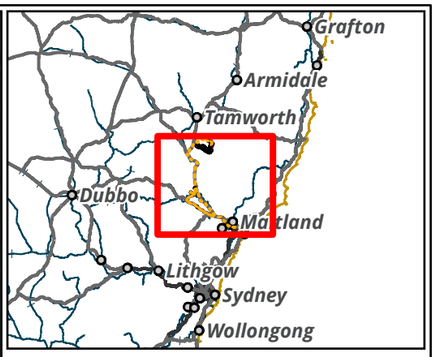
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F2_Overview
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx





Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Transport haul routes
- Wind farm site boundary
- Transmission line

Figure 3 Haul route project overview

0 6,000 12,000 18,000 24,000

Meters

Scale: 1:600,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F3_HaulRouteOverview
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

1.2 Project location

The Project is located approximately 4km south of Hanging Rock, 8km south east of the Nundle and 60km south east of Tamworth, within the Tamworth Regional Local Government Area (LGA), Upper Hunter Shire LGA and Liverpool Plains LGA. The eastern boundary of the site is adjacent to Ben Halls Gap Nature Reserve. Crawney Pass National Park is situated to the west of the project.

The development footprint predominately supports agricultural land on flatter topographies that are dominated by exotic grasslands created as part of cattle grazing activities. There is a higher percentage of overstorey native vegetation within steeper terrain and situated adjacent to the development footprint associated with the wind farm infrastructure. The development footprint is primarily classified as primary production land zone and lies adjacent to forestry, National Parks and Nature Reserves zones.

1.3 Development corridor

During early planning phases of the project, a wind farm development corridor was designated, based on property boundaries and a broader area of investigation for the placement of wind farm infrastructure and location of access routes. This development corridor should also be considered the 'subject land', as defined by the BAM, and has undergone ground-validated assessment as described in the following chapters of this BDAR.

Preliminary ecological surveys were completed across the subject land in 2019, with a vegetation zone and habitat constraints map prepared to inform layout decisions. Fieldwork was also carried out over the broader area referred to as the development corridor, however much of the focus on the BAM assessment refer to the direct and indirect impacts associated with the development footprint.

1.4 Development footprint

For the purpose of assessing impacts to biodiversity, a single development footprint has been assessed covering the five project elements that comprise the overall project infrastructure described in Section 1.5.1 and Table 10. This development footprint has been prepared based on the current design developed to date to understand the maximum impacts associated with the construction and operation of the Project.

The proposed design is advanced, however it still remains indicative and subject to further detailed design which will occur in tandem with construction contracting requirements and further detailed geotechnical investigations and the selection of the final wind turbine model. The development footprint design has been significantly updated since that exhibited with the EIS so as to materially reduce the biodiversity impacts of the Project.

In order to continue to reduce impacts to the assessed worst case in this BDAR, the Proponent will continue to refine the layout during the detailed design process in order to achieve reduced biodiversity impacts. The Proponent commits to undertaking pre-clearing surveys and micro-siting of wind turbines and ancillary infrastructure during the detailed design stage of the project to further avoid impacts to any previously unrecorded threatened species and ecologically sensitive areas, as far as practicable.

To permit this allowance, micrositing of infrastructure within the subject land from the locations identified in the Amendment Report is sought. Micrositing in areas outside of the subject land may require additional survey. Other project infrastructure components may also be relocated within the subject land, subject to ensuring that change in location does not result in greater impacts than assessed in this BDAR and complies with all conditions imposed on any development consent granted for the Project.

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Modifications would be sought only to re-determine associated residual impacts and credit liabilities if micrositing results in increased impacts and associated credit requirement. Reduction in impacts would not require a modification, however an addendum to the BDAR outlining the re-assessment of impacts and credit liabilities would be required, if a reduction in credit requirements is sought.

Final layout documentation will be prepared and submitted to DPIE prior to commencement of construction along with updated vegetation integrity surveys and required BAM plots to confirm biodiversity impact is no greater than this assessment.

1.5 Assessment Area

The assessment area for this BDAR includes the development footprint, as defined in Section 1.4 and Section 1.5.1, as well as a 1,500m buffer for the landscape assessment (Figure 2 and Figure 3). This buffer has been applied in accordance with Section 3.1 of the BAM, which requires landscape attributes to be assessed for a 1,500m buffer around the development footprint.

Detailed field surveys were carried out within the subject land and development footprint, as defined below, and desktop information was used to assess landscape attributes within the 1,500m buffer area.

1.5.1 Project infrastructure

Lands within the development footprint will be subject to direct impacts as a result of the project. This includes the permanent and temporary elements outlined in Table 10, and includes:

1. Wind turbine infrastructure, consisting of wind turbine generators and hardstands for construction.
2. Ancillary infrastructure including operations and maintenance buildings, substation, battery energy storage system, switching station and parking/storage/laydown areas.
3. Internal roads connecting wind farm infrastructure.
4. Internal and External transmission line and switching station.
5. Transmission line access tracks.
6. Transport haul route from Port of Newcastle to the wind farm site.

Concept design work was completed to confirm a conservative maximum development footprint to be assessed in this BDAR. The concept design was developed by the project team, which included wind farm designers and civil designers, with input from ecologists and other specialists to minimise impacts as much as practicable.

The concept design has also considered temporary construction phase impacts associated with ancillary sites, access routes, hardstand and laydown areas, storage, stockpile and site office facilities. This development footprint is considered to be a maximum footprint based on the current level of concept design, with refinements and reductions expected during detailed design.

The development footprint for the assessment of biodiversity impacts has also considered a network of access tracks for the construction of the transmission line. As much as possible these tracks have been mapped using the existing farm track network to minimise impacts to areas of native vegetation. A 10m corridor on each of these tracks has been included in the development footprint to capture any potential vegetation clearing required to use these tracks. The intent of including these areas in the biodiversity impact assessment is to understand the potential maximum development footprint that will be subject to assessment under the BAM.

The majority of the impacted areas associated with the transport route upgrades are required to enable the over mass and oversize construction vehicles required to transport Project components are also included in Table 10. The majority of these areas are developed or modified areas that are not required to be assessed under the BAM. A detailed desktop assessment of all works areas along the haul route was carried out to

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identify areas that contain biodiversity features and required field survey to identify vegetation communities, condition and habitat suitability for threatened species (Appendix A).

From the desktop assessment, a total of 25 sites along the haul route were confirmed to have biodiversity values that required assessment under the BAM. These areas were included in the development footprint and ecological fieldwork was carried out to confirm Plant Community Type (PCT) and habitat value for threatened fauna.

Table 10 Wind farm infrastructure project elements for biodiversity assessment

Project Component		Permanent (ha)	Temporary (ha)	Total (ha)
Wind Farm (WF)	WTGs including crane pad assembly areas and asset protection zones	40.67	6.52	47.19
	Internal access roads [3,4]	19.13	29.27	48.41
	Ancillary infrastructure including: • Operations and maintenance building • Substation • BESS • Temporary facilities (Parking, storage, laydown areas and batching plants)	11.45	6.61	18.06
	Temporary construction footprint[5]	-	92.11	92.11
Total WF		**71.25**	**134.52**	**205.77**
Transmission Line (TL)	Transmission line [7]	0.15	63.82	63.97
	Transmission line access roads	21.10	-	21.10
Total TL		**21.16**	**63.82**	**85.08**
Transport Route (TR)	Transport route upgrades	7.73	1.47	9.20
Total TR		**7.73**	**1.47**	**9.20**
Total WF + TL + TR		**100.24**	**199.81**	**300.05**

[1] Estimated permanent footprint does not allow for rehabilitation. In areas where existing Permanent Disturbance from farm tracks are utilised for wind farm infrastructure, this will not contribute to Development Footprint calculations.
2 Temporary footprint areas are areas that will be rehabilitated after completion of construction.
[3] Internal access road calculation includes internal roads between hardstands, emergency access track from Head of the Peel Road to Project Area and transverse track.
[4] Calculation based on Turnbull Engineering designs assuming inclusion of cut/fill batters, 33kV cable runs, and drainage
[5] Underground 33kV electrical reticulation network will generally be located within the disturbance footprint of the access road network where possible, to the side of the trafficable pavement, unless design or construction optimisations do not allow this.
[6] Temporary areas to be rehabilitated include cut and fill batters (where possible), non-permanent roads, Asset Protection Zones (APZ), non-permanent ancillary infrastructure, and transmission line easement.
[7] 330kV transmission line is 24km of 60m easement and 33kV aboveground power line is 2.46km of 15m easement.
[8] It has been estimated that 90% of the 330kV easement can be rehabilitated using native grasses. Spans that would not impact the existing vegetation underneath were determined based on further design work and were not included as part of the project footprint.

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[9] Access tracks for the transmission line have been developed at a concept level only to provide for a worst-case scenario for biodiversity impacts. The concept alignment of these tracks has followed existing tracks as much as practicable.
[10] It is estimated that 50% of the transport route upgrades will be rehabilitated with native grass.

For all project elements, a maximum development footprint has been proposed for assessment in this BDAR and it is expected to be refined and reduced during detailed design phases.

The amendments to this updated BDAR to reduce impacts to the Development Footprint and associated biodiversity is summarised in Table 11. Details on each project element change is provided in Table 1.

Table 11 Total Development Footprint changes in this amendment

Project Component	BDAR Nov 2020 (ha)	Updated BDAR Sept 2021 (ha)	Change (ha)
Wind Farm (WF) including: • WTGs including crane pad assembly areas and asset protection zones. • Internal access roads. • Operations and maintenance building. • Substation. • BESS. • Temporary facilities (Parking, storage, laydown areas and batching plants). • Wind monitoring masts.	261	206	-55
Transmission Line (TL) including: • Transmission line. • Switching station. • Transmission line access roads.	196	85	-111
Transport route (TR) including: • Transport route upgrades.	56	9	-47
Total WF + TL + TR	**513**	**300**	**-213**

1.6 Project staging plan

The Project proposes to stage the construction to ensure ongoing avoidance and minimisation of impact can be achieved as the detailed design of the project progresses, as well as staged retirement of biodiversity credit liabilities. A detailed staging plan will be based on final turbine and balance of plant contractor selected and associated construction plan preferences.

Prior to works commencing for each of the construction stages listed below, the biodiversity offset required associated with each stage will be secured through the creation and/or transfer, followed by the retirement of biodiversity credits, or via payment to the Biodiversity Offset Fund. Further detail is provided in Section 9.1.

The following set of example construction stages (or components) provided in Table 12 has been considered possible to be discrete packages of work for which staging of offset obligations is feasible, resultant offset credit liabilities for each of these stages is provided in Section 9.1.

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Table 12 Construction Staging Concept Scope of Works

Scope of Work	Description
Haulage and External Route Upgrades	Required public road upgrades associated with bringing in materials and commencing construction on site.
Construction Compound and Internal Roads, Turbine Hardstands and Foundations	Establishment of construction facility and temporary laydown areas and commencement of internal road upgrades. This may be further broken up in stages by area of the project.
Ancillary Infrastructure	Substation, batching plant, O&M Facility and temporary laydown areas.
Transmission Line	External Transmission line construction.
Switching Station	This is located 20km from the wind farm Project Site and may be staged separately.

The Proponent will provide a final project staging plan to DPIE with final detailed layout plan, updated surveys (if required and outside of the current subject land) and BAM calculations during detailed design and prior to the commencement of construction.

1.7 Report purpose

This Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the requirements of the BC Act to address the Secretary's Environmental Assessment Requirements (SEARs) for the proposed Hills of Gold Wind Farm.

Specifically, this report assesses:

- Impacts to native vegetation, including threatened ecological communities listed under the BC Act and the EPBC Act.
- Impacts to listed threatened species under the BC Act and the EPBC Act.
- Impacts of blade strike on birds and bats, with specific focus on listed threatened bats and raptors observed.
- Impacts associated with development near to National Parks or State Reserves, including the adjacent Ben Halls Gap Nature Reserve.
- Measures to manage identified impacts (including details of adaptive management protocols and ability to obtain achievable offsets).
- Measures to avoid, mitigate and offset impacts, with the objective of achieving an overall 'improve or maintain' environmental outcome for the project.

1.8 Sources of information

The following information sources were used in the preparation of this BDAR:

- Project spatial information provided by Hills of Gold Wind Farm Pty Limited (Formerly Wind Energy Partners).

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- Preliminary Environmental Assessment (PEA), Hills of Gold Wind Energy Project (NGH Environmental 2018).
- Hills of Gold Wind Farm Preliminary Biodiversity and EPBC Act Significant Impact Assessment ('EPBC Assessment') (Arup 2019).
- DAWE EPBC Protected Matters Search Tool (PMST).
- DAWE Species Profiles and Threats (SPRAT) database.
- DAWE Interim Biogeographic Regionalisation for Australia (IBRA) mapping.
- NSW Mitchell Landscapes mapping, version 3.1.
- DPI Key Fish Habitat mapping.
- OEH BioNet Atlas of NSW database.
- OEH Threatened Biodiversity Data Collection (formerly known as the Threatened Species Profiles database).
- State Vegetation Type Map: Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a).
- State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020b).
- Greater Hunter Native Vegetation Mapping Version 4.0. VIS_ID 3855 (DPIE, 2015).
- OEH BioNet Vegetation Classification Database.
- OEH online BAM calculator.
- Biodiversity Assessment Method (OEH, 2020).
- Groundwater Dependent Ecosystems Atlas (Bureau of Meteorology (BOM), 2020).
- LiDAR Survey data was used to assess areas of steep cliffs and rocky outcrops for cave-dwelling bat roost habitats.
- Relevant published literature on threatened biota.
- Submissions received through the Major Projects Website relevant to the BDAR update.

1.9 Report structure

In accordance with the requirements of the BAM, the assessed development footprint includes the area of land that may be directly and indirectly impacted by the project. This updated BDAR also includes all information as outlined in Appendix K of the BAM (2020) Table 13 provides a summary of where the required information for a BDAR is located, to demonstrate compliance with the BAM.

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Table 13 Minimum information requirements for BDAR from Appendix K of BAM

Required report section	Required information	Required maps, tables and data	Section of this BDAR
Introduction	Introduction to the biodiversity assessment including: brief description of the proposal identification of subject land boundary, including: • Operational footprint (if BDAR) • Construction footprint indicating clearing associated with temporary/ancillary construction facilities and infrastructure (if BDAR) • General description of the subject land Sources of information used in the assessment, including reports and spatial data	• Map of the subject land boundary showing the final proposal footprint, including the construction footprint for any clearing associated with temporary/ancillary construction facilities and infrastructure (if BDAR)	Section 1 provides a description of the project elements, the project location, the development footprints and the subject land. Project overview figures are provided as Figure 2 and Figure 3.
Landscape Context	Identification of site context components and landscape features, including: • General description of subject land topographic and hydrological setting, geology and soils • Percent native vegetation cover in the assessment area (as described in BAM Section 3.2) • IBRA bioregions and subregions (as described in BAM Subsection 3.1.3(2.)) • Rivers and streams classified according to stream order (as described in BAM Subsection 3.1.3(3.) and Appendix E) • Wetlands within, adjacent to and downstream of the site (as described in BAM Subsection 3.1.3(3.)) • Connectivity of different areas of habitat (as described in BAM Subsection 3.1.3(5–6.)) • Karst, caves, crevices, cliffs, rocks and other geological features of significance and for vegetation clearing proposals, soil hazard features (as described in BAM Subsections 3.1.3(7.) and 3.1.3(12.)	• Site Map - Boundary of subject land - Cadastre of subject land - Landscape features identified in BAM Subsection 3.1.3 • Location Map - Digital aerial photography at 1:1,000 scale or finer - Boundary of subject land - Assessment area, (i.e. the subject land and either 1500 m buffer area or 500 m buffer for linear development • Landscape features identified in BAM Subsection 3.1.3 • Additional detail (e.g. local government area boundaries) relevant at this scale Landscape features identified in BAM Subsection 3.1.3 and to be shown on	Section 3 provides all of the required landscape features identified within the 1,500m landscape assessment buffer. The required elements for the Location Map are shown on the series of maps in Figure 4 and the native vegetation extent is shown on the series of maps in Figure 5.

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	• Areas of outstanding biodiversity value occurring on the subject land and assessment area (as described in BAM Subsection 3.1.3(8–9.)) • Any additional landscape features identified in any SEARs for the proposal • NSW (Mitchell) landscape on which the subject land occurs	the Site Map and/or Location map include: • IBRA bioregions and subregions • Rivers, streams and estuaries • Wetlands and important wetlands • Connectivity of different areas of habitat • Karst, caves, crevices, cliffs, rocks and other geological features of significance and if required, soil hazard features • Areas of outstanding biodiversity value occurring on the subject land and assessment area • Any additional landscape features identified in any SEARs for the proposal • NSW (Mitchell) landscape on which the subject land occurs	
Native vegetation	• Identify native vegetation extent within the subject land, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery (as described in BAM Section 4.1(1–3.) and Subsection 4.1.1). • Provide justification for all parts of the subject land that do not contain native vegetation (as described in BAM Subsection 4.1.2). • Review of existing information on native vegetation including references to previous vegetation maps of the subject land and assessment area (described in BAM Section 4.1(3.) and Subsection 4.1.1)	• Map of native vegetation extent within the subject land at scale not greater than 1:10,000 including identification of cleared areas (as described in BAM Section 4.1(1–3.)) and all parts of the subject land that do not contain native vegetation (BAM Subsection 4.1.2). • Map of PCTs within the subject land (as described in BAM Section 4.2(1.)).	The native vegetation extent within the development footprint is described in detail in Section 4 of the Updated BDAR. Section 4.2 and Table 25 provides a list of the PCTs, vegetation class and vegetation type, as well as the area of each PCT within the development footprint. Appendix B provides the detailed PCT descriptions and the list of species used for identification. The field data sheets for the

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	• Describe the systematic field-based floristic vegetation survey undertaken in accordance with BAM Section 4.2 • Where relevant, describe the use of more appropriate local data, provide reasons that support the use of more appropriate local data and include the written confirmation from the decision-maker that they support the use of more appropriate local data (as described in BAM Subsection 1.4.2 and Appendix A). For each PCT within the subject land, describe: • Vegetation class. • Extent (ha) within subject land. • Evidence used to identify a PCT including any analyses undertaken, references/sources, existing vegetation maps (BAM Section 4.2(1–3.)). • Plant species relied upon for identification of the PCT and relative abundance of each species. • If relevant, TEC status including evidence used to determine vegetation is the TEC (BAM Subsection 4.2.2(1–2.)). • Estimate of percent cleared value of PCT (BAM Subsection 4.2.1(5.)). Describe the vegetation integrity assessment of the subject land, including: • Identification and mapping of vegetation zones (as described in BAM Subsection 4.3.1). • Assessment of patch size (as described in BAM Subsection 4.3.2). • Survey effort (i.e. number of vegetation integrity survey plots) as described in BAM Subsection 4.3.4(1–2.). • Use of relevant benchmark data from BioNet Vegetation Classification (as described in BAM Subsection 4.3.3(5.)).	• Map of vegetation zones within the subject land (as described in BAM Subsection 4.3.1). • Map the location of floristic vegetation survey plots and vegetation integrity survey plots relative to PCTs boundaries. • Map of TEC distribution on the subject land and table of TEC listing, status and area (ha). • Map of patch size locations for each native vegetation zone and table of patch size areas (as described in BAM Subsection 4.3.2). Table of current vegetation integrity scores for each vegetation zone within the site and including: • Composition condition score. • Structure condition score. • Function condition score. • Presence of hollow bearing trees.	BAM plots include evidence of the quantitative information used to allocate PCTs. This information also includes details on the vegetation class, type and percent cleared for each PCT. This information is available in Appendix H (and in electronic form). Vegetation zones are presented in Table 20 and mapped in Figure 7. The patch size assessment for the development footprint is presented in Section 3.2.2 and mapped on Figure 8. The number of BAM plots surveyed and where benchmark data was used is presented in Section 4.1.4 and Table 20. TEC status of the PCTs and vegetation zones are provided in Table 26, with additional description of TECs in Section 4.3. Maps of TECs are provided in Figure 9. The current vegetation integrity scores for the development footprint area provided in Table 25.

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
Threatened species	Identify ecosystem credit species likely to occur on the subject land, including: • list of ecosystem credit species derived from the BAM-C (as described in BAM Subsection 5.1.1 and Section 5.2(1.)) • justification and supporting evidence for exclusion of any ecosystem credit species based on geographic limitations, habitat constraints or vagrancy (as described in BAM Subsections 5.2.1 and 5.2.2) • justification for addition of any ecosystem credit species to the list Identify species credit species likely to occur on the subject land, including: • list of species credit species derived from the BAM-C (as described in BAM Subsection 5.1.1) • justification and supporting evidence for exclusions based on geographic limitations, habitat constraints or vagrancy (as described in BAM Subsections 5.2.1 and 5.2.2) • justification and supporting evidence for exclusions based on degraded habitat constraints and/or microhabitats on which the species depends (as described in BAM Subsection 5.2.2) • justification for addition of any species credit species to the list From the list of candidate species credit species, identify: • species assumed present within the subject land (if relevant) (as described in BAM Subsection 5.2.4(2.a.)) • species present within the subject land on the basis of being identified on an important habitat map for a species (as described in BAM Subsection 5.2.4(2.d.)) • species for which targeted surveys are to be completed to determine species presence (Subsection 5.2.4(2.b.))	Table showing ecosystem credit species in accordance with BAM Section 5.1.1, and identifying: • the ecosystem credit species removed from the list • the sensitivity to gain class of each species Table detailing species credit species in accordance with BAM section 5.2 and identifying: • the species credit species removed from the list of species because the species is considered vagrant, out of geographic range or the habitat or micro habitat features are not present • the candidate species credit species not recorded on the subject land as determined by targeted survey, expert report or important habitat map Table detailing species credit species recorded or assumed as present within the subject land, habitat constraints or microhabitats associated with the species, counts of individuals (flora)/extent of suitable habitat (flora and fauna) (as described in BAM Subsection 5.2.6) and biodiversity risk weighting (BAM Section 5.4)	Ecosystem credit species on the development footprint, as identified in the BAM Calculator are provided in Table 30. A list of species credit species and justification for their inclusion or exclusions based on habitat features is provided in Table 31, with more detailed analysis provided in Appendix C. Field survey methods, including technique, effort, timing and weather conditions are provided in Section 5.3. These are summarised in Table 32. The location of field surveys is provided in Figure 10 showing flora survey tracks and Figure 12 for the targeted fauna surveys. Threatened species survey results are provided in Section 5.4. The methodology for developing species habitat polygons is provided in Section 5.5, with detailed descriptions of the habitat features used provided in Table 47. No expert reports were used to include or exclude candidate species. The list of candidate species to be assessed was identified from assessment of habitat suitability and targeted surveys.

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	• species for which an expert report is to be used to determine species presence (Subsection 5.2.4(2.c.)) Present the outcomes of species credit species assessments from: • threatened species survey (as described in BAM Section 5.2.4) • expert reports (if relevant) including justification for presence of the species and information used to make this determination (as described in BAM Section 5.2.4 and 5.3, Box 3) Where survey has been undertaken include detailed information on: • survey method and effort, (as described in BAM Section 5.3) • justification of survey method and effort (e.g. citation of peer-reviewed literature) if approach differs from the Department's taxa-specific survey guides or where no relevant guideline has been published • timing of survey in relation to requirements in the TBDC or the Department's taxa-specific survey guides. Where survey was undertaken outside these guides include justification for the timing of surveys • survey personnel and relevant experience • describe any limitations to surveys and how these were addressed/overcome Species polygon completed for species credit species present within the subject land (assumed present or determined on the basis of survey, expert report or important habitat map) ensuring that: • the unit of measure for each species is documented • for species assessed by area:	• Map indicating the GPS coordinates of all individuals of each species recorded within the subject land and the species polygon for each species (as described in BAM Subsection 5.2.5)	

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	- the polygon includes the extent of suitable habitat for the target species within the subject land (as described in BAM Subsection 5.2.5) - a description of, and evidence-based justification for, the habitat constraints, features or microhabitats used to map the species polygon including reference to information in the TBDC for that species and any buffers applied • for species assessed by counts of individuals: - the number of individual plants present on the subject land (as described in BAM Subsection 5.2.5(3.)) - the method used to derive this number (i.e. threatened species survey or expert report) and evidence-based justification for the approach taken - the polygon includes all individuals located on the subject land with a buffer of 30 m around the individuals or groups of individuals on the subject land Identify the biodiversity risk weighting for each species credit species identified as present within the subject land (as described in BAM Section 5.4)		
Prescribed impacts	Identify potential prescribed biodiversity impacts on threatened entities, including: • Karst, caves, crevices, cliffs, rocks and other geological features of significance (as described in BAM Subsection 6.1.1). • Occurrences of human-made structures and non-native vegetation (as described in BAM Subsection 6.1.2). • Corridors or other areas of connectivity linking habitat for threatened entities (as described in BAM Subsection 6.1.3).	• Map showing location of any prescribed impact features (i.e. karst, caves, crevices, cliffs, rocks, human-made structures, etc.). • Maps of habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site (for wind farm developments only).	Prescribed impacts are addressed in Section 8.5 with some aspects addressed as part of the assessment of Indirect Impacts in Section 8.3. Requirements for wind farm developments are specifically addressed in these two Sections. The results of three seasons worth of bird utilisation surveys did not identify any

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	• Water bodies or any hydrological processes that sustain threatened entities (as described in BAM Subsection 6.1.4). • Protected animals that may use the proposed wind farm development site as a flyway or migration route (as described in BAM Subsection 6.1.5). • Where the proposed development may result in vehicle strike on threatened fauna or on animals that are part of a threatened ecological community (as described in BAM Subsection 6.1.6). Identify a list of threatened entities that may be dependent upon or may use habitat features associated with any of the prescribed impacts. Describe the importance of habitat features to the species including, where relevant, impacts on life-cycle or movement patterns (e.g. Subsection 6.1.3). Where the proposed development is for a wind farm: • Identify a candidate list of protected animals that may use the development site as a flyway or migration route, including: resident threatened aerial species, resident raptor species and nomadic and migratory species that are likely to fly over the proposal area (as described in BAM Subsection 6.1.5). • Provide details of targeted survey for candidate species of wind farm developments undertaken in accordance with BAM Subsection 6.1.5(2–3.). • Predict the habitual flight paths for nomadic and migratory species likely to fly over the subject land and map the likely habitat for resident threatened aerial and raptor species (BAM Subsection 6.1.5(4.)).		habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site. Location of prescribed impacts are mapped on Figure 28.
Avoid and minimise impacts	Demonstration of efforts to avoid and minimise impacts on biodiversity values (including prescribed impacts) associated with the proposal location in accordance with	• Table of measures to be implemented to avoid and minimise the impacts of the proposal, including action,	Section 7 provides a detailed summary of the design phase measures to avoid and minimise impacts.

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	Chapter 7, including an analysis of alternative: • Modes or technologies that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed mode or technology • Routes that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed route. • Alternative locations that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed location. • Alternative sites within a property on which the proposal is located that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed site. Describe efforts to avoid and minimise impacts (including prescribed impacts) to biodiversity values through proposal design (as described in BAM Sections 7.1 and 7.2). Identification of any other site constraints that the Porponent has considered in determining the location and design of the proposal (as described in BAM Section 7.2.1(3.)).	outcome, timing and responsibility. • Map of alternative footprints considered to avoid or minimise impacts on biodiversity values; and of the final proposal footprint, including construction and operation. • Maps demonstrating indirect impact zones where applicable.	A table of mitigation and management measures is summarised in Section 8.9 and Table 82. Maps of the assessed development footprint include areas that will be impacted by construction and operation of the project. Figure 23 presents alternative development footprints considered, and Figure 26 shows the area of indirect impact from the operation of the wind turbines.
Assessment of Impacts	Determine the impacts on native vegetation and threatened species habitat, including a description of direct impacts of clearing of native vegetation, threatened ecological communities and threatened species habitat (as described in BAM Section 8.1). Assessment of indirect impacts on vegetation and threatened species and their habitat including (as described in BAM Section 8.2): • Description of the nature, extent, frequency, duration and timing of indirect impacts of the proposal.	• Table showing change in vegetation integrity score for each vegetation zone as a result of identified impacts	Direct impacts associated with the project are outlined in Section 8.2. Indirect impacts associated with the project area outlined in Section 8.3. Prescribed impacts associated with the project area outlined in Section 8.5. Changes in vegetation integrity scores are presented in Appendix G.

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	• Documenting the consequences to vegetation and threatened species and their habitat including evidence-based justifications. • Reporting any limitations or assumptions, etc. made during the assessment. • Identification of the threatened entities and their habitat likely to be affected. Assessment of prescribed biodiversity impacts (as described in BAM Section 8.3) including the assessment of the nature, extent and duration of impacts on the habitat of threatened species or ecological communities associated with: • Karst, caves, crevices, cliffs, rocks and other features of geological significance. • Human-made structures. • Non-native vegetation. • Connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range. • Movement of threatened species that maintains their life cycle. • Water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities. • Assessment of the impacts of wind turbine strikes on protected animals. • Assessment of the impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC.		
Mitigation and Management of Impacts	Identification of measures to mitigate or manage impacts in accordance with the recommendations in BAM Sections 8.5 and 8.5 including:	Table of measures to be implemented to mitigate and manage impacts of the proposal, including action, outcome, timing and responsibility.	Section 8.9 provides a detailed summary of the measures to be implemented to mitigate and manage impacts of the proposal.

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	• Techniques, timing, frequency and responsibility. • Identify measures for which there is risk of failure. • Evaluate the risk and consequence of any residual impacts. • Document any adaptive management strategy proposed. Identification of measures for mitigating impacts related to: • Displacement of resident fauna (as described in BAM Subsection 8.4.1(2.)). • Indirect impacts on native vegetation and habitat (as described in BAM Subsection 8.4.1(3.)). • Mitigating prescribed biodiversity impacts (as described in BAM Subsection 8.4.2). Details of the adaptive management strategy proposed to monitor and respond to impacts on biodiversity values that are uncertain (BAM Section 8.5).		Table 82 outlines the mitigation and management measures to be implemented.
Impact Summary	Identification and assessment of impacts on TECs and threatened species that are at risk of a serious and irreversible impacts (SAII, in accordance with BAM Section 9.1) including: • Addressing all criteria in Subsection 9.1.1 for each TEC listed as at risk of an SAII present on the subject land • Addressing all criteria in Subsection 9.1.2 for each threatened species at risk of an SAII present on the subject land. • Documenting assumptions made and/or limitations to information. • Documenting all sources of data, information, references used or consulted. • Clearly justifying why any criteria could not be addressed. Identification of impacts requiring offset in accordance	Map showing the extent of TECs at risk of an SAII within the subject land. Map showing location of threatened species at risk of an SAII within the subject land. Map showing location of: • Impacts requiring offset. • Impacts not requiring offset. • Areas not requiring assessment.	The impact summary is provided in Section 9, with Table 89 showing the direct impacts and the number of offset credits for each vegetation zone and threatened species. Impacts requiring offset, not requiring offset and areas not requiring assessment are provided on Figure 29. SAII entities are addressed in Section 8.6 and Appendix E and mapped on Figure 28. A summary of ecosystem credit and species credits required by the project is provided in Section 9 and Appendix G.

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Required report section	Required information	Required maps, tables and data	Section of this BDAR
	with BAM Section 9.2. Identification of impacts not requiring offset in accordance with BAM Subsection 9.2.1(3.). Identification of areas not requiring assessment in accordance with BAM Section 9.3.		
	Ecosystem credits and species credits that measure the impact of the development on biodiversity values, including: • Future vegetation integrity score for each vegetation zone within the subject land (Equation 25 and Equation 26 in BAM Appendix H). • Change in vegetation integrity score (BAM Subsection 8.1.1). • Number of required ecosystem credits for the direct impacts of the proposal on each vegetation zone within the subject land (BAM Subsection 9). • Number of required species credits for each candidate threatened species that is directly impacted on by the proposal (BAM Subsection 10.1.3).	• Table of PCTs requiring offset and the number of ecosystem credits required. • Table of threatened species requiring offset and the number of species credits required.	
Biodiversity credit report	Description of credit classes for ecosystem credits and species credits at the development or clearing site or land to be biodiversity certified (BAM Section 10.2).	Table of credit class and matching credit profile.	The biodiversity credit report as output from the BAM-Calculator is provided in Appendix G.

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1.9.1 Interpretation of maps

Map sets presenting survey effort, survey results, and biodiversity constraints are provided for the total development footprint, in accordance with the requirements of the BAM. Each map set contains an overview map and a set of detailed maps. The overview map shows the order in which the detailed maps are referenced and their location within the assessment area.

When locations are referenced within the report, they are described using the infrastructure elements defined in Section 1.5.1 and Table 10.

1.9.2 Relevant personnel

The BDAR has been prepared in accordance with the BAM (OEH 2017) by Arup and Biosis, followed by updates to meet the requirements of the BAM (DPIE 2020) by Biosis following the end of the 12 month transitional arrangements period for SSD projects. The following accredited biodiversity assessors have prepared, provided input into and reviewed sections of this BDAR in accordance with the BAM:

- Chani Wheeler (BAAS 19077) – Arup
- Matt Davis (BAAS 18090) – Arup
- Nicola Trulock (BAAS 19058) – Biosis
- Callan Wharfe (BAAS 18138) – Biosis
- Rebecca Dwyer (BAAS 17067) – Biosis
- Mitchel Palmer (BAAS17051) – Biosis

Additional personnel contributed to the field survey effort, data analysis, interpretation and mapping, including:

- Caroline Tan – Arup Terrestrial Ecologist
- Andrea McPherson – Arup Aquatic Ecologist
- Tony Cable – Biosis Senior Zoologist
- Paul Price – Biosis Consultant Botanist
- Brooke Corrigan – Biosis Consultant Botanist
- Matthew Hyde - Biosis Consultant Zoologist
- Carragh Heenan – Biosis Zoologist
- Joel Nicholson – Biosis Zoologist
- Kayla Asplet - Biosis Zoologist
- Sarah Allison - Biosis Zoologist
- Byron Dale – Biosis Zoologist
- Adam Baus – Biosis Zoologist (Aquatic)
- Bianca Klein – Biosis Botanist
- Tobias Scheid – Biosis Botanist
- Heather Lee-Kiorgaard – Biosis Botanist

Technical input into the assessment of impacts to microbats and birds has also been provided by Biosis' following technical experts:

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- Ian Smales – Principal Zoologist
  - Ian has over forty years of professional experience in wildlife research and natural resource management with the public and private sectors. He has been a long-standing member of recovery teams for two endangered bird species and the scientific advisory panel for the South-west Victorian Brolga project. In 2020 Ian was appointed as a member of the Victorian Government's Scientific Advisory Committee for the Flora and Fauna Guarantee Act. He is also a member of the IUCN Species Survival Commission Reintroduction Specialist Group. Since 2003, he has had a particular involvement with the wind energy sector and has investigated effects on birds and bats at multiple proposed and operating wind farms. He is the author of a number of publications on that field in the international literature. Ian has had a lead role in the development and application of the Biosis bird collision risk model, which has been used in the assessment of many wind energy projects in Australia and the Pacific.
  - Ian's publications relevant to the project's impact assessment include;
    - Lumsden, L.F., Moloney, P. and Smales, I. 2019. *Developing a science-based approach to defining key species of birds and bats of concern for wind farm developments in Victoria*. Arthur Rylah Institute for Environmental Research Technical Report Series No. 301. Department of Environment, Land, Water and Planning, Heidelberg, Victoria.
    - Moloney, P.D., Lumsden, L.F. and Smales, I. 2019. Investigation of existing post-construction mortality monitoring at Victorian wind farms to assess its utility in estimating mortality rates. Arthur Rylah Institute for Environmental Research Technical Report Series No. 302. Department of Environment, Land, Water and Planning, Heidelberg, Victoria.
    - Smales, I. 2017. *Modelling of collision risk and populations.* in M. Perrow (ed) Volume 2 Wildlife and Wind Farms: conflicts and solutions. Pelagic Publishing. UK.
    - Smales, I. 2014. Fauna Collisions with Wind Turbines: Effects and Impacts, Individuals and Populations. What Are We Trying to Assess? Pp 23 – 40 in Hull, C., Bennett, E., Stark, E., Smales, I., Lau, J. & Venosta, M. (eds) Wind and Wildlife: Proceedings from the Conference on Wind Energy and Wildlife Impacts, October 2012,Melbourne, Australia. Springer Dordrecht.
    - Smales, I., Muir, S., Meredith, C. & Baird, R. 2013. *A description of the Biosis model to assess risk of bird collisions with wind turbines.* Wildlife Society Bulletin 37(1): 59–65
    - Hull, C., Bennett, E., Stark, E., Smales, I., Lau, J. & Venosta, M. 2015. Wind and Wildlife. Proceedings from the Conference on Wind Energy and Wildlife Impacts, October 2012, Melbourne, Australia. Springer.
- Mark Venosta – Team - Leader Zoology (Biosis' senior microbat ecologist)
  - Mark contributed the bat assessment components of the Environment Protection and Heritage Council 2010 National Wind Farm Development Guidelines and has been involved in preparing draft bats and wind energy assessment guidelines for the Australasian Bat Society and ccompleted Australian and New Zealand wind farm guidelines for bats and avifauna (federal government). Mark has utilised novel assessment and survey techniques while investigating potential impacts to threatened bats from proposed wind energy facilities, including thermal imaging and the use/applicability of radar techniques. He has also attended the inaugural bats and wind energy workshop hosted by Bat Conservation International as the sole Australian representative, which

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provided an excellent forum for discussing current assessment methods and advances in survey technologies. Mark is a member of the Australaisian Bat Society.

  - Mark's publications relevant to the project's impact assessment include;
    - Hull, C., Bennett, E., Stark, E., Smales, I., Lau, J. & Venosta, M. 2015. Wind and Wildlife. Proceedings from the Conference on Wind Energy and Wildlife Impacts, October 2012, Melbourne, Australia. Springer.

- Felicity Williams – Consultant Zoologist (microbat ecologist)
  - Felicity has over eight years' experience in applied ecology and ecological consulting, with specialist skills in microbat acoustic data collection, analysis and assessment. Felicity is a member of the Australasian Bat Society and completed the honours thesis; *Williams, F. (2009) The influence of fire on the foraging activity of insectivorous bats in the Victorian Mallee*.

This amended BDAR has been compiled by various authors from Arup and Biosis, including the accredited assessors listed above. Callan Wharfe (BAAS 18138) completed the attached BAM Calculator to identify offset credit requirements, updated from the previous version established by Matt Davis (BA 18090).

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2 Statutory considerations

2.1 NSW legislation and policies

2.1.1 *Environmental Planning and Assessment Act 1979* (EP&A Act)

The Project is State Significant Development (SSD) and development consent is being sought under Section 4 of the NSW EP&A Act. An EIS is a requirement of the development assessment process.

Environmental Assessment Report (now called Scoping Report) was prepared and submitted to the NSW Department of Planning and Environment (now Department of Planning, Industry and Environment (DPIE)) in October 2018. Secretary's Environmental Assessment Requirements (SEARs) were issued for the Project on 22 November 2018. The SEARs form the basis of the assessment criteria for the Project. Supplementary SEARs were issued on 18 February 2020 in relation to the determination of the Project as a Controlled Action under the Commonwealth EPBC Act.

State Environmental Planning Policy (Koala Habitat Protection) 2020 & State Environmental Planning Policy (Koala Habitat Protection) 2021

State Environmental Planning Policy (Koala Habitat Protection) 2021 (Koala SEPP 2021) applies to identified LGAs in areas not zoned as RU1 Primary Production, RU2 Rural Landscape or RU3 Forestry, and within these rural land zonings, the former State Environmental Planning Policy (Koala Habitat Protection) 2020 (Koala SEPP 2020) continues to apply. Portions of the development footprint occur on both rural zonings and non-rural zoning so both Koala SEPP 2020 and Koala SEPP 2021 are potentially relevant to the project.

However, both SEPPs only apply to development applications where Council is the consent authority, which is not the case for the project that has been designated as SSD under Section 4 of the EP&A Act, neither SEPP is applicable to the project.

However the aims of both Koala SEPP 2020 and Koala SEPP 2021 are to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline.

These aims and considerations have been addressed in accordance with the BAM and the NSW *Biodiversity Conservation Act 201*6 (BC Act), as well as the Commonwealth EPBC Act, in preparation of this BDAR. Targeted surveys have been undertaken for Koala to ascertain their presence within the subject land, specific measures to avoid and minimise impacts to the species have been employed, detailed impact assessments have been carried out, and like-for-like offsets will be secured for residual impacts that have been unable to be avoided.

2.1.2 *Biodiversity Conservation Act 2016* (BC Act)

The BC Act and Biodiversity Conservation Regulation 2017 (BC Regulation) provide a framework for the assessment of biodiversity and the implementation of the Biodiversity Offset Scheme (BOS) in NSW. The NSW Biodiversity Assessment Method (BAM) supports the implementation of the BOS and establishes a consistent approach to assessing biodiversity values on lands within NSW.

Under the BC Act, impacts to biodiversity, including those associated with land clearing and development, must be assessed by an accredited person to determine proposal requirements for entry into the BOS. Entry into the BOS may be triggered where areas of mapped biodiversity value will be impacted, where land clearing exceeds area thresholds or where impacts to threatened species or ecological communities are likely to be significant. A proposal may also be refused where it is likely to result in serious or irreversible impacts to biodiversity, as defined by the BC Act.

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2.2 Commonwealth legislation

2.2.1 *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

The project has also been referred under the EPBC Act (2019/8535) and determined to be a controlled action which is required to be assessed under the Bilateral Agreement made under section 45 of the EPBC Act relating to environmental assessment between the Commonwealth of Australia and the State of New South Wales. The bilateral agreement endorses the BAM and the NSW Biodiversity Offsets Scheme as accredited processes. Guidelines for preparing the EIS under the Bilateral Agreement have been provided by DAWE (Supplementary SEARS). This BDAR has been prepared to address approval requirements under the EPBC Act as set out in the Supplementary SEARs.

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3 Landscape features

In accordance with Section 3.1 of the BAM, a landscape assessment was completed for the assessment area, as shown in Figure 4. This landscape assessment has been carried out for the 1,500m buffer around the development footprint, as required by Section 3.1 of the BAM. For the purpose of this BDAR, the 1,500m landscape buffer around the development footprint is defined as the assessment area.

This assessment area includes a total 42,315.90 hectares of land comprising the development footprint and the 1,500m buffer around all parts of the development footprint. This section provides a summary of the wider landscape features of the assessment area that contribute to the ecological values within the development footprint.

3.1 Identified features

Section 3.1.3 of the BAM lists the required identified features that need to be mapped in this BDAR. Relevant landscape features identified for the assessment area are shown in Figure 4.

3.1.1 IBRA bioregions and subregions

The assessment area intersects four Interim Biogeographic Regionalisation for Australia (IBRA) subregions, as detailed in Table 14 and shown in Figure 4. The Nandewar IBRA bioregion and Peel IBRA subregion dominates the assessment area. In accordance with Section 5.2,1,7 of the BAM, these have formed the basis for the habitat suitability assessment documented within this BDAR.

At the scale of the development footprint, the majority of the project is located within the Peel sub-region within the Nandewar bioregion.

Table 14 IBRA region and sub-regions in which the subject land is located

IBRA Region	IBRA Sub-region	Extent (ha)	% Assessment area
New England Tablelands	Walcha Plateau	59,71	19%
Nandewar	Peel	13,655	44%
NSW North Coast	Tomalla	3,183	10%
Sydney Basin	Hunter	8,586	27%

3.1.2 NSW landscape regions (Mitchell Landscapes)

The assessment area supports 19 NSW landscapes, as detailed in Table 15.

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Table 15 NSW (Mitchell) Landscapes within the assessment area

Landscape	Corresponding Ecosystem Meso Grouping	Extent (ha)	% assessment area
Mount Royal Tops	NNC Barrington - Gloucester	7161	23%
Mount Royal Ridges	NNC Barrington - Gloucester	9112	29%
Manning Great Escarpment Southern Aspects	NNC Barrington - Gloucester	143	<1%
Manning Great Escarpment Western Aspects	NNC Barrington - Gloucester	18	<1%
Nundle Hills	NAN Peel	5969	19%
Slippery Rock Range	NAN Peel	42	0<1%
Tamworth- Keepit Slopes and Plains	NAN Peel	192	1%
Central Hunter Alluvial Plains	SB Hunter	155	1%
Central Hunter Foothills	SB Hunter	4053	13%
Lower Hunter Channels and Floodplains	SB Hunter	492	2%
Newcastle Coastal Ramp	SB Hunter	394	1%
Upper Hunter Channels and Floodplain	SB Hunter	2517	8%
Gosford-Cooranbong Coastal Slopes	SB Wyong	142	1%
Moonbi-Walcha Granites	NET Granites	77	<1%
Nowendoc- Yarras Serpentinite	NNC Ultramafics	93	<1%
Sydney- Newcastle Barriers and Beaches	SB Coastal Barriers	609	2%

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3.1.3 Rivers and streams

There are several waterways and wetland/farm dams in the assessment area, with many being defined as first order streams as per Appendix E of the BAM.

Rivers and streams (classified by stream order and including riparian buffers) are shown on the Site Map and Location Map in Figure 4. The majority of the streams that occur within the assessment area are first-order watercourses, which is characteristic of the location of the project on a ridgeline. The majority of these flow north and west of the ridgeline into the Namoi catchment area. The southern portion of the development footprint for the wind farm and transmission line flows south to the Hunter catchment area. A small portion of the eastern portion of this development footprint flows east to the Manning Catchment Area.

There are 76 named streams within the assessment area for the wind farm and transmission line, the 20 watercourses with the longest mapped extent within the assessment area include:

- Hunter River
- Basin Creek
- Wombramurra Creek
- Oakenville Creek
- Woodleys Creek
- Barnard River
- Wallis Creek
- Happy Valley Creek
- Back Creek
- Peel River
- Talbots Creek
- Ryans Oaky Creek
- Wiles Gully
- Goonoo Goonoo Creek
- Throsby Creek
- Woodleys Gully
- Burrows Creek
- Rosebrook Creek
- Limestone Oaky Creek
- Paynes Gully

A desktop assessment of aquatic habitats impacted as a result of the development are discussed in Section 5, including identification of where works forming part of the development footprint are required within waterways, primarily for site access and transport haul route upgrades.

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3.1.4 Wetlands

The assessment area supports 388.51ha of mapped NSW wetlands, as detailed in Table 16. However, each of these are contained within the 1,500m assessment area around small areas of road upgrades and related works along the transport route and none will be impacted by the development footprint.

Mapped wetlands include the Hunter River, Southern Hunter River, Throsby Creek and the Kooragang Nature Reserve (refer to Figure 4). As outlined above, none of these will be directly or indirectly impacted by the development footprint.

Approximately 2.8 hectares of coastal wetlands, and 13.1 hectares of coastal wetlands proximity areas are mapped under the State Environmental Planning Policy (SEPP) (Coastal Management) 2018, also occur within the assessment area, but will not be subject to any direct or indirect impacts associated with the project. These are situated at Newcastle and include the Southern Hunter River and Throsby Creek.

Table 16 NSW (2006) wetlands within the assessment area

Wetland group	Extent within assessment area (ha)
Reservoir/ dam	3.2
Floodplain wetland	5.3
Estuarine wetland	245.8
Non-wetland	144.3
Total	**398.7**

3.1.5 Connectivity features

The wind farm and transmission line is well connected to vegetation both within and outside of the 1,500m landscape assessment area surrounding the subject land, with biodiversity features conserved in reserves, steep slopes and watercourses.

In the subject land and assessment buffer, there are extensive agricultural pastures along ridgelines and low-lying topography is used as grazing land, with existing access roads, tracks and fence lines. Scattered and intermittent tree cover is present within grazing land. There are also grassy woodlands on the undulating foothills and escarpments.

Forested mountain tops are dominated by dense, mature forests, most notably associated with Ben Halls Gap Nature Reserve to the east, Hanging Rock to the north and Crawney Pass National Park to the west. Adjacent land uses include predominantly cattle grazing, as well as areas of forestry present to the north.

As required under Section 3.1 of the BAM for connectivity features:

- The connectivity of different areas of habitat that may facilitate the movement of threatened species across their range are identified on the Location Map (Figure 4).
- No flyways for migratory species have been identified within the assessment area during desktop assessments, including extracts from the Bionet records and field assessments completed for this BDAR. As part of the Collision Risk Model (CRM) validation three seasons of bird utilisation surveys were completed. In addition, targeted surveys for threatened and migratory bird species surveys were undertaken in winter, spring and summer 2019 and autumn/winter 2020 and not flyways or substantial numbers of migratory species were observed.

The biodiversity corridors that facilitate the movement of threatened species across their range for this project can broadly be classified into two types. The first corridor provides for the maintenance of movement

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across the vegetated ridgelines and the second provides for movement of altitudinal migrants between the Mount Royal and Liverpool Ranges (Figure 4). The ridgeline corridors are associated with vegetation retained on upper ridgelines and steep slopes, with previous grazing land uses removing vegetation on more gentle slopes and foothills. Corridors extend from the range and escarpment, largely following vegetated watercourses where thin strips of riparian vegetation have been retained.

There is also a network of protected areas in the wider landscape associated with Ben Halls Gap Nature Reserve, Wallabadah Nature Reserve and Crawney Pass National Park. The biodiversity corridors within the assessment area, particularly along the ridgelines, provide important connectivity between these conservation areas.

The majority of these mapped corridors occur outside the development footprint and will not be directly or indirectly impacted by the project. The corridor that runs along the ridgeline connecting Ben Halls Gap to areas of native vegetation to the north and to Crawney Pass National Park intersects and adjoins part of the development footprint. This corridor will be maintained, as the spatial distribution of vegetation on the ridgeline where wind farm infrastructure and internal roads are proposed is fragmented and patchy. The larger patches of contiguous vegetation and habitat are located to the south and north of the ridgeline, within protected area reserves and steeper terrain and are not impacted by the development footprint.

3.1.6 Areas of geological significance and soil hazard features

The presence of habitat features including karsts, caves, crevices and cliffs or other areas of geological significance likely to occur within and adjacent to the assessment area have been assessed. Field surveys have identified a number of areas of steep, rocky crevices on either side of the escarpment that provide potential roosting habitat for microbats. The location of steep cliff lines on the edge of the escarpments in the assessment area were mapped The GIS desktop analysis was undertaken as follows:

- A 5 m Digital Elevation Model (DEM) was created from a LiDAR bare earth point cloud.
- Focal statistics were run on the DEM to create a surface representing the range of elevation in a 2x2m cell neighbourhood around each input cell (roughly a 10m buffer).
- Focal range surface was reclassified to remove areas with a range less than 3m between highest and lowest points in the neighbourhood.
- The resulting cliff lines layer was symbolised to show areas of potential cliff lines based on where the range was 3, 4, 5, 6, 7 or >7 metres within the 2x2 neighbourhood.

These areas of steep cliff lines were initially used to identify all potential areas where cave-dwelling microbats could establish breeding or diurnal roosts. Follow-up desktop and ground-thruthing surveys have been able to be undertaken to better refine areas of potential habitat within and surrounding the development footprint.

Furthermore, expert advice regarding the presence of geological features of significance within the development footprint and in the broader landscape has been provided by Environmental Geosurveys Pty Ltd (Neville Rosengren, Geomorphologist and Honorary Associate La Trobe University). The full report (Environmental Geosurveys 2021) is attached as Appendix F of this BDAR. The assessment found that the landscape surrounding and encompassing the assessment area supports highly diverse terrain and lithology, which combined with dynamic geomorphology result in a high potential for geological features potentially suitable for microbat roosting sites to occur at all elevations.

The detailed findings of the geomorphological assessment and the follow-up desktop and ground-truthing assessment of potential microbat roots surrounding the assessment area are provided in Section 5.4.2. The updated microbat roosting habitat areas have been mapped in more detail in Section 5.5 of this BDAR.

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In the wider landscape, outside of the development footprint defined by the BAM, there are known caves that support threatened cave bats:

- The presence of a known important winter roost site for Large Bent-winged Bat *Miniopterus orianae* subsp*. oceanensis* at Timor Caves, approximately 5 kilometres south-west of the assessment area.
- Known breeding and non-breeding roosts for Large Bent-winged Bat and Little Bent-winged Bat *Miniopterus australis* are also known to occur at Willi National Park (130 kms north-east), Wellington Cave (225 kms south-west), Borenore Karst (260 kms south-west), Kangara Boyd (270 kms south) and Wee Jasper (460 kms south-west).
- Four other known karst systems (caves) within 50 kilometres that support potential habitat for roosting and/or breeding microbats.
- The location of the development site is approximately 150 – 280 kilometres away from four known important maternity roost sites for Large-eared Pied Bat *Chalinolobus dwyeri* which are located on the same side of the dividing range as the development footprint. This the distance bats move from maternity roosts to non-breeding roosts has not been established but it likely to be less than 100 kilometres (DAWE 2020).

Due to the presence of cliffs within and directly adjacent to the development site, and caves and karst landscapes in the wider locality, a detailed assessment of the presence and relative abundance of cave-dwelling bats was carried out and is reported on in subsequent sections of this BDAR.

There are no known significant soil hazard features at the time of preparing this BDAR.

A search of the ASC Soil Type Map of NSW (OEH, 2019) reveals that the Ferrosols soil type dominates the Project Area. Ferrosols are characterised by their deep red friable soils that lack strong texture contrast, which are high in free iron oxide and generally have a high clay content. Soils appeared generally stable during the field surveys, with a reasonable cover of exotic grasses or native vegetation in areas. There was some minor erosion associated with waterways observed during the field survey.

A search of the NSW EPA Contaminated Sites Register, identified the closest sites recorded to the project area are two sites within the Tamworth LGA and two sites within the Upper Hunter Shire LGA, located within Tamworth and Scone (over 50km away from the assessment area). As such it was determined that the project location does not appear on the list of NSW contaminated sites. It was considered unlikely that contamination is present.

3.1.7 Biodiversity Values Map

The NSW Biodiversity Values Map identifies land with high biodiversity value that is particularly sensitive to impacts from development and clearing. The map forms part of the Biodiversity Offsets Scheme Threshold which is one of the triggers for determining whether the Biodiversity Offset Scheme (BOS) applies to a clearing or development proposal.

Based on a search of the NSW Biodiversity Values Map, there are areas of mapped high biodiversity value located within the assessment area as shown in Figure 4). The majority of the areas mapped in the Biodiversity Values Map are located outside of the development footprint and are associated with adjacent nature reserves, national park and higher order streams in the wind farm and transmission line corridor section of the project. There are only very small areas mapped in the Biodiversity Values Map within the development footprint in these areas (Figure 4).

For the development footprint associated with the transport haul route there are no areas mapped in the Biodiversity Values Map (Figure 4).

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3.1.8 Protected areas

Within the assessment area, but outside the development footprint there are two conservation areas protected by NSW legislation, which have been considered as part of the collection of baseline information on the ecological values of the assessment area and as part of the impact assessment.

Ben Halls Gap Nature Reserve is located directly adjacent to the development area and in close proximity to the certain infrastructure and internal roads elements of the development footprint. This reserve covers over 2,500 hectares of tall, old growth eucalypt forest, with a mix of grassy eucalypt woodland, tall moist eucalypt forest and rainforest (NPWS, 2002). It contains important fauna habitat for a number of threatened species, including Koala *Phascolarctos cinereus*, Spotted-tailed Quoll *Dasyurus maculatus*, forest owls and microbats. Given the proximity of the Ben Halls Gap Nature Reserve to the development footprint additional field surveys were carried out to ground-truth the vegetation communities, condition and habitat features 100m into those parts of the reserve which adjoin the development footprint.

At its closest point, Crawney Pass National Park is located 50m from parts of the development footprint for the transmission line corridor. In most sections, there is an approximately 300m buffer from the national park boundary to the development footprint. The national park is just over 310ha in size and contains mostly grassy open eucalypt forests and woodlands, with some smaller patches of rainforest on lower slopes on major creeklines on the southern side of the park (NPWS, 2019). There are no known populations of threatened plants in the National Park; however, it does provide habitat for Koala, forest owls, gliders and microbats.

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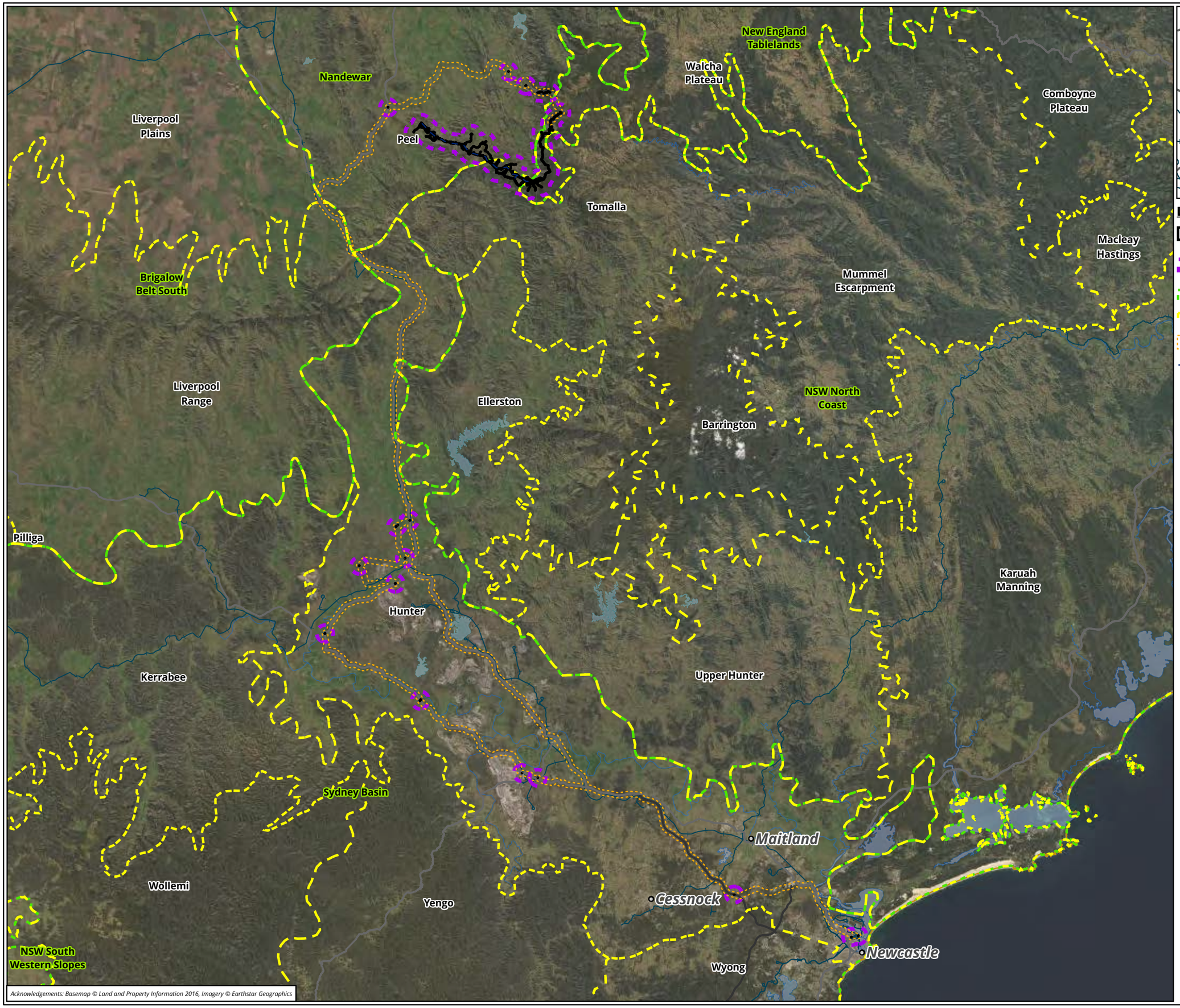

Figure 4 Site map and location map features, Page 1

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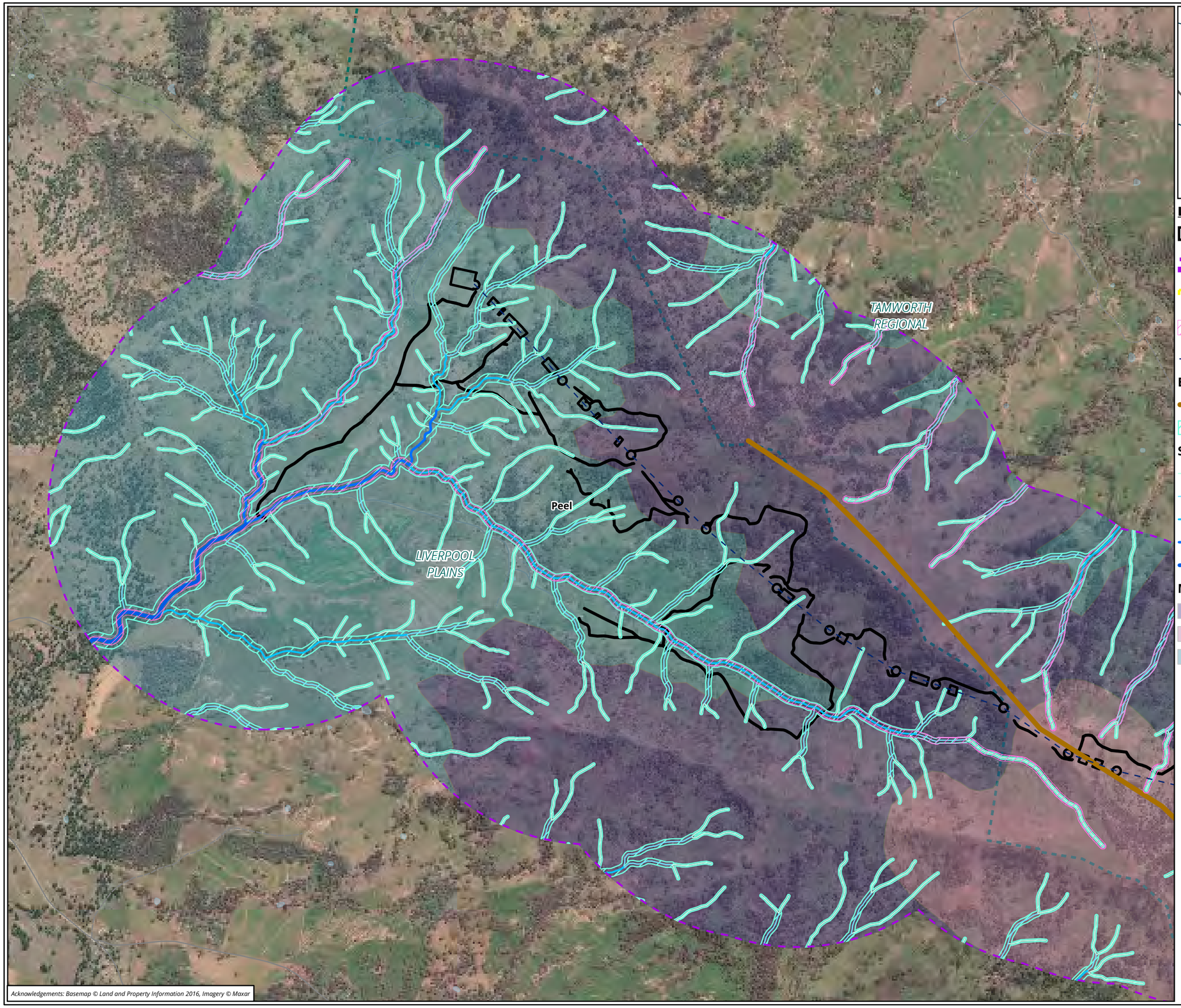

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Transmission line

Biodiversity corridors

- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 5

Mitchell landscapes

- Mount Royal Ridges
- Mount Royal Tops
- Nundle Hills

Figure 4 Site map and location map features, Page 2

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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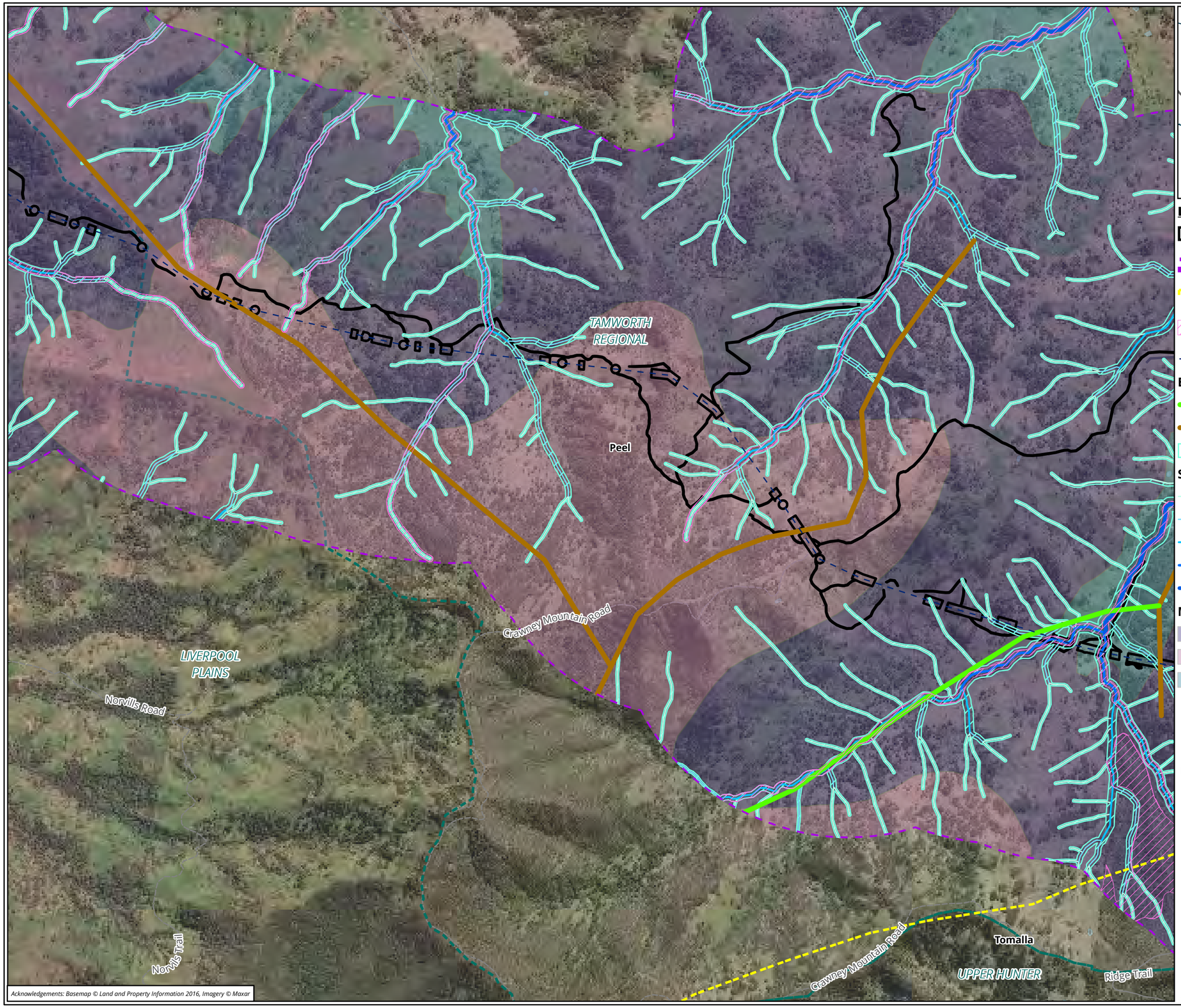

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Transmission line

Biodiversity corridors

- Altitudinal
- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 5

Mitchell landscapes

- Mount Royal Ridges
- Mount Royal Tops
- Nundle Hills

Figure 4 Site map and location map features, Page 3

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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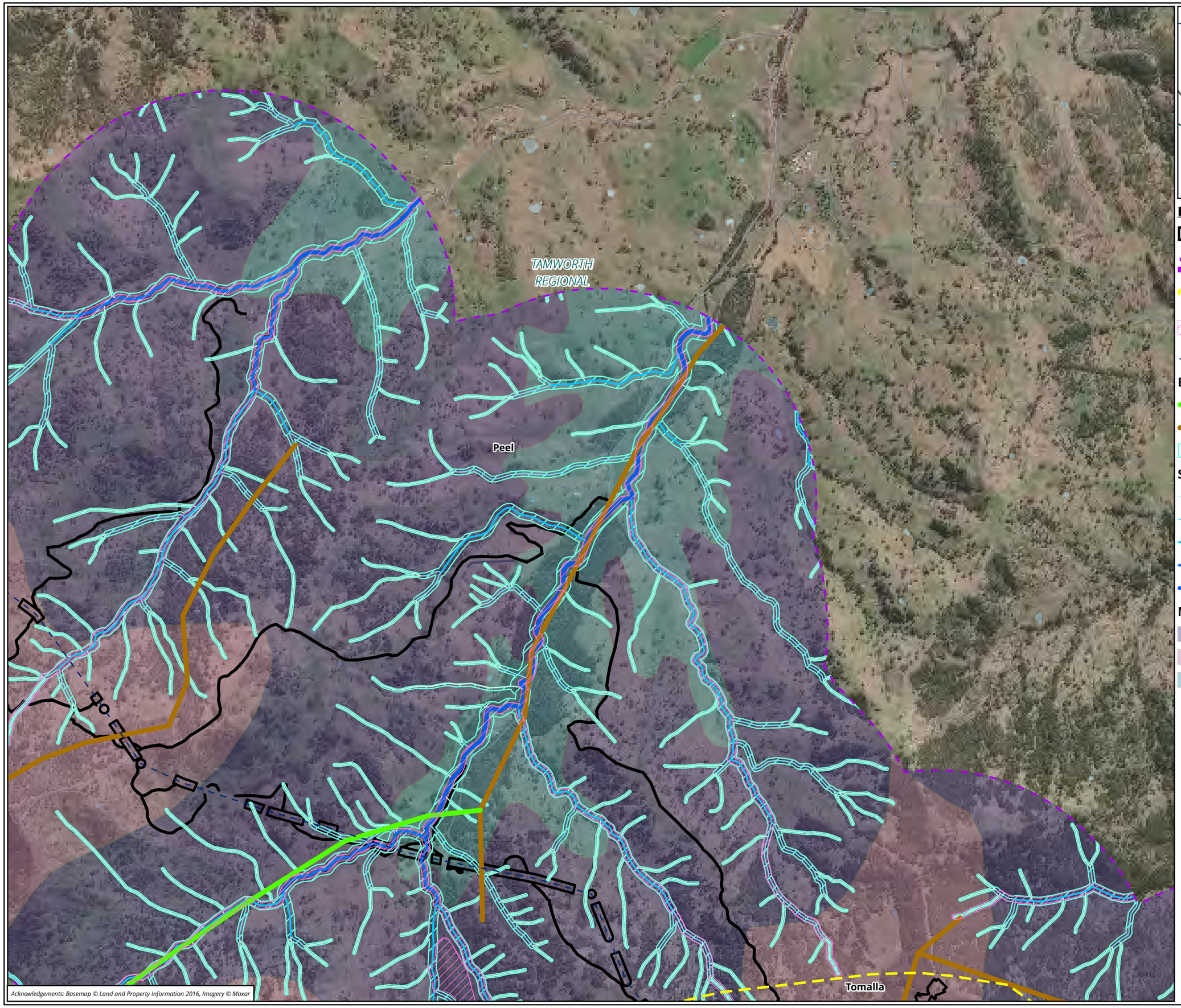

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Transmission line

Biodiversity corridors

- Altitudinal
- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 5

Mitchell landscapes

- Mount Royal Ridges
- Mount Royal Tops
- Nundle Hills

Figure 4 Site map and location map features, Page 4

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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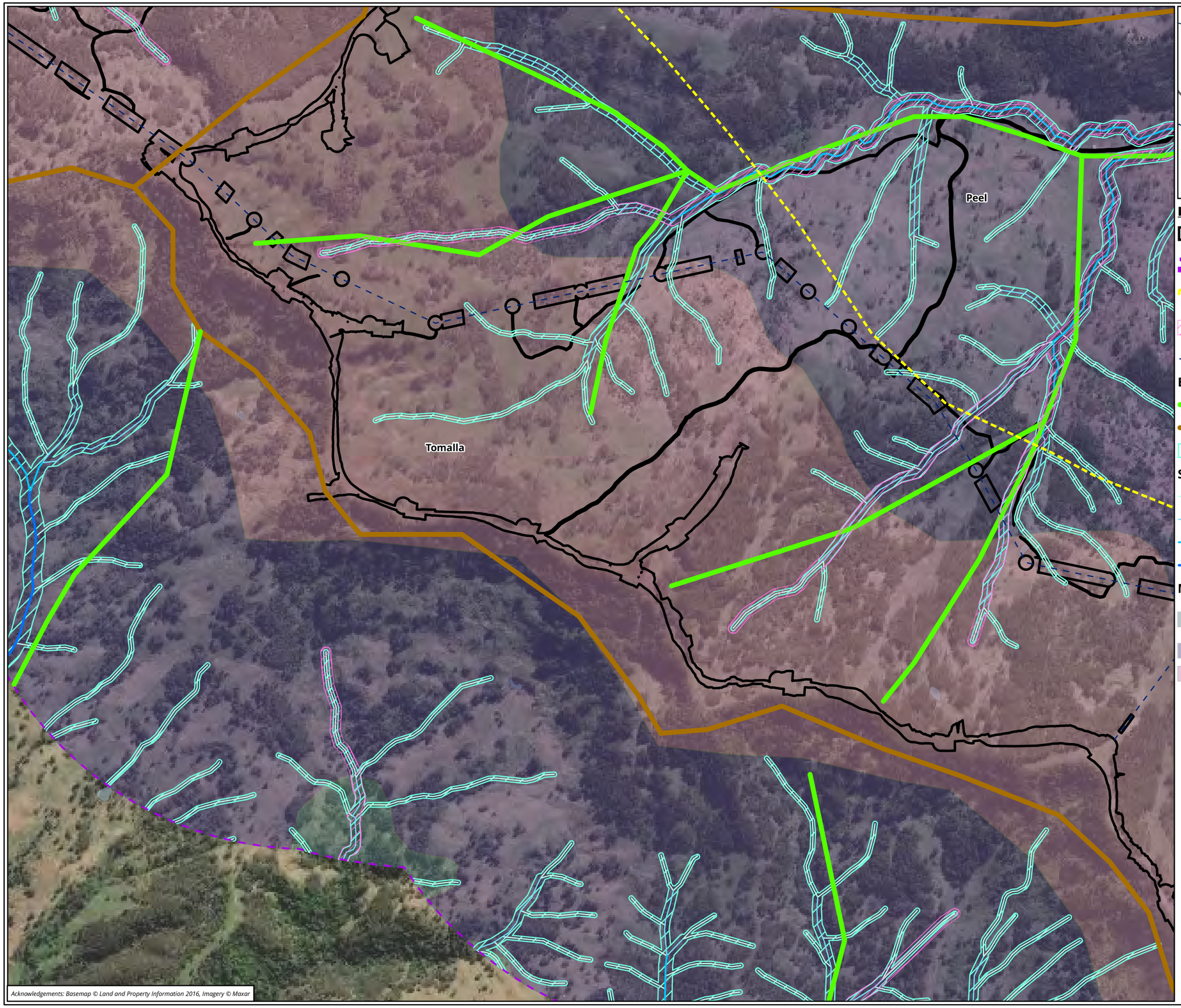

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Transmission line

Biodiversity corridors

- Altitudinal
- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4

Mitchell landscapes

- Manning Great Escarpment Western Aspects
- Mount Royal Ridges
- Mount Royal Tops

Figure 4 Site map and location map features, Page 5

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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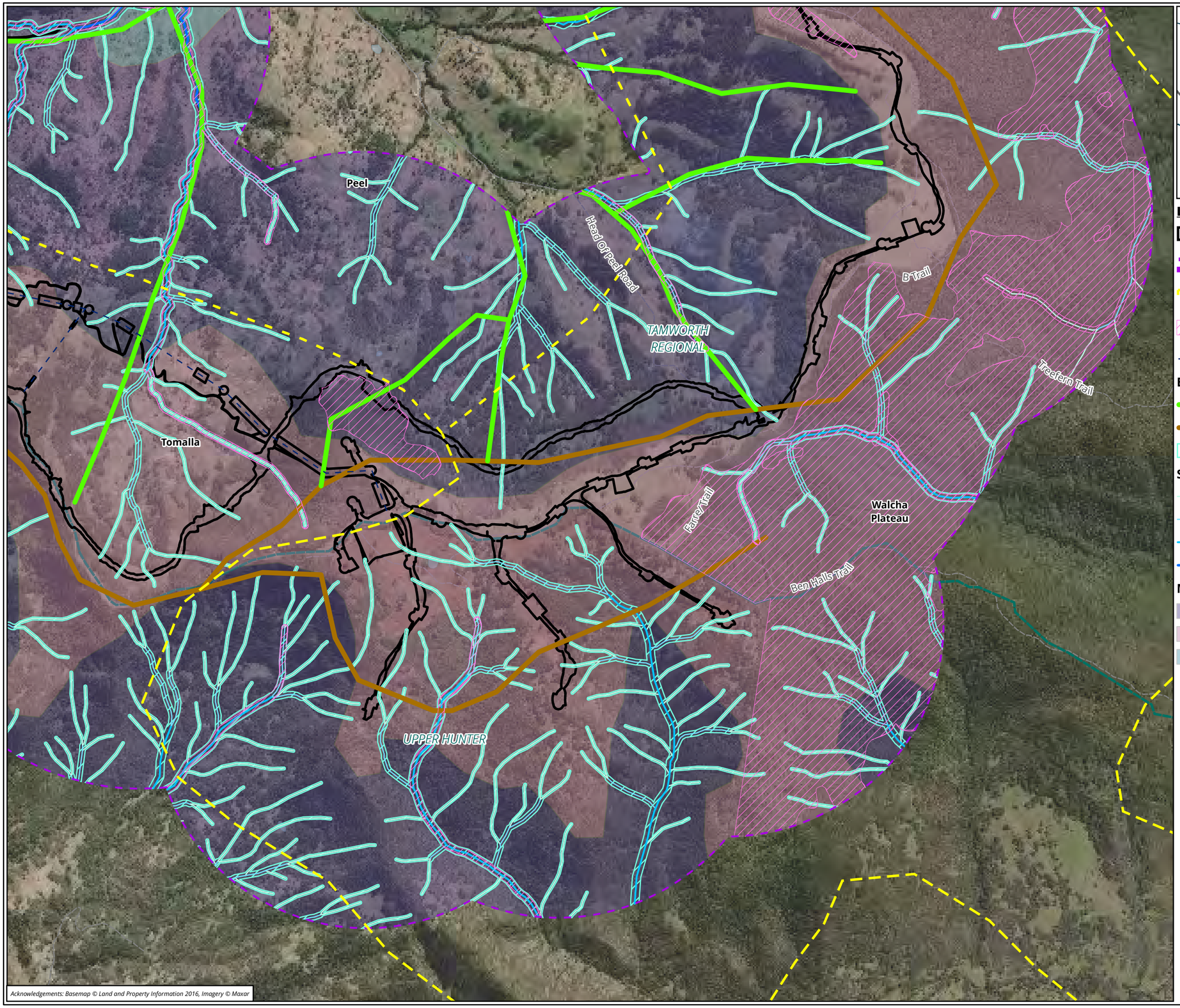

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Transmission line

Biodiversity corridors

- Altitudinal
- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4

Mitchell landscapes

- Mount Royal Ridges
- Mount Royal Tops
- Nundle Hills

Figure 4 Site map and location map features, Page 6

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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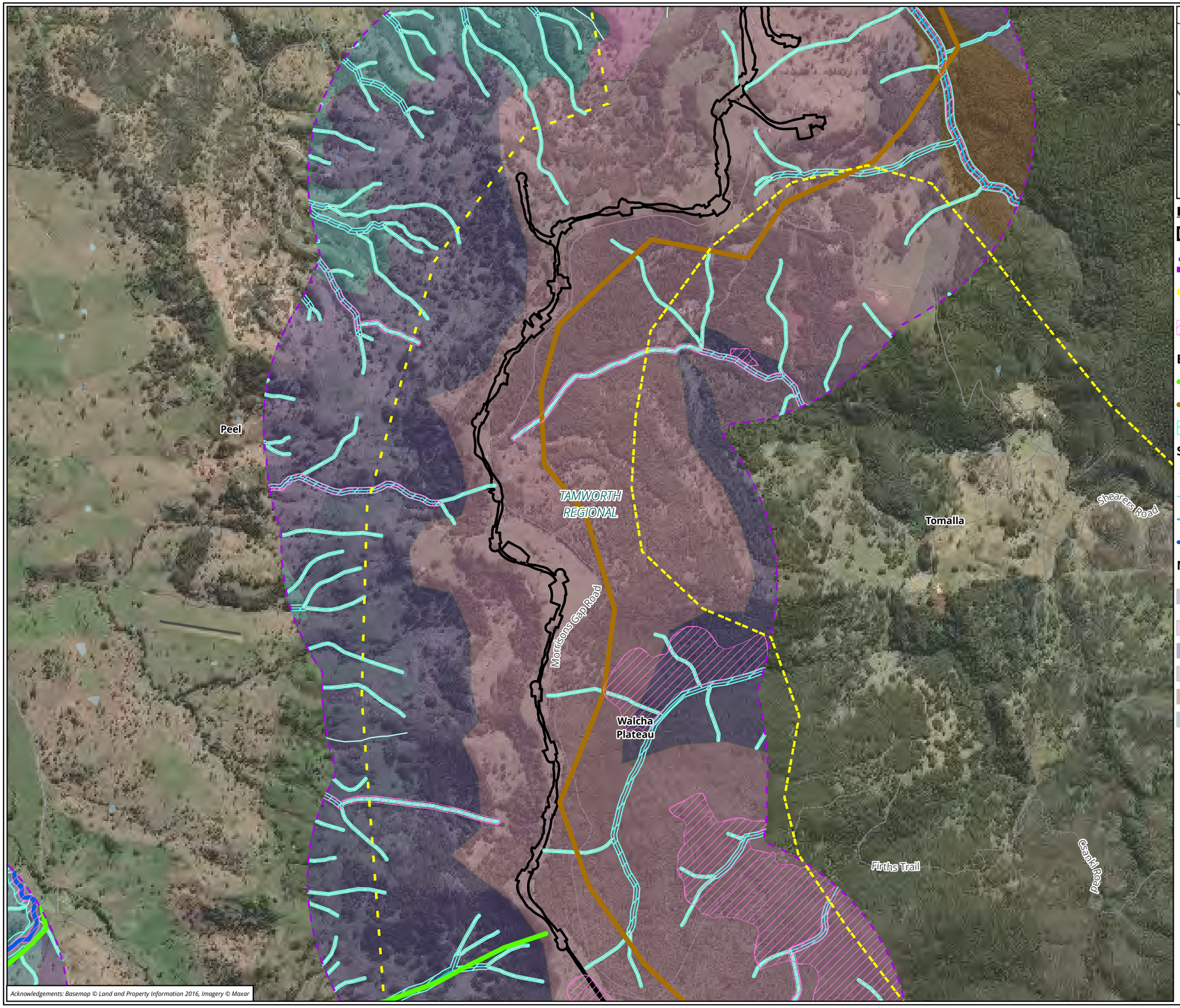

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)

Biodiversity corridors

- Altitudinal
- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 5

Mitchell landscapes

- Manning Great Escarpment Southern Aspects
- Moonbi - Walcha Granites
- Mount Royal Ridges
- Mount Royal Tops
- Nowendoc - Yarras Serpentinite
- Nundle Hills

Figure 4 Site map and location map features, Page 7

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

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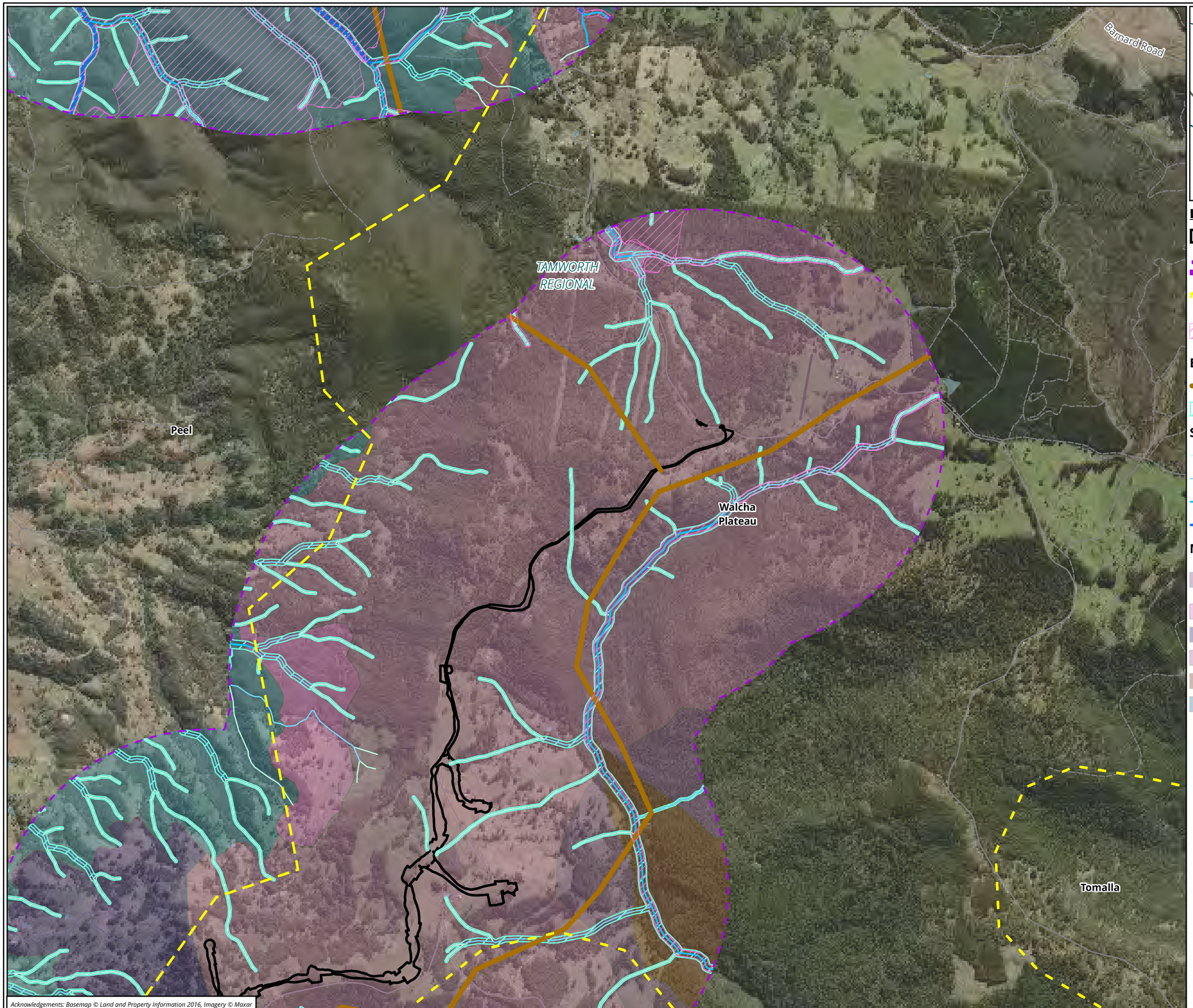

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)

Biodiversity corridors

- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4

Mitchell landscapes

- Manning Great Escarpment Southern Aspects
- Moonbi - Walcha Granites
- Mount Royal Ridges
- Mount Royal Tops
- Nowendoc - Yarras Serpentinite
- Nundle Hills

Figure 4 Site map and location map features, Page 8

0 250 500 750 1,000

Meters

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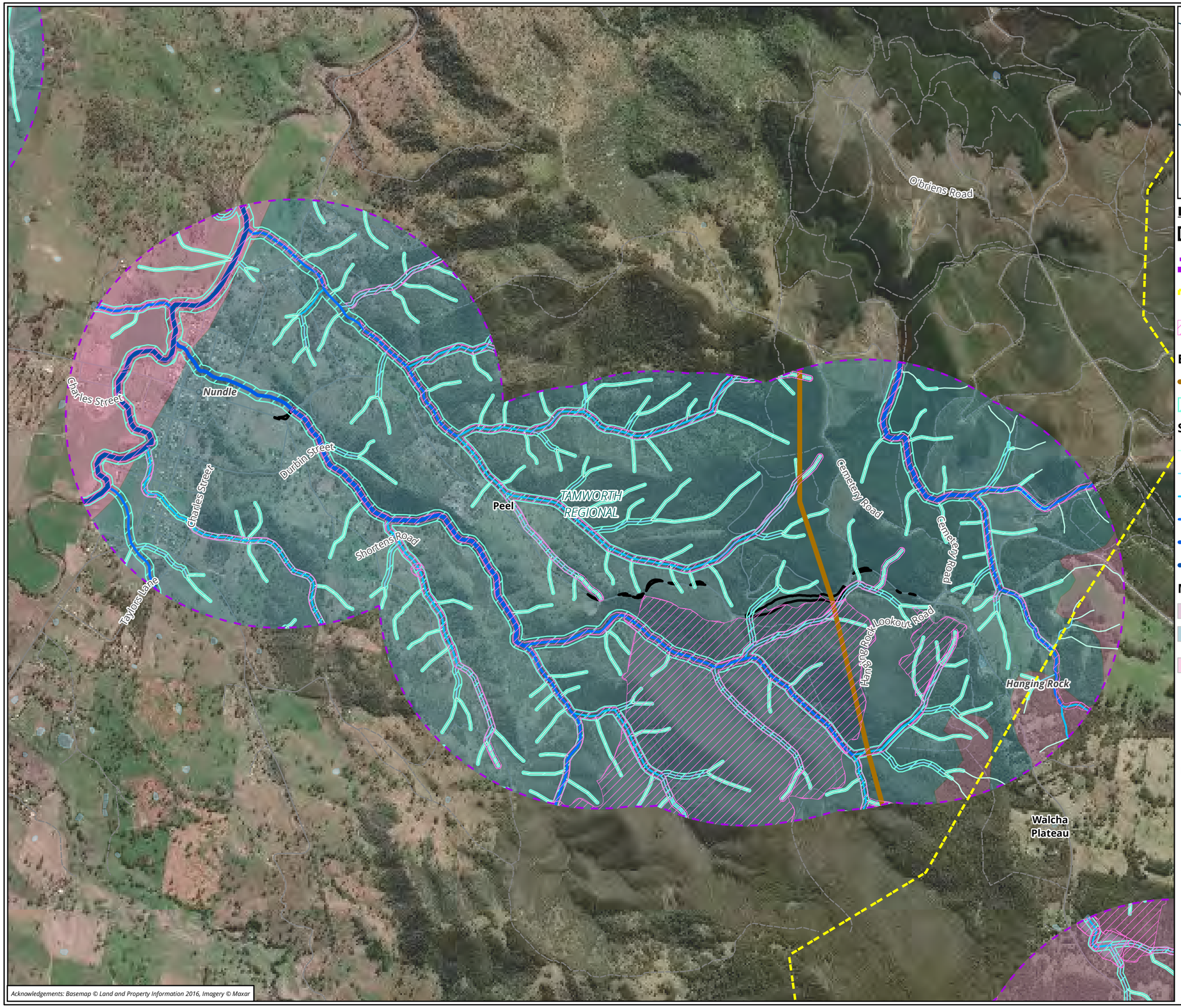

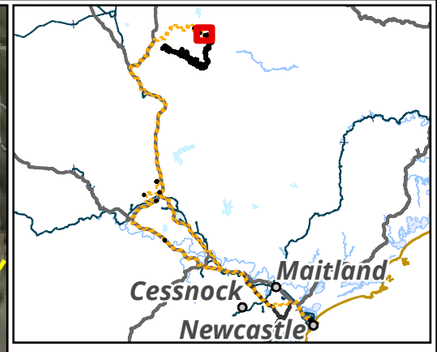

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)

Biodiversity corridors

- Ridgeline
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 5
- 6

Mitchell landscapes

- Mount Royal Tops
- Nundle Hills
- Tamworth - Keepit Slopes and Plains

Figure 4 Site map and location map features, Page 9

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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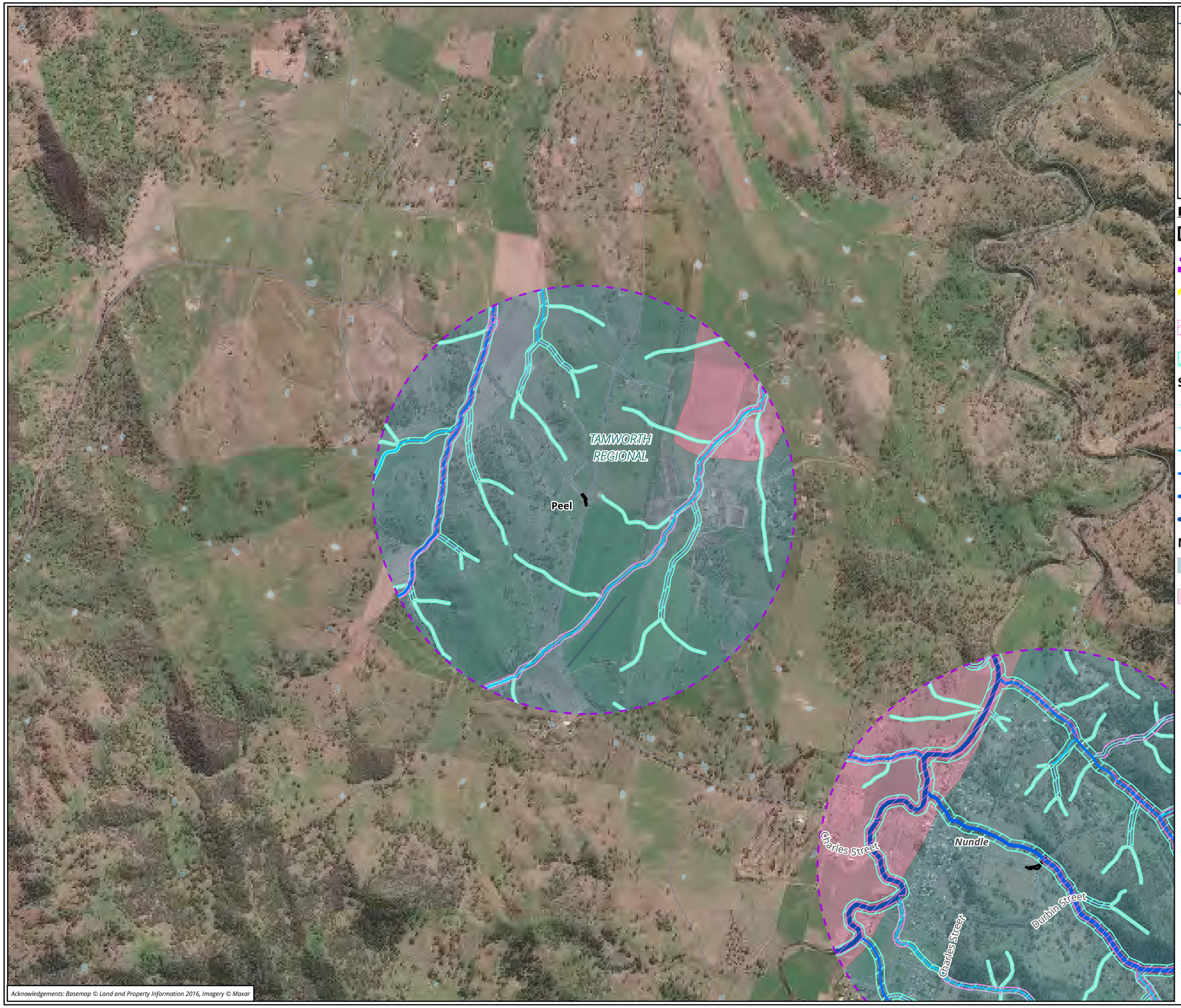

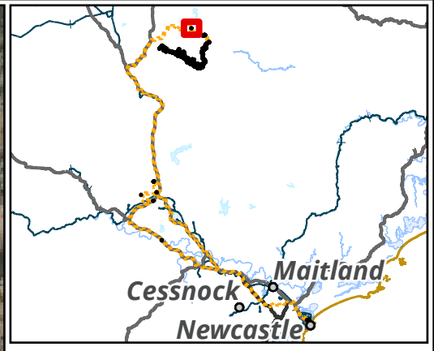

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 5
- 6

Mitchell landscapes

- Nundle Hills
- Tamworth - Keepit Slopes and Plains

Figure 4 Site map and location map features, Page 10

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

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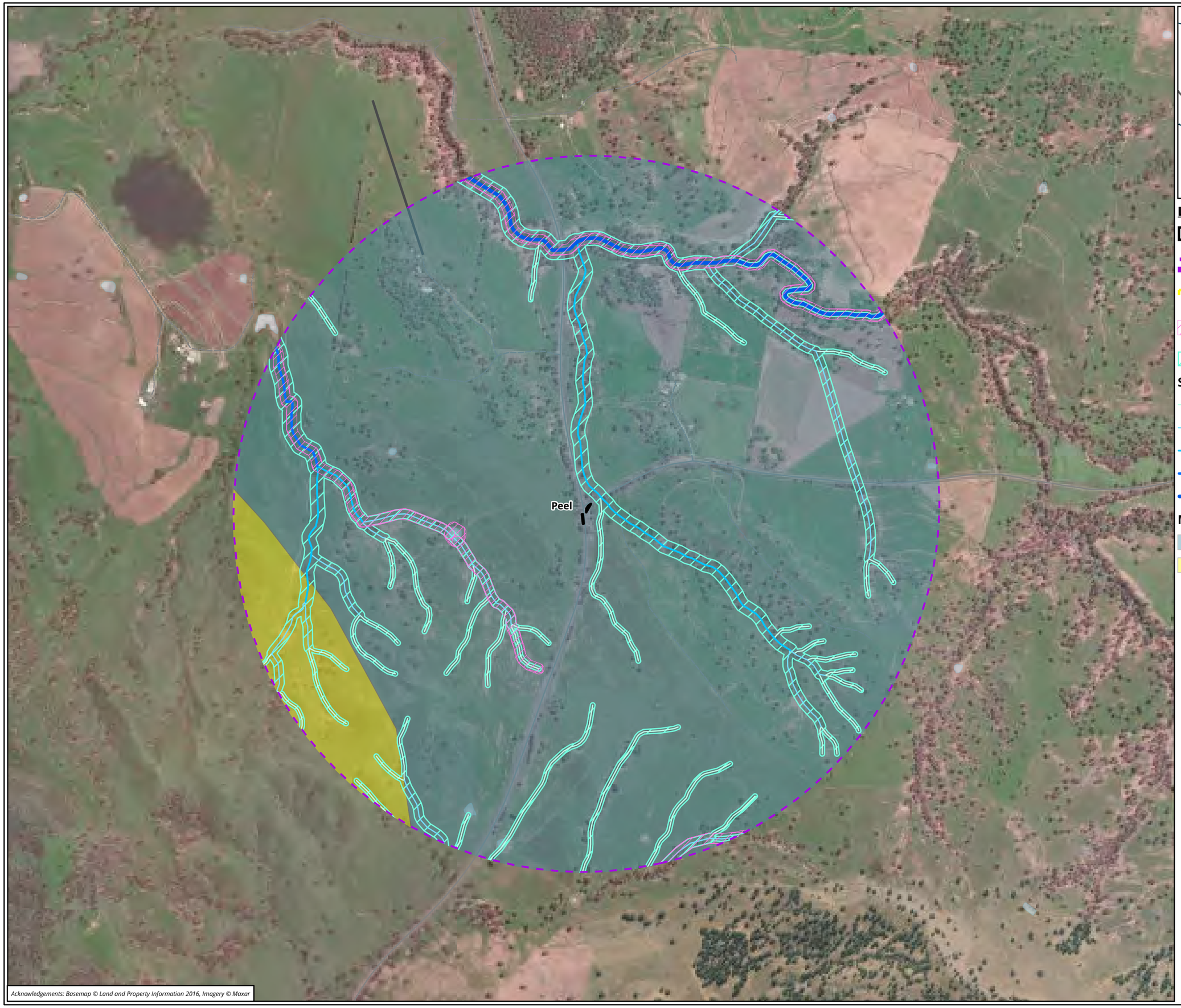

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 5

Mitchell landscapes

- Nundle Hills
- Slippery Rock Range

Figure 4 Site map and location map features,
Page 11

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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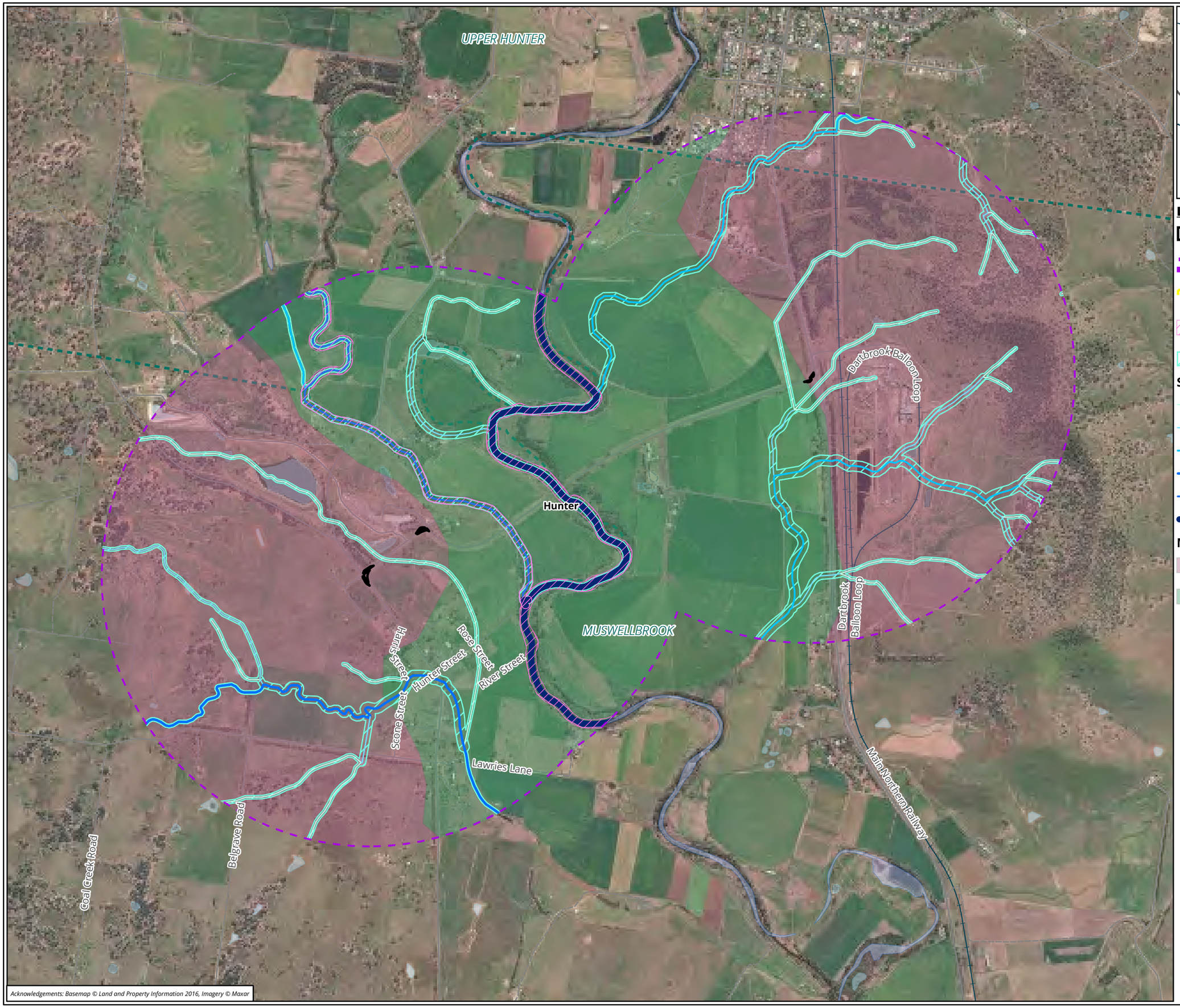

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 7
- 9

Mitchell landscapes

- Central Hunter Foothills
- Upper Hunter Channels and Floodplain

Figure 4 Site map and location map features, Page 12

0 200 400 600 800

Meters

Scale: 1:20,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 5
- 6
- 9

Mitchell landscapes

- Central Hunter Foothills
- Upper Hunter Channels and Floodplain

Figure 4 Site map and location map features, Page 13

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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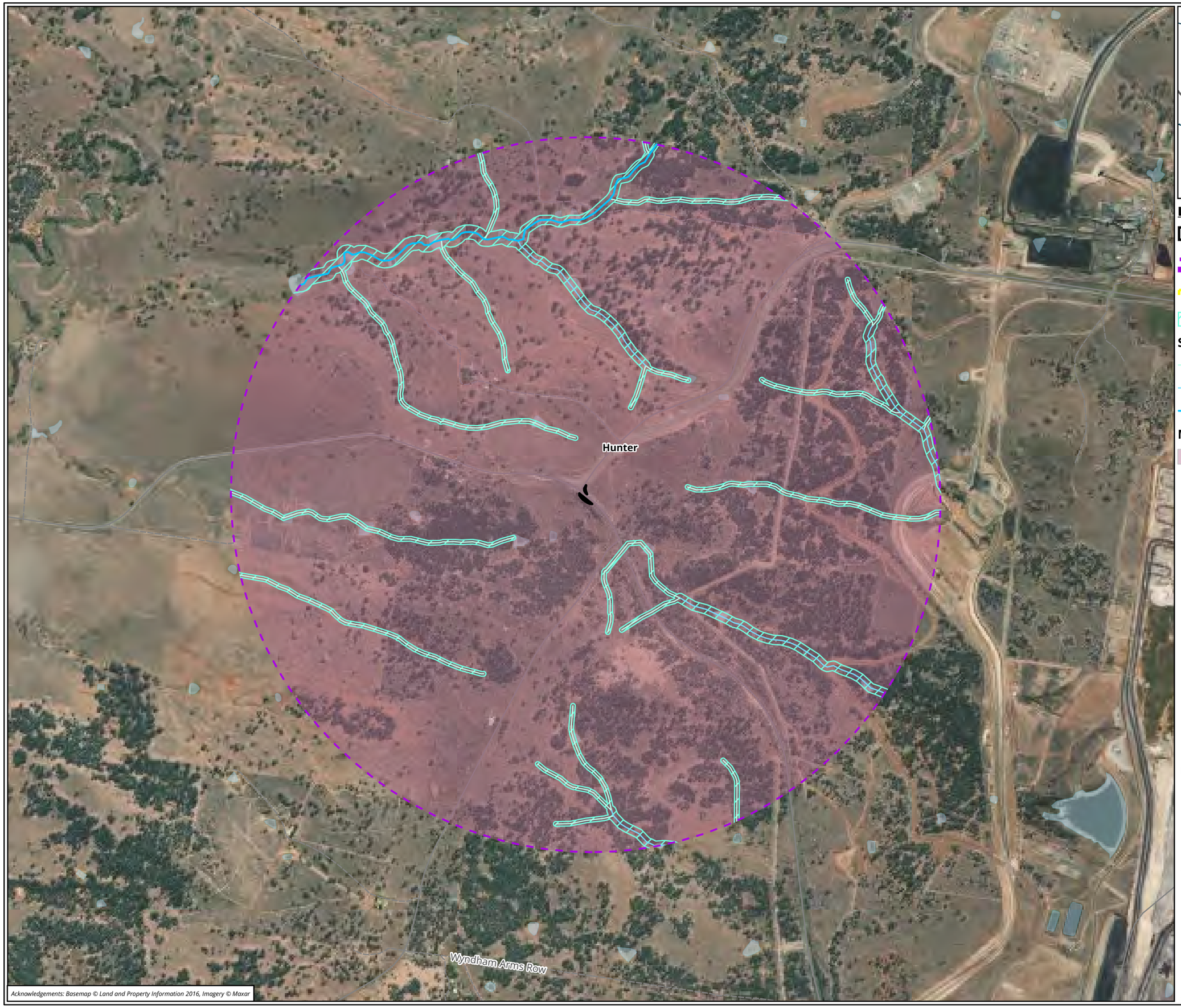

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Riparian lands

Strahler Order

- 1
- 2
- 3

Mitchell landscapes

- Central Hunter Foothills

Figure 4 Site map and location map features, Page 14

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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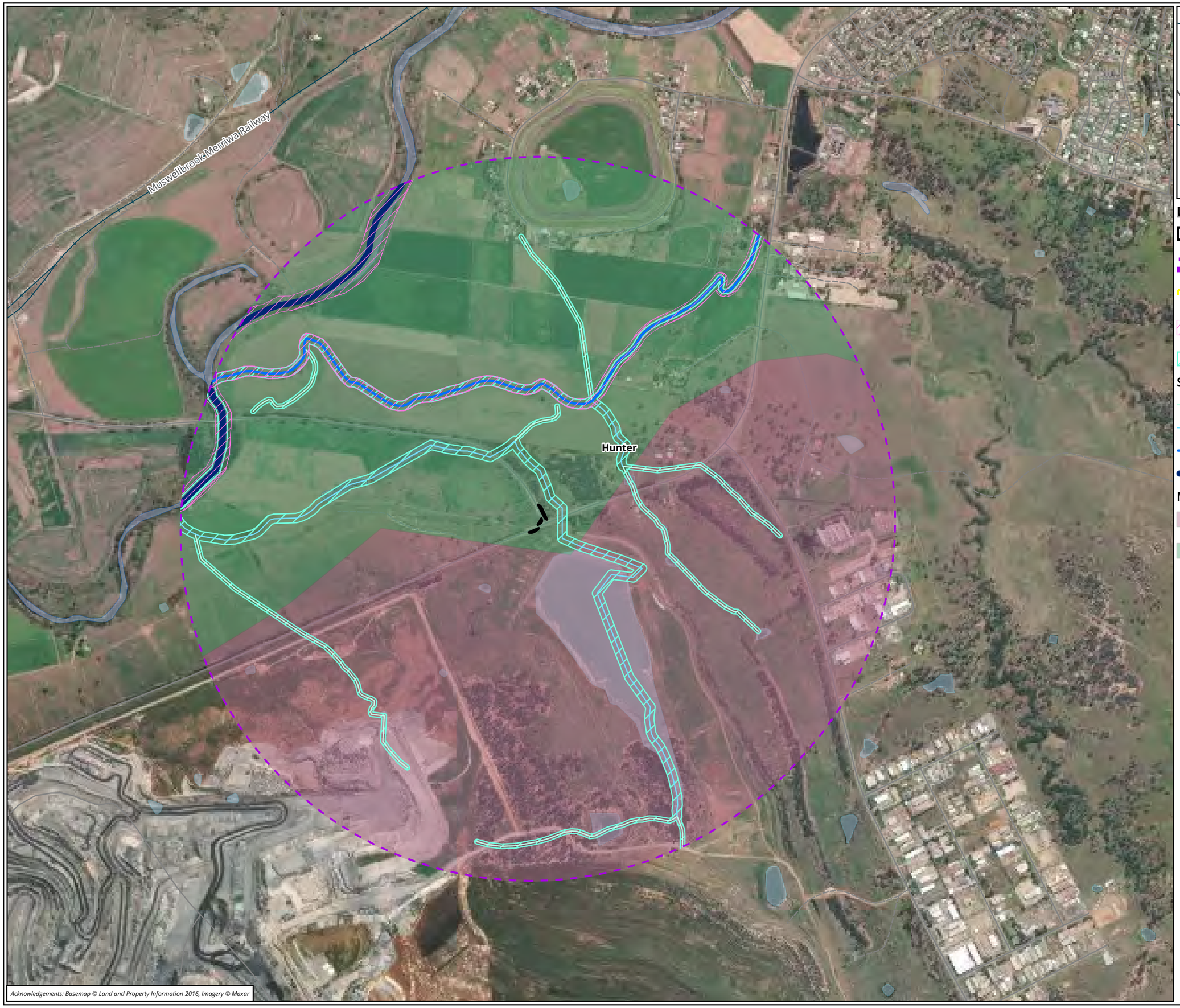

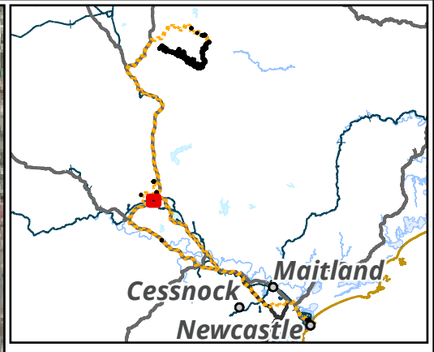

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 4
- 9

Mitchell landscapes

- Central Hunter Foothills
- Upper Hunter Channels and Floodplain

Figure 4 Site map and location map features, Page 15

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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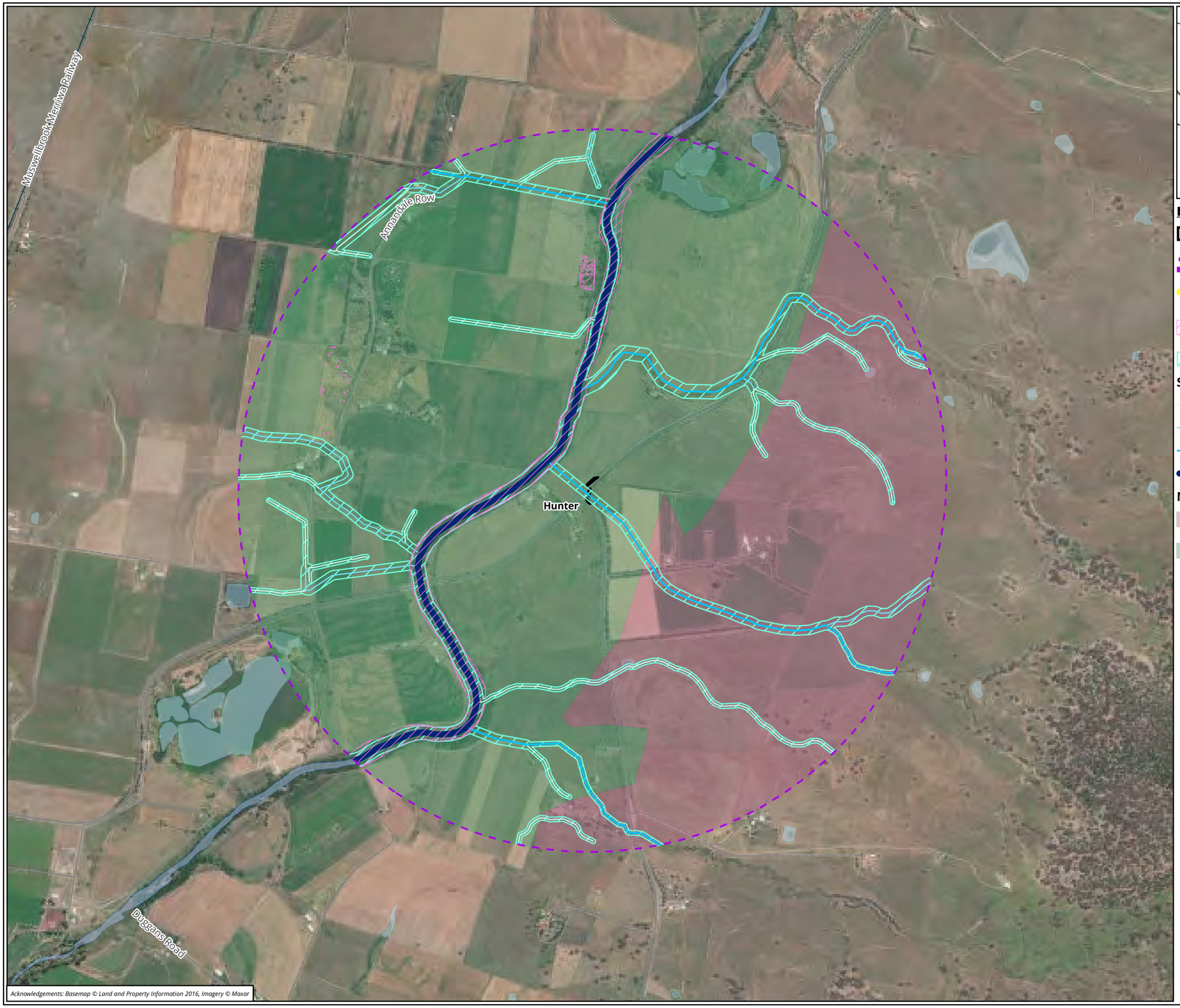

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 9

Mitchell landscapes

- Central Hunter Foothills
- Upper Hunter Channels and Floodplain

Figure 4 Site map and location map features, Page 16

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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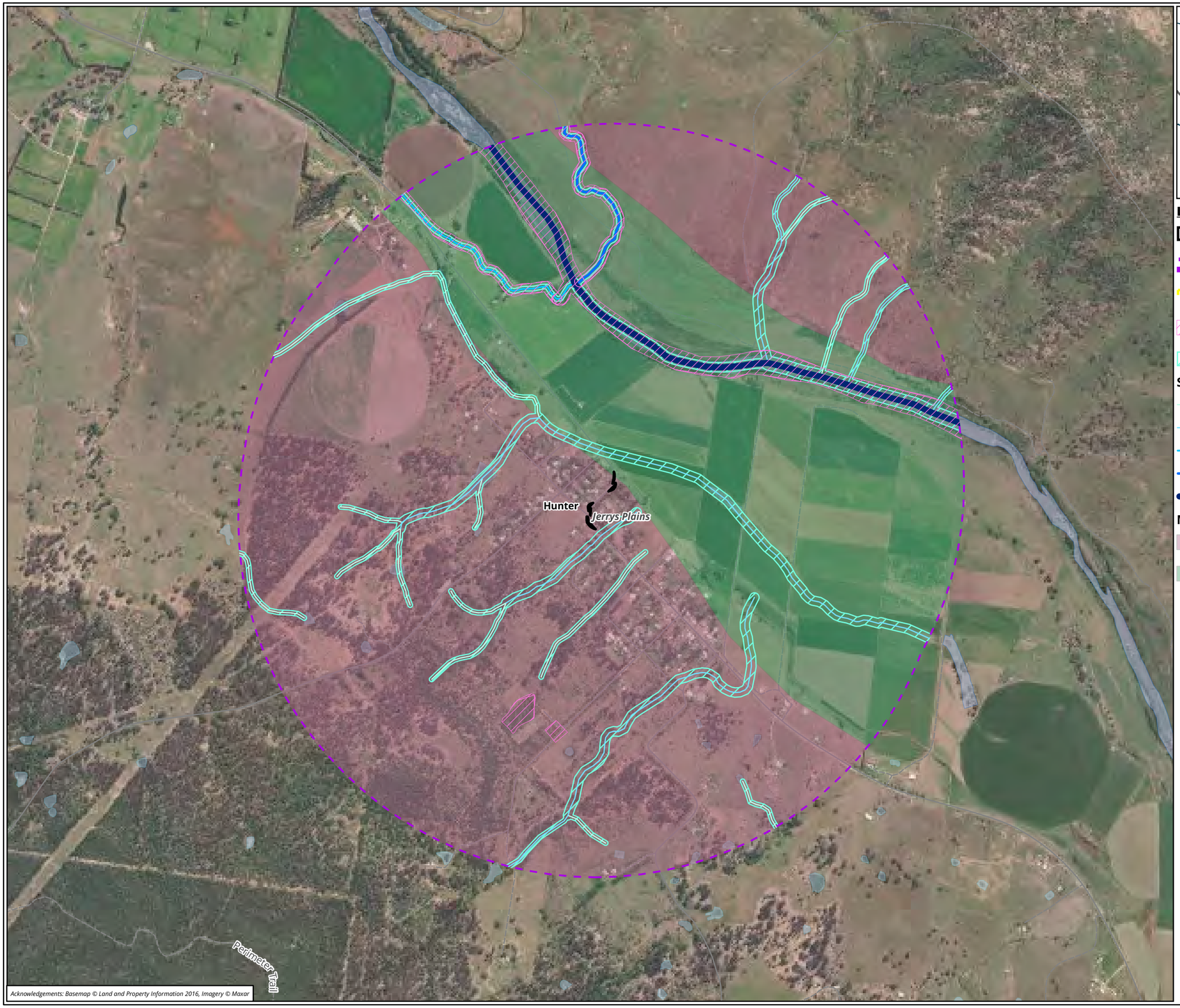

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 9

Mitchell landscapes

- Central Hunter Foothills
- Upper Hunter Channels and Floodplain

Figure 4 Site map and location map features, Page 17

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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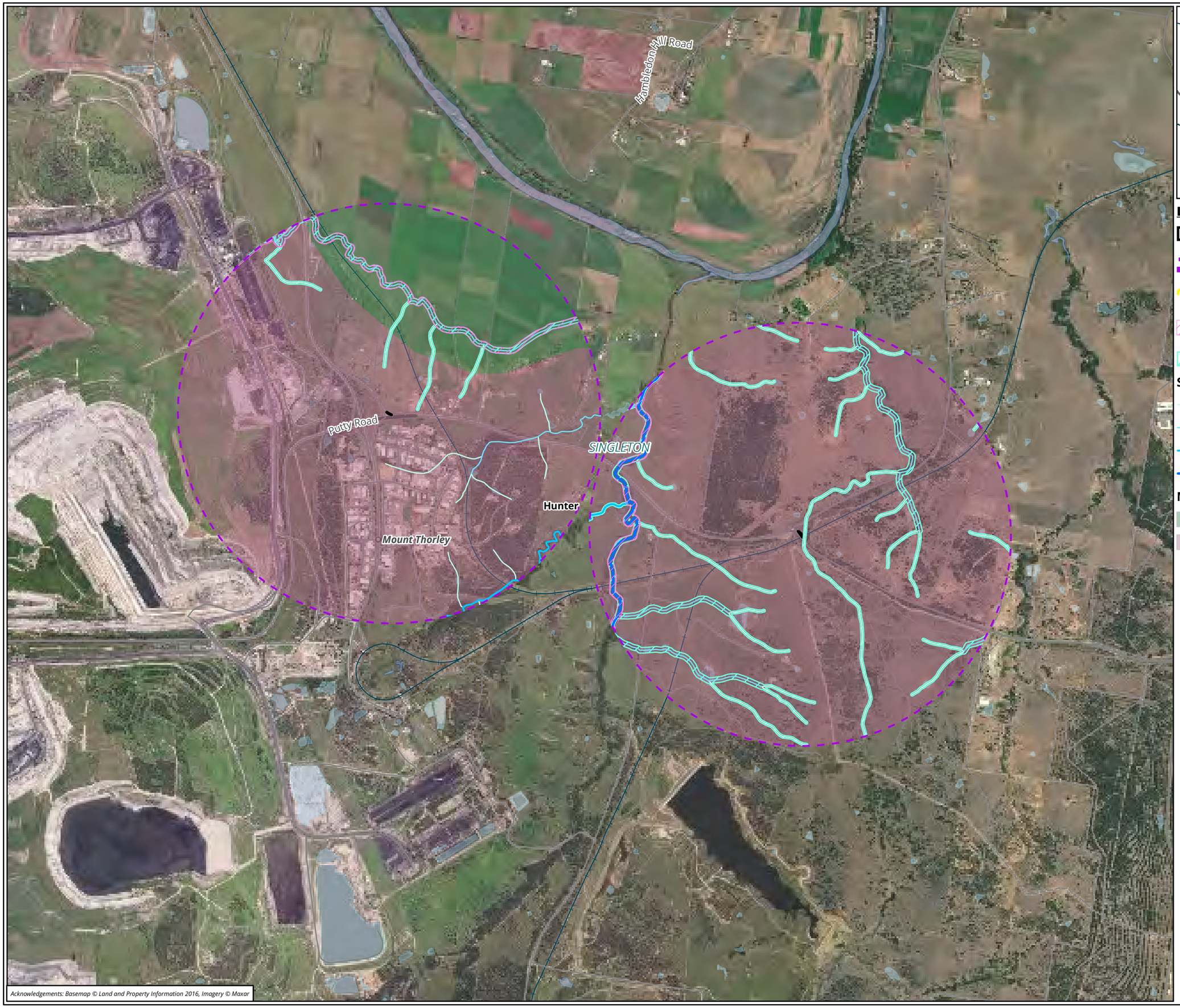

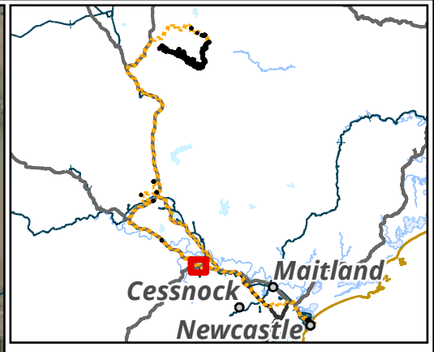

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4

Mitchell landscapes

- Central Hunter Alluvial Plains
- Central Hunter Foothills

Figure 4 Site map and location map features, Page 18

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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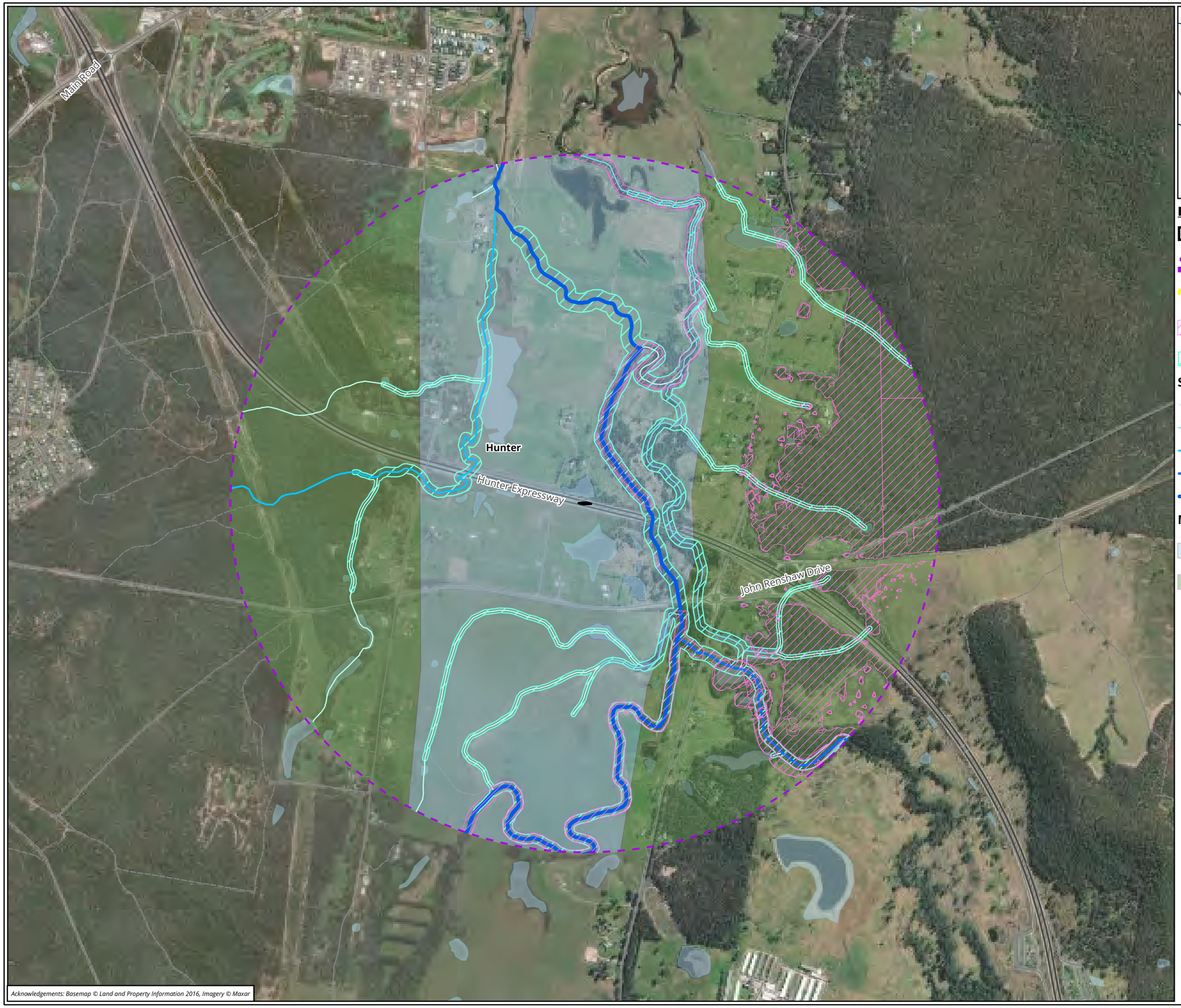

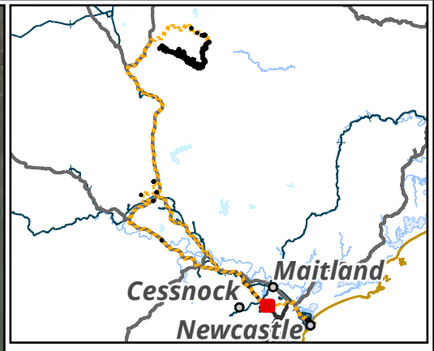

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 4
- 5

Mitchell landscapes

- Lower Hunter Channels and Floodplains
- Newcastle Coastal Ramp

Figure 4 Site map and location map features, Page 19

0 150 300 450 600

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- IBRA subregions
- Biodiversity values map (DPIE, 2020)
- Riparian lands

Strahler Order

- 1
- 2
- 3
- 5
- 9

Mitchell landscapes

- Gosford - Cooranbong Coastal Slopes
- Lower Hunter Channels and Floodplains
- Sydney - Newcastle Barriers and Beaches

Figure 4 Site map and location map features, Page 20

0 200 400 600 800

Meters

Scale: 1:20,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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3.2 Site context

Site context considerations include the assessment of native vegetation cover and patch size, in accordance with Section 3.2 and 4.3 of the BAM. These assessments were undertaken using the following existing vegetation mapping available for the region:

- Ground-truthed PCT map prepared for the wind farm infrastructure area and haul route sites.
- State Vegetation Type Map: Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a).
- State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020b).
- Greater Hunter Native Vegetation Mapping Version 4.0. VIS_ID 3855 (DPIE, 2015).
- OEH BioNet Vegetation Classification Database.

Figure 5 shows native vegetation cover and patch assignment relative to the estimated development footprint.

Parts of the assessment area were burnt by the summer 2019/2020 bushfires which burnt large tracks of the surrounding vegetation. Within a 20 kilometre buffer area of the assessment area approximately 32,000 hectares (25%) of native vegetation has been burnt, with the area estimated to support a total of approximately 116,500 hectares of native vegetation. Most (approximately 26,200 hectares or 82%) of this vegetation has been burnt to a medium or high degree of intensity, in accordance with the burnt area classes outlined in the GEEBAM (NSW Department of Planning, Industry and Environment 2020), meaning both the canopy and understorey have either been partially of completely burnt.

Within the vicinity of the wind farm, bushfire effected areas along the southern side of the central portion of the development footprint within and surrounding Ben Halls Gap Nature Reserve, nears turbines WP20 to WP45. Consideration of bushfire effects on vegetation, habitat and refugia within and surrounding the development site has been considered during this assessment.

3.2.1 Native vegetation cover

About 49% of the 42,316ha of the landscape assessment has been cleared of native vegetation. However, approximately 21,540ha (or 51% of the assessment area) consists of native vegetation which is classified as having a cover class of between >30-70% meaning that this is the percentage of native vegetation cover within the assessment area. This is summarised in Table 17.

The extent of native vegetation cover across all areas of the landscape context maps are provided in Figure 5.

Table 17 Native vegetation cover

Native vegetation extent (ha)	Assessment area (ha)	% landscape assessment area	Native vegetation cover class
21,540	42,316	51%	>30-70%

3.2.2 Patch size

Patch size for the native vegetation within the assessment area has been assessed in accordance with the requirements of Section 4.3.2 of the BAM. Each native vegetation zone in the development footprint was assessed and assigned to a required patch size class, being <5ha, 5–<25ha, 25–100ha or ≥100ha.

Patch size was assessed in accordance with the BAM using ArcGIS to select, measure and classify native vegetation patches. Within each NSW Landscape, all native vegetation not defined as low condition and

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separated by a distance of less than 100 metres (woody vegetation types) and 30 metres (non-woody vegetation types) was mapped sequentially using the development footprint PCT mapping and desktop mapped data.

Vegetation patches and associated patch size classes were all classified in the greater than 100ha patch size class in accordance with Section 4.3.2 of the BAM. This is due to the vegetation zones within the development footprint occurring less than 100m apart and so being assigned to the same patch as under the BAM, the definition of a patch is an area of intact native vegetation that occurs within the development footprint and includes other areas of native vegetation that are within 100m of the patch.

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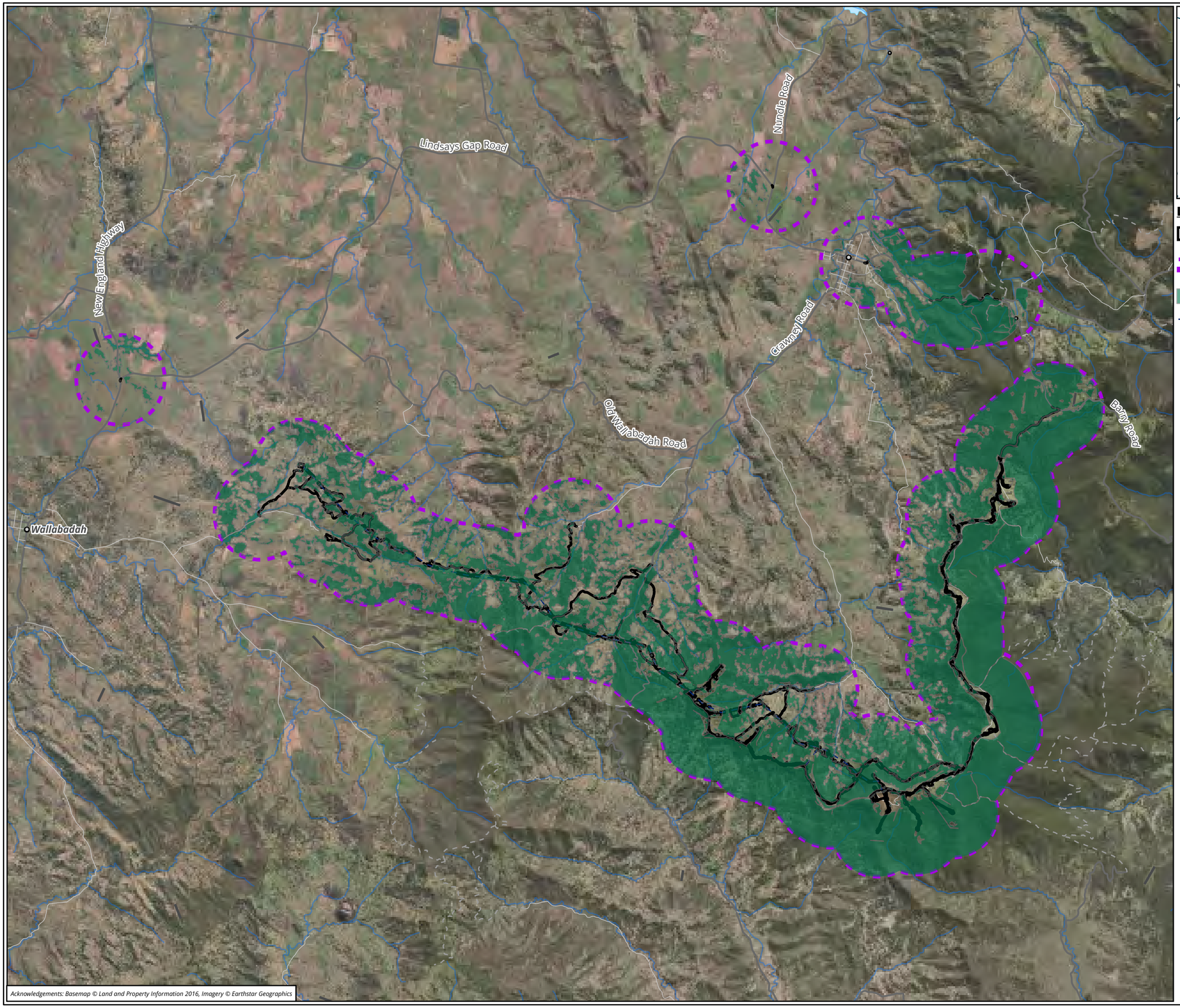

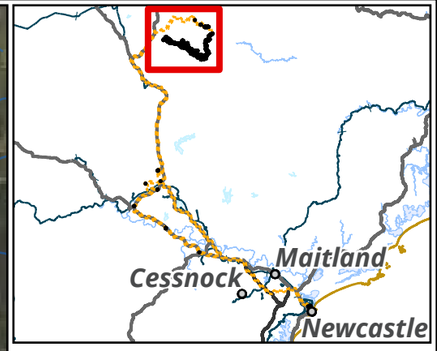

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation
- Transmission line

Figure 5 Location map native vegetation cover, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:120,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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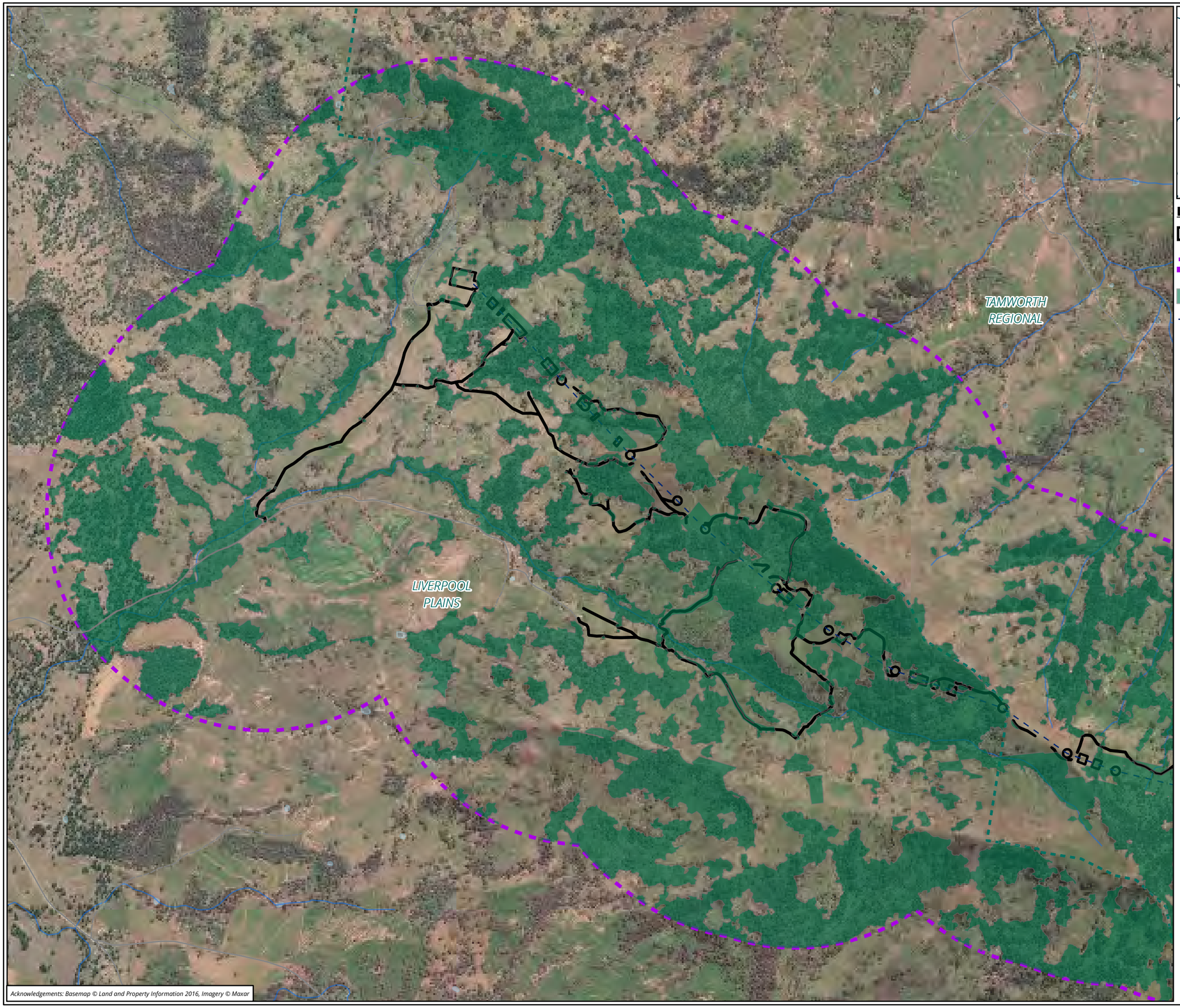

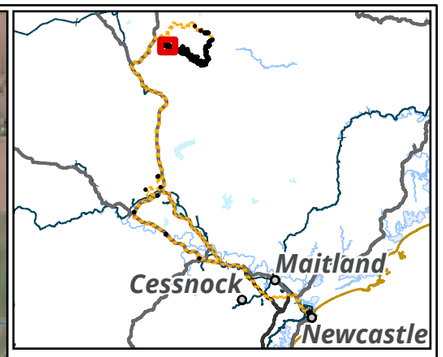

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation
- Transmission line

Figure 5 Location map native vegetation cover, Page 2

0 300 600 900 1,200 N

Meters

Scale: 1:25,000 @ A3

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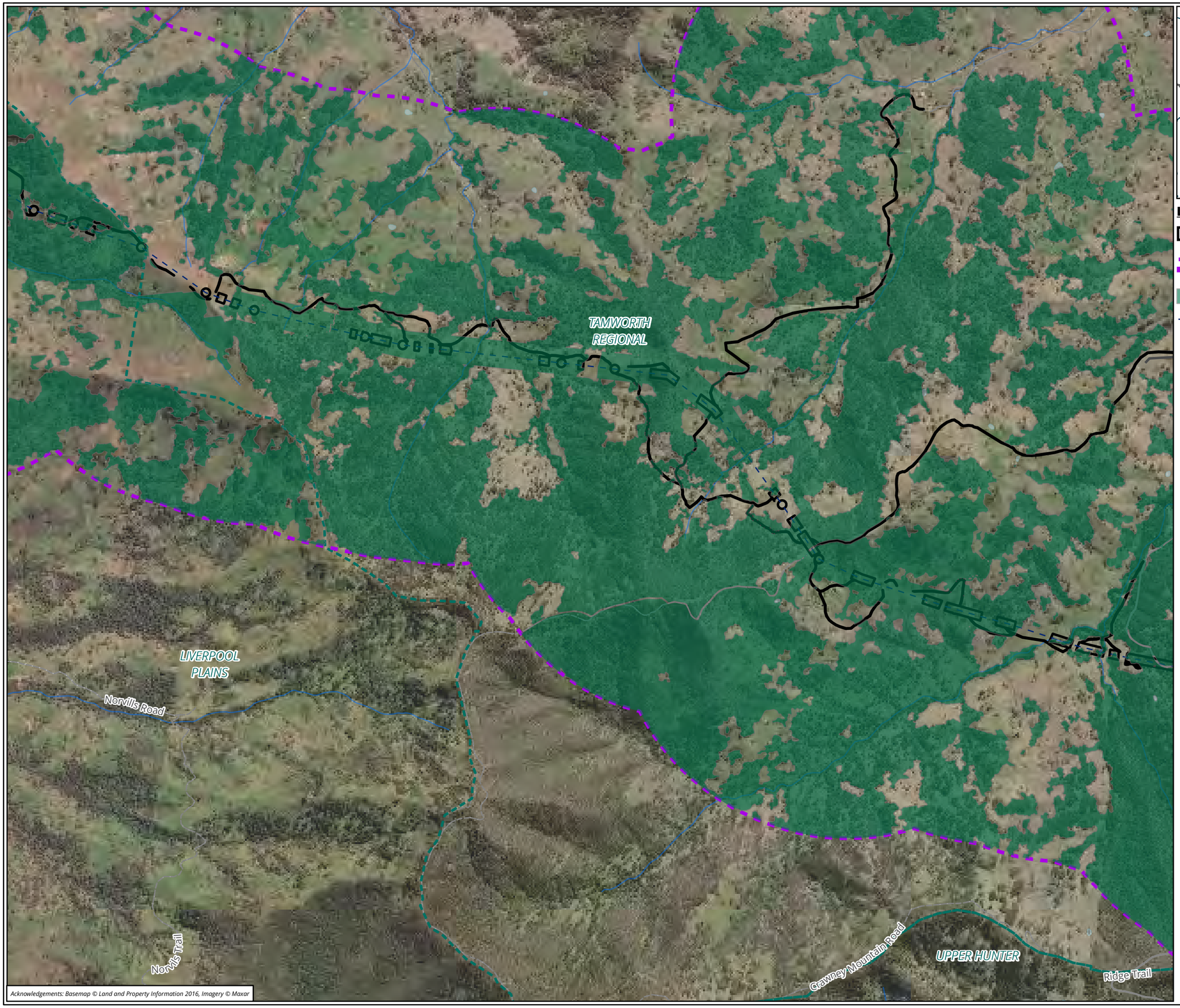

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation
- Transmission line

Figure 5 Location map native vegetation cover, Page 3

0 300 600 900 1,200 N

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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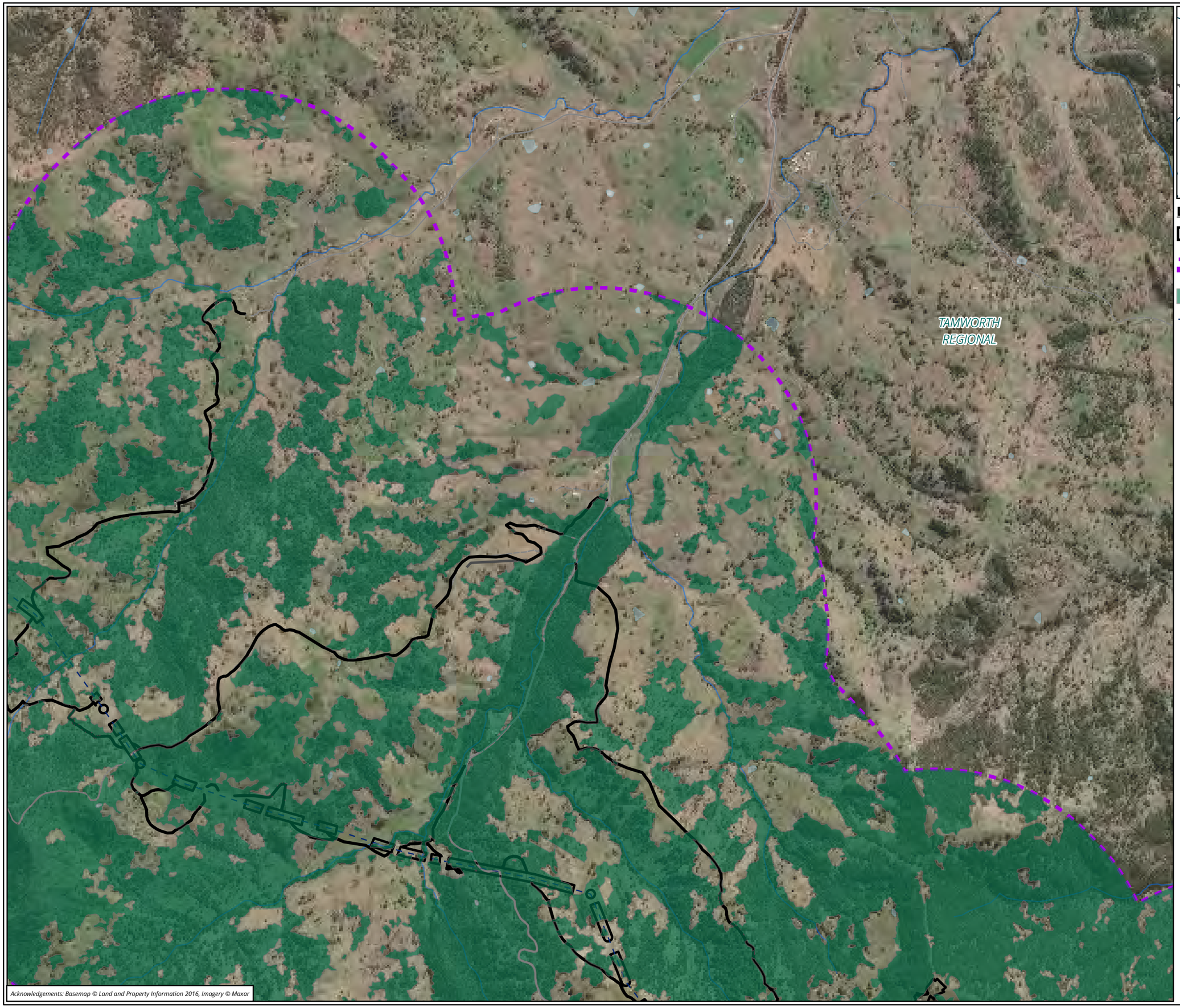

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation
- Transmission line

Figure 5 Location map native vegetation cover, Page 4

0 300 600 900 1,200

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation
- Transmission line

Figure 5 Location map native vegetation cover, Page 5

0 180 360 540 720

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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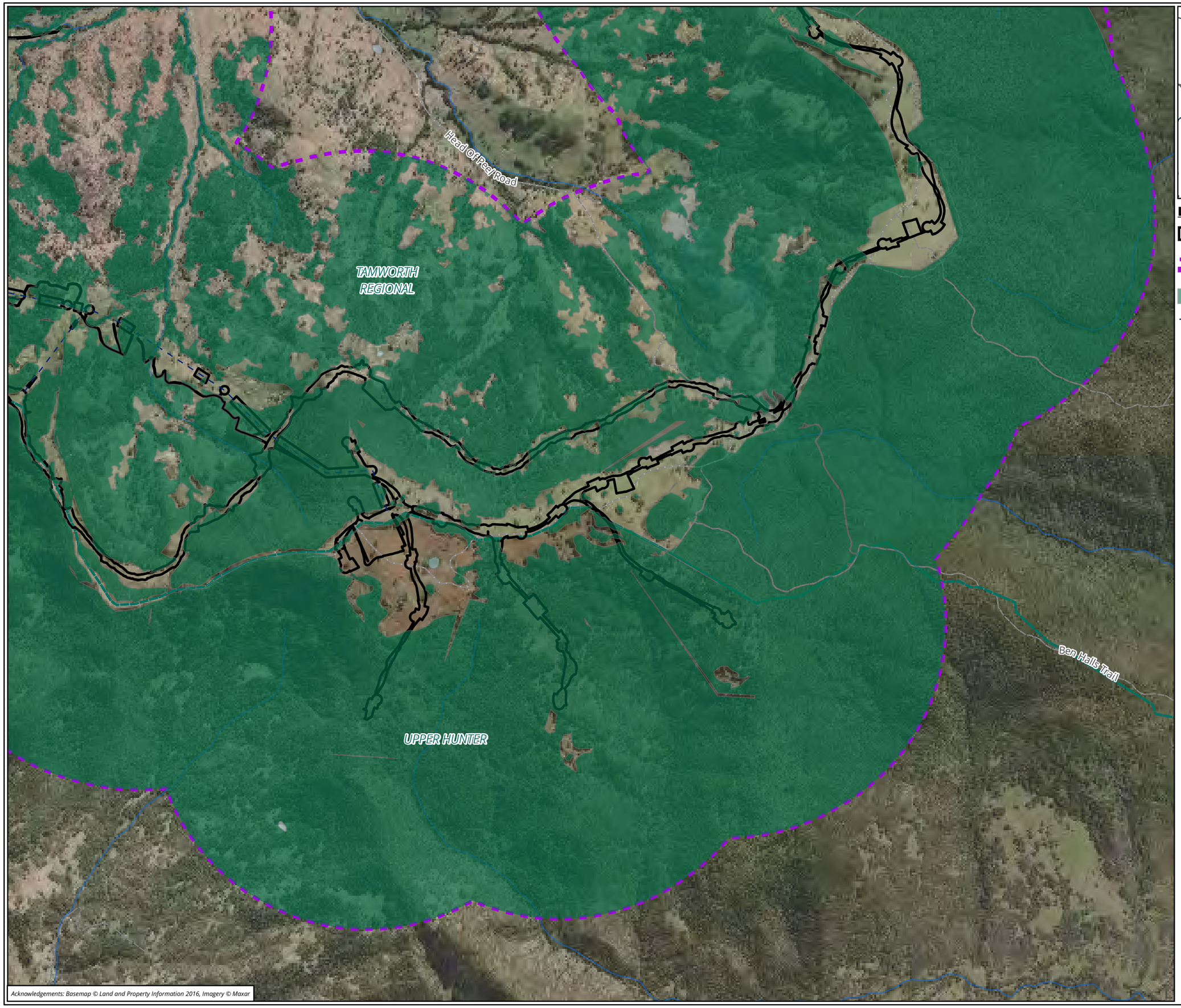

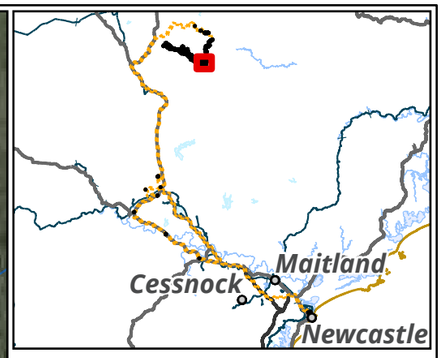

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation
- Transmission line

Figure 5 Location map native vegetation cover, Page 6

0 300 600 900 1,200

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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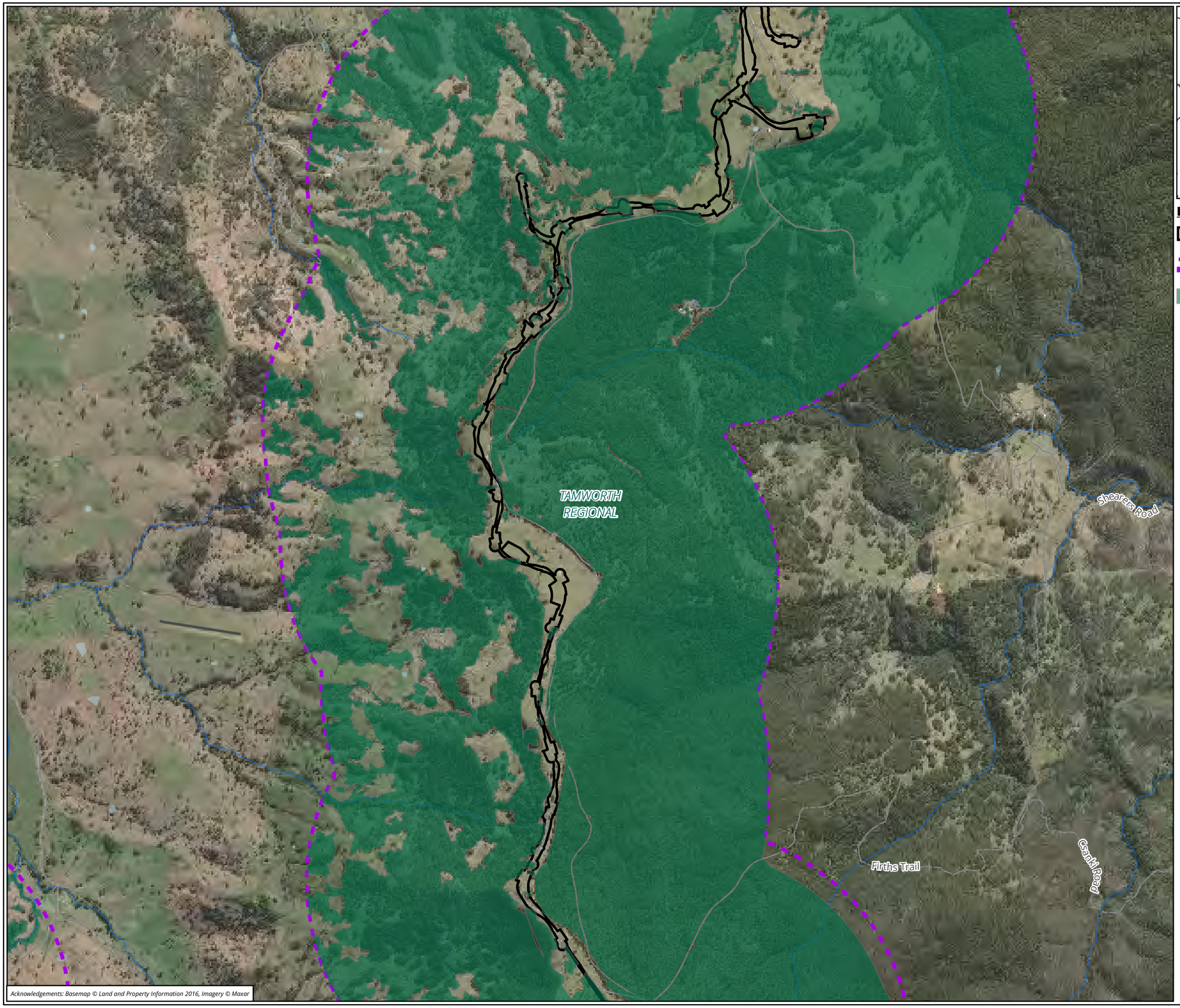

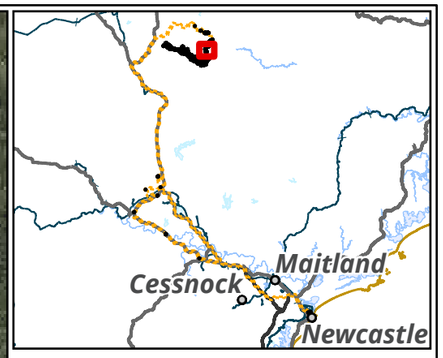

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 7

0 300 600 900 1,200 N

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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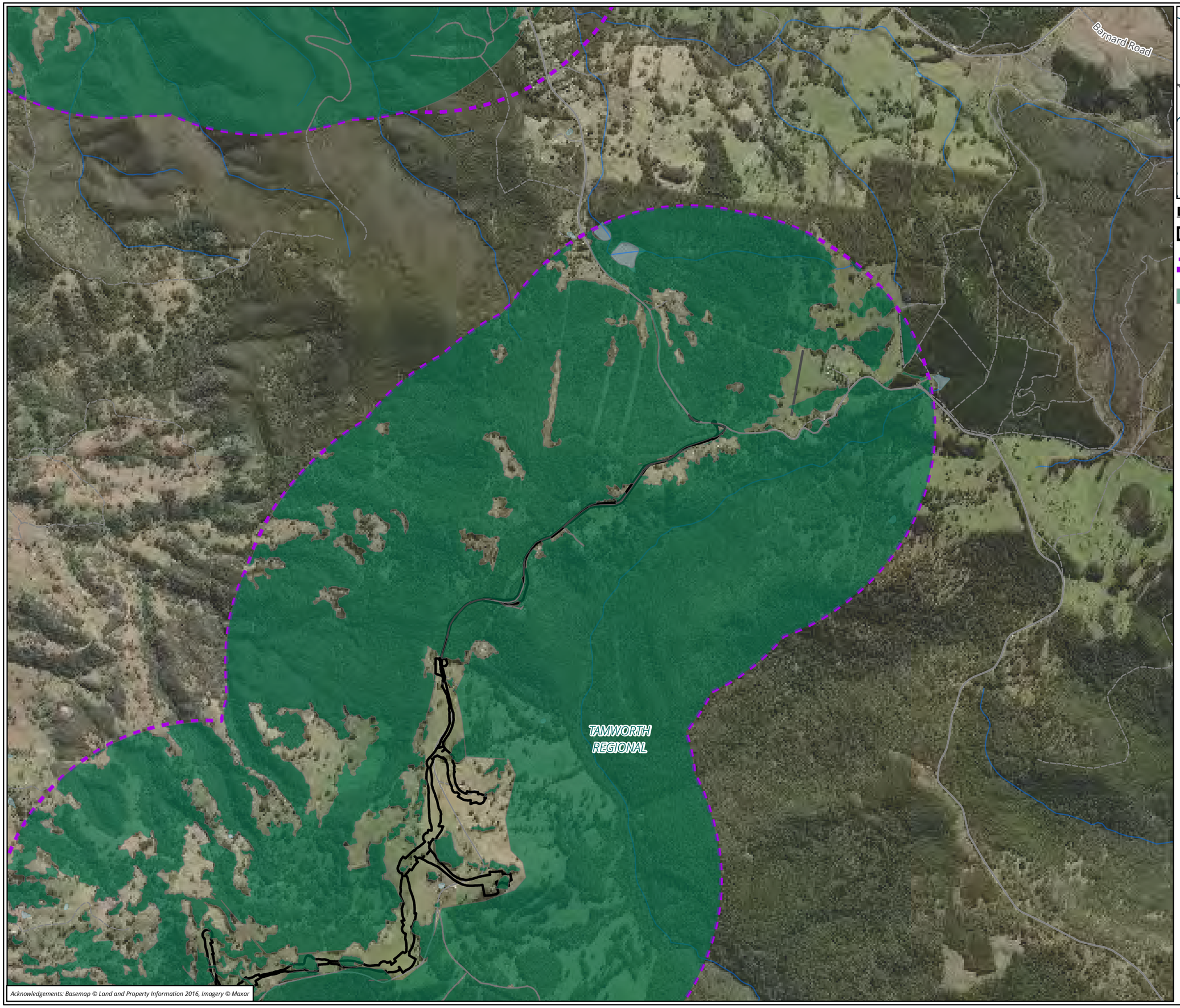

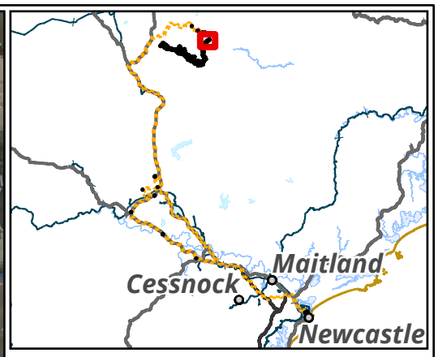

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 8

0 300 600 900 1,200

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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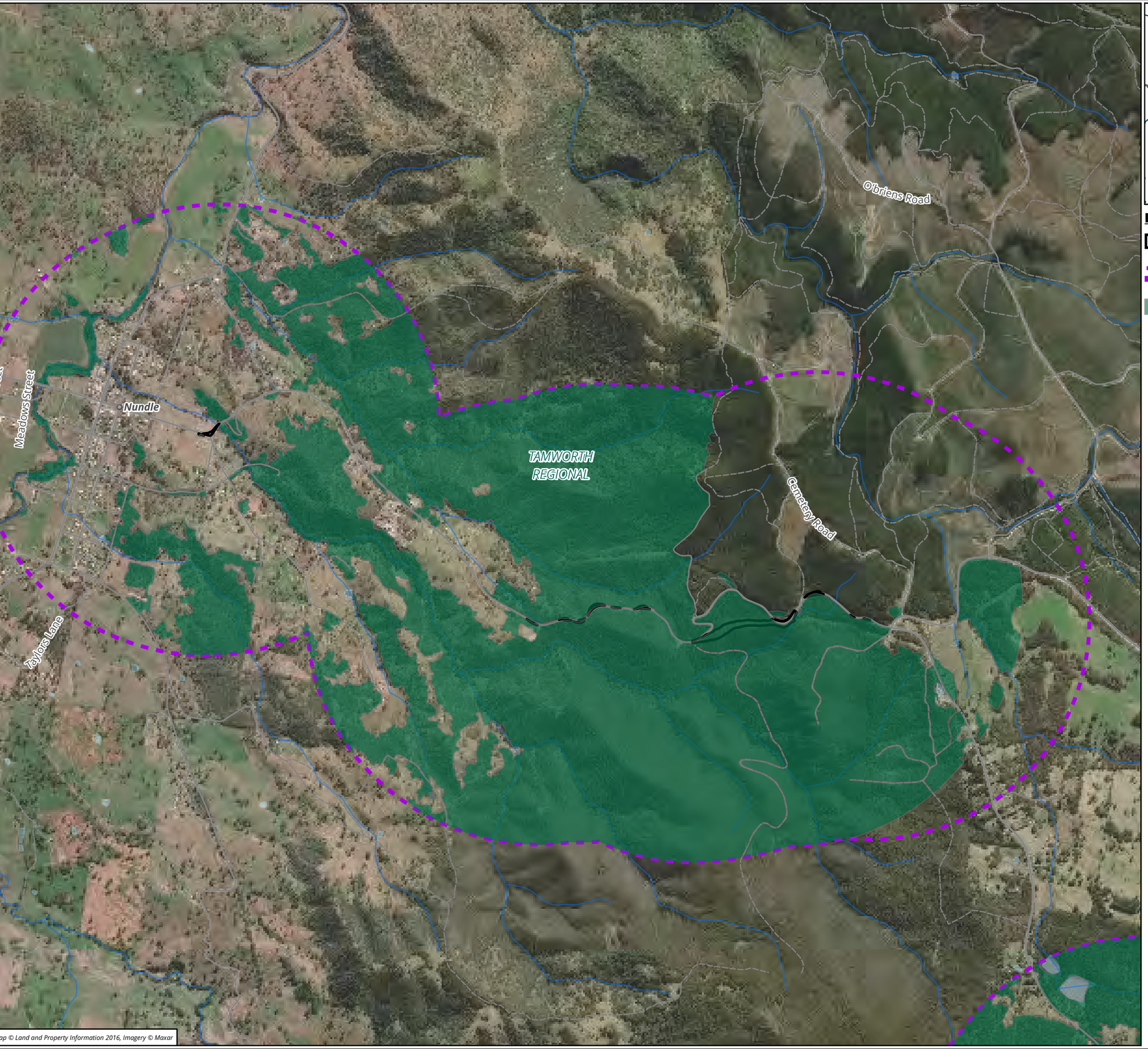

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 9

0 300 600 900 1,200 N

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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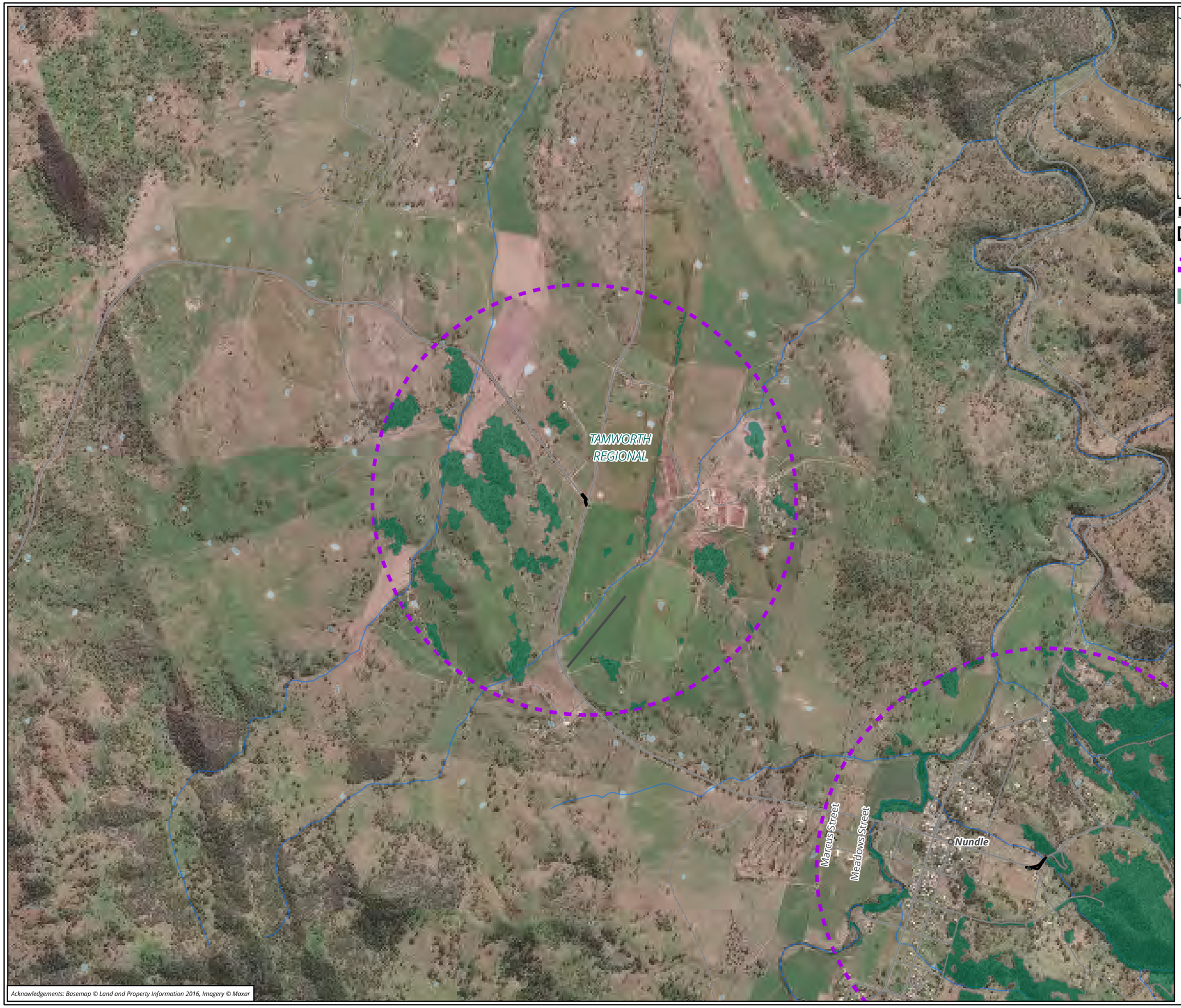

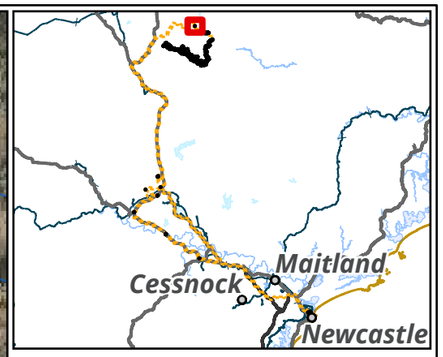

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 10

0 300 600 900 1,200

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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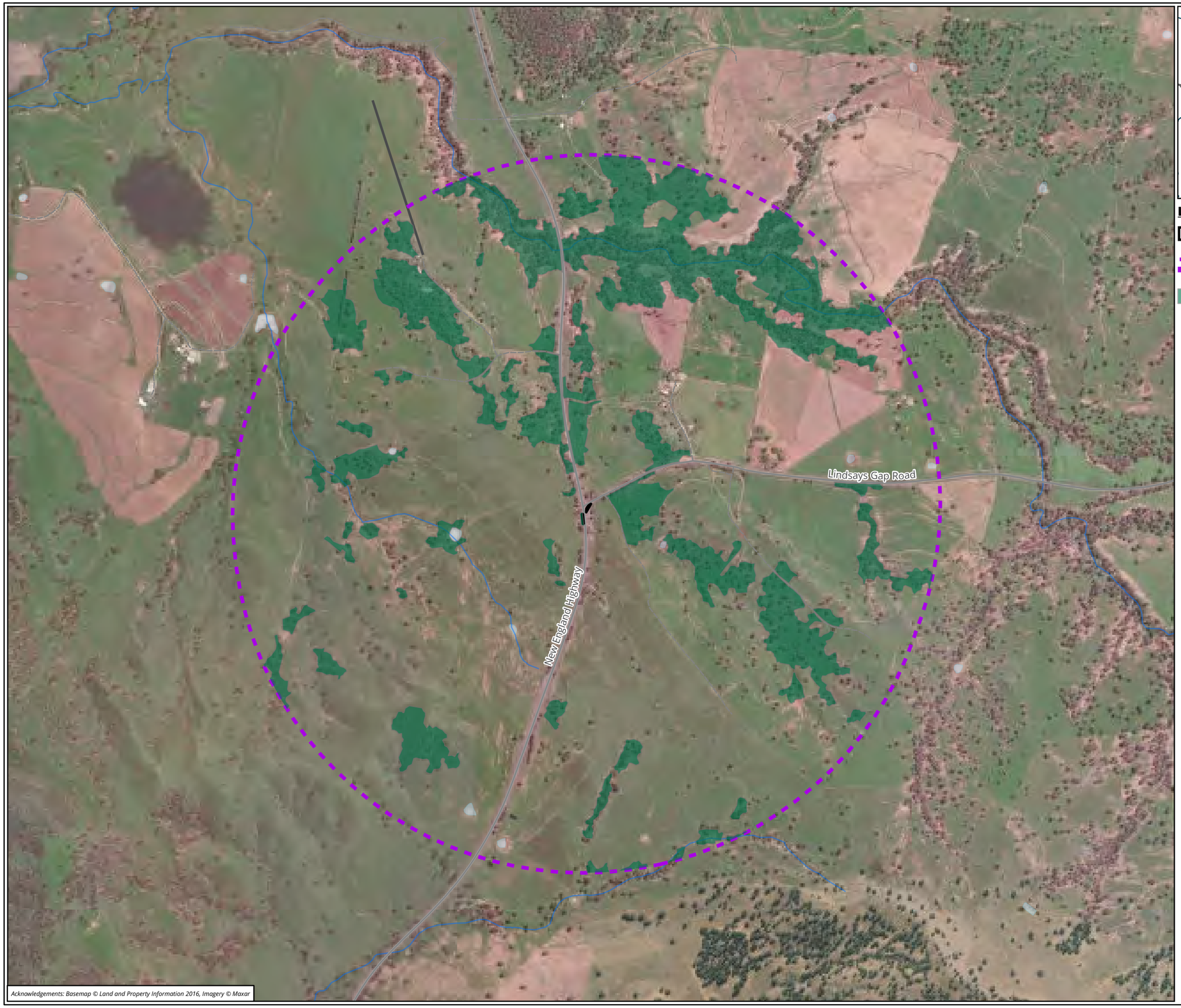

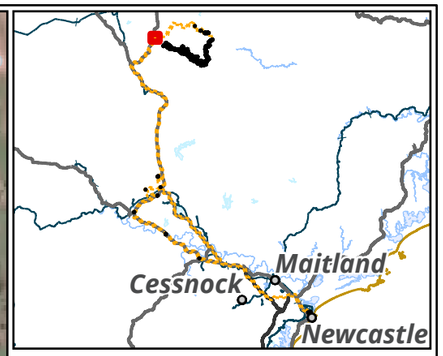

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 11

0 180 360 540 720

Meters

Scale: 1:15,000 @ A3

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Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

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Figure 5 Location map native vegetation cover, Page 12

0 240 480 720 960 N

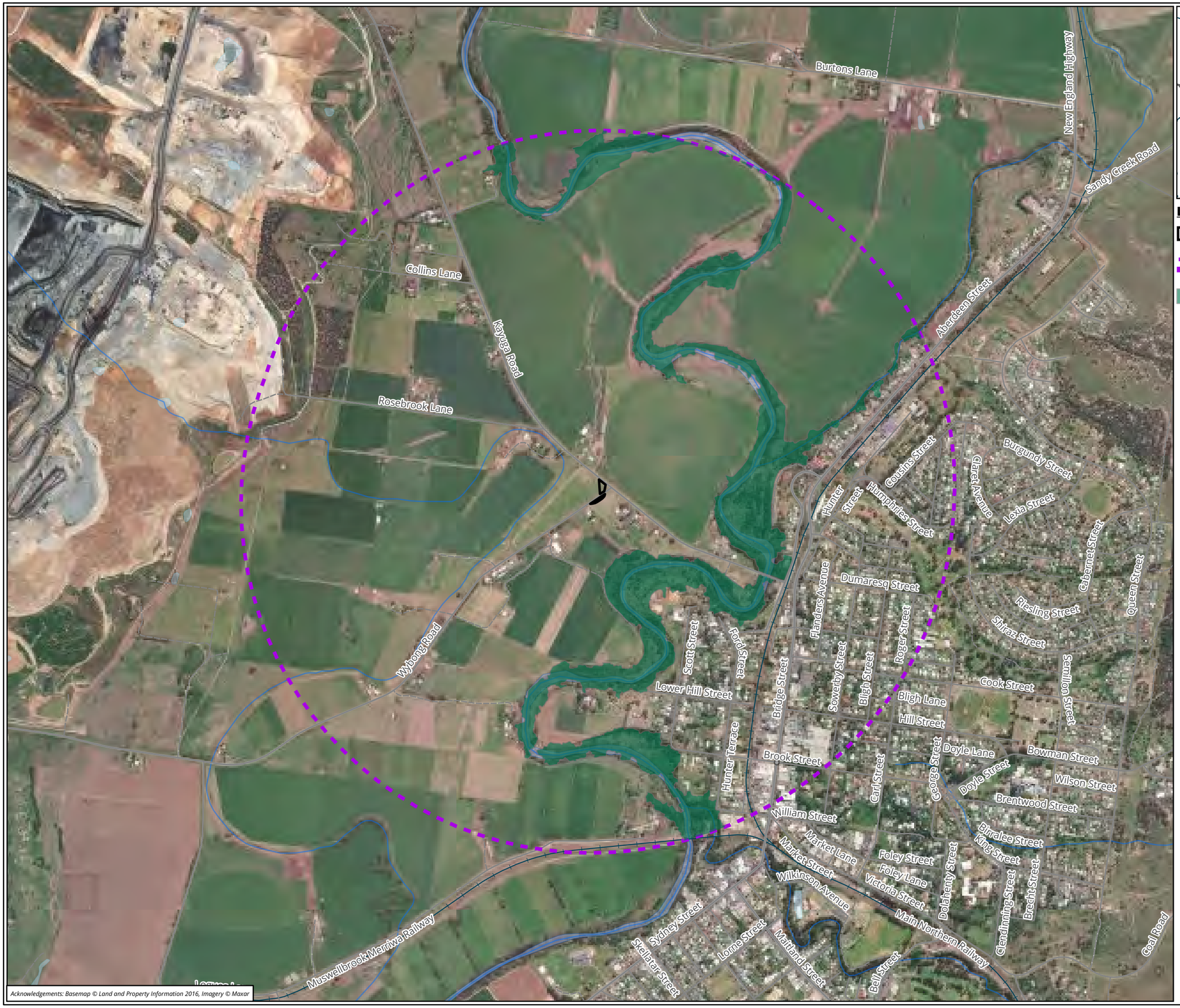
Meters

Scale: 1:20,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx



Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Maxar

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Figure 5 Location map native vegetation cover, Page 13

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Layout: 34963_F5_NativeVeg
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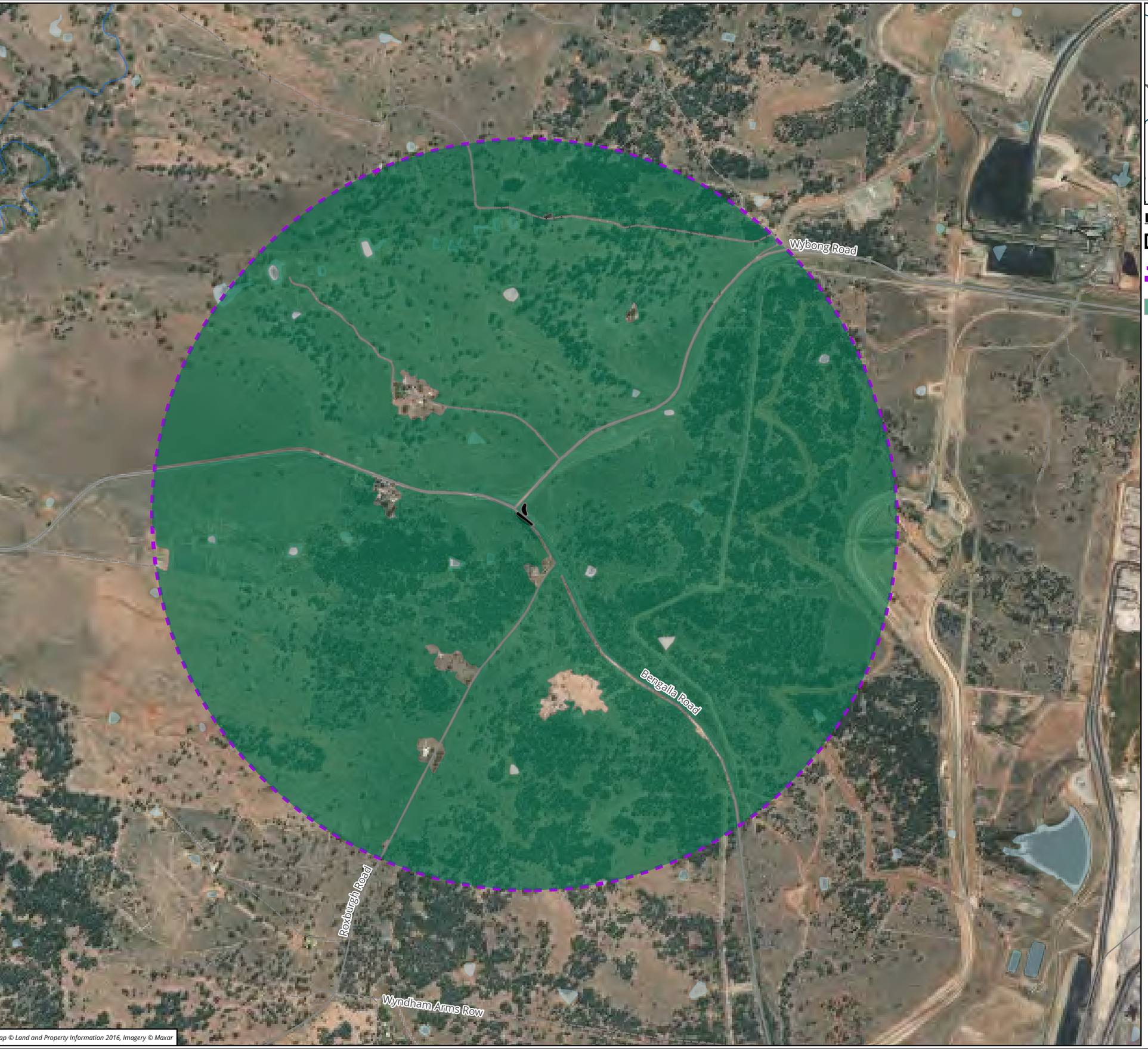


Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 14

0 180 360 540 720 N

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 15

0 180 360 540 720 N

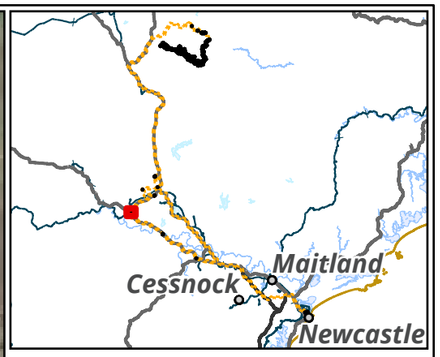
Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx



Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 16

0 180 360 540 720 N

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
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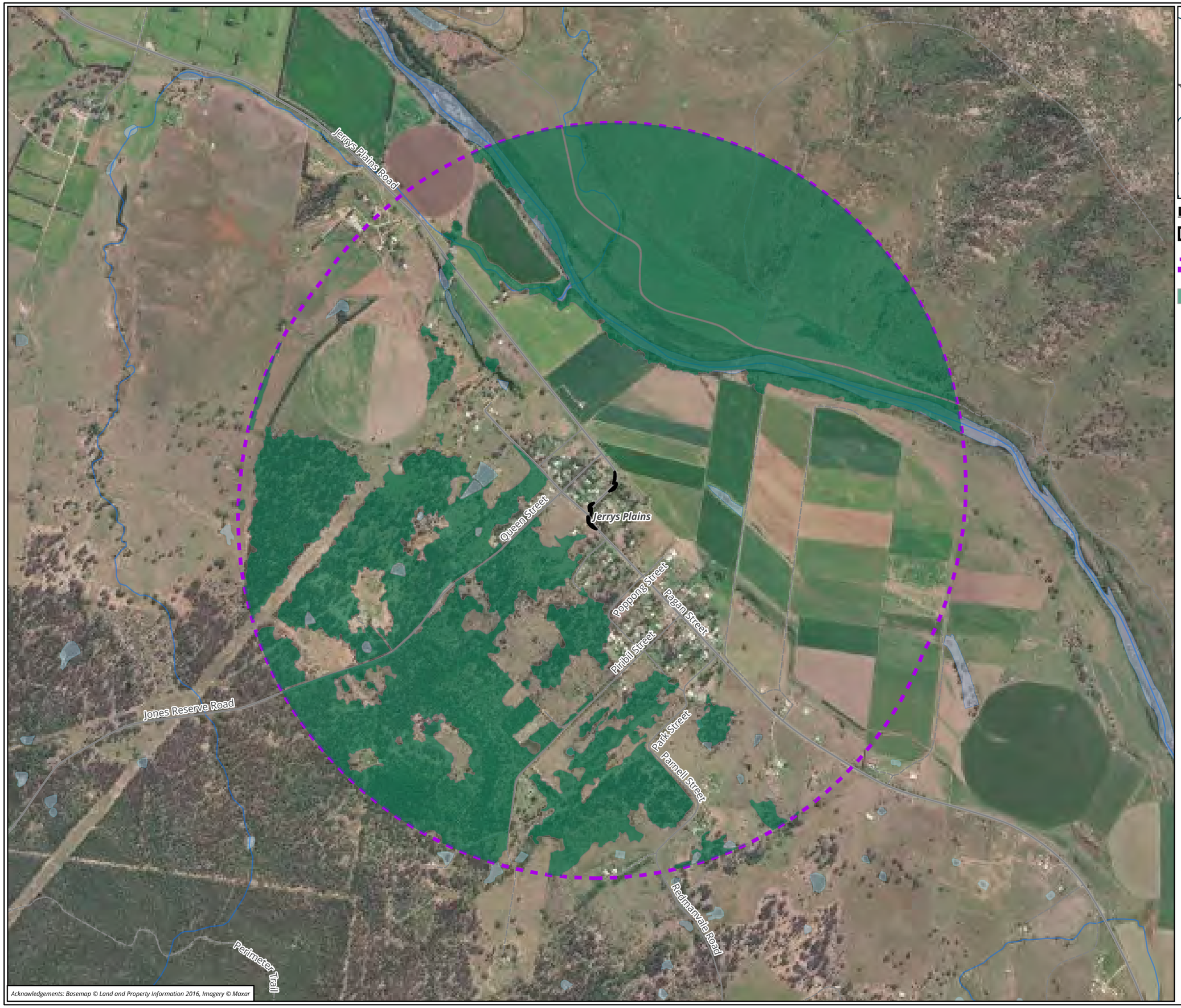

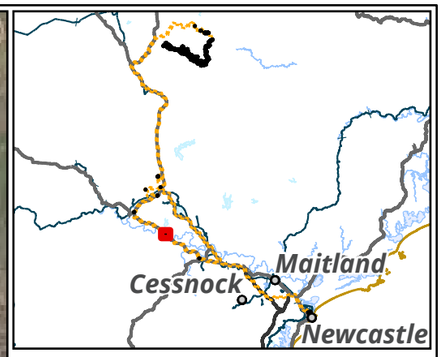

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 17

0 180 360 540 720 N

Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
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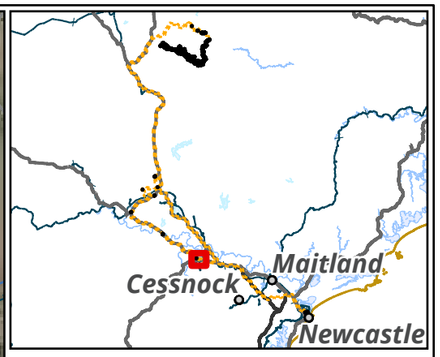


Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 18

0 300 600 900 1,200 N

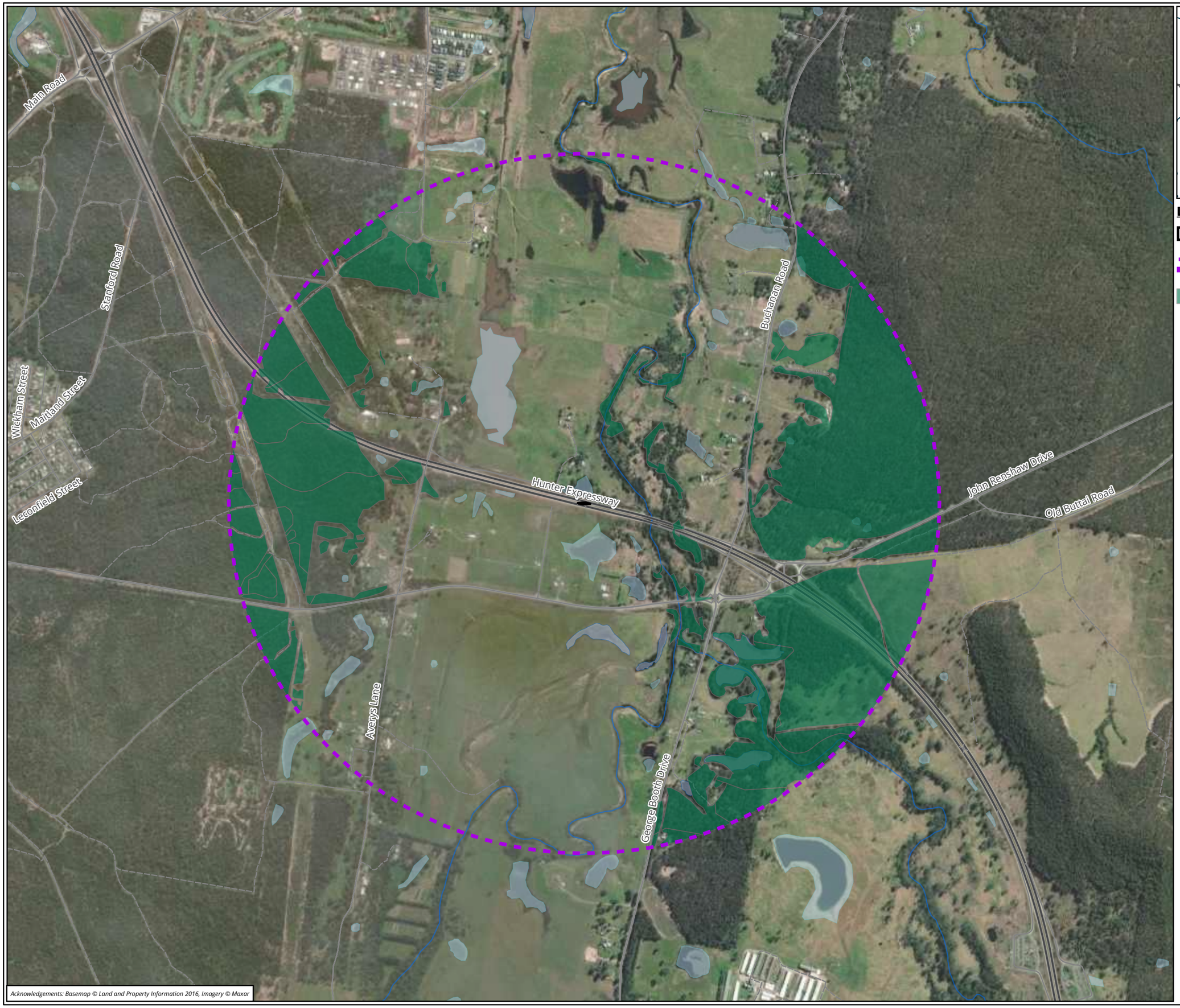
Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx



Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 19

0 180 360 540 720 N

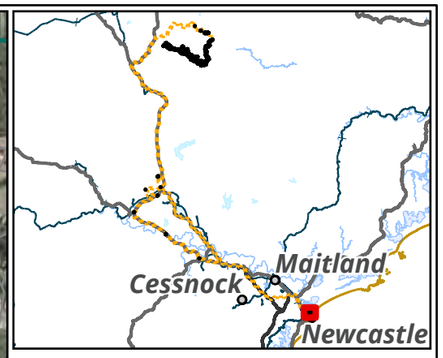
Meters

Scale: 1:15,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx



Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Native vegetation

Figure 5 Location map native vegetation cover, Page 20

0 240 480 720 960 N

Meters

Scale: 1:20,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F5_NativeVeg
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

4 Native vegetation

4.1 Methodology

4.1.1 Data gathering

Existing spatial datasets and documentation relevant to terrestrial vegetation communities within the assessment area was gathered to inform plant community mapping and requirements for more targeted field surveys. Relevant information sources for the review are outlined in Section 1.8 of this document.

4.1.2 Vegetation surveys and timing

Plant community delineation and mapping of vegetation zones involved review and field validation of OEH mapped vegetation communities over a number of field events over 21 days as follows:

- An initial survey of the wind farm development footprint from 12 November 2018 to 15 November 2018 by two ecologists totalling 60 person hours.
- Subsequent winter survey of the wind farm development footprint over 5 days in August 2019 by two ecologists totalling 80 person hours.
- Subsequent spring survey over 5 days in November 2019 for the proposed transmission line and wind farm development footprint by two ecologists totalling approximately 80 person hours.
- Subsequent summer survey over 5 days in February 2020 for the proposed transmission line and wind farm development footprint totalling approximately 50 person hours.
- Supplementary winter survey completed 17-21 August 2020 for the proposed access/transportation routes, adjusted transmission line corridor and within Ben Halls Gap Nature Reserve, extending 100m buffer from the development footprint, by two ecologists totalling 100 person hours.
- Additional surveys to collect BAM plot data in March 2021 by two botanists over 80 person hours and 24 additional plots. This included collection of detailed flora plot data within the sections of 'Devil's Elbow' proposed for re-alignment, as well as along Morrisons Gap Road.

Each field event incorporated the rapid survey of vegetation at locations where distinct PCTs could be observed within the development footprint, noting the extent and structure of existing vegetation and dominant species within each stratum. Signs of disturbance such as clearing, fire damage or weed invasion were also noted. Weather conditions (BOM, 2020) during the field surveys are provided in Table 18.

Table 18 Weather observations during flora and vegetation surveys

Survey date	Temperature (°C)[1]		Rainfall to 0900 hrs (mm)[1]
	Minimum	Maximum	
12 November 2018	10.0	26.3	0.0
13 November 2018	13.8	27.8	0.0
14 November 2018	17.3	22.4	0.0
15 November 2018	16.8	28.6	0.0
27 August 2019	8.3	19.3	0.0
28 August 2019	6.4	18.7	0.0

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Survey date	Temperature (°C)[1]		Rainfall to 0900 hrs (mm)[1]
	Minimum	Maximum	
29 August 2019	6.2	15.5	0.0
30 August 2019	5.8	11.1	0.0
31 August 2019	6.3	12.0	0.0
18 November 2019	10.0	26.5	0.0
19 November 2019	16.3	32.5	0.0
20 November 2019	14.0	29.5	0.0
21 November 2019	11.9	32.1	0.0
25 February 2020	15.4	25.5	2.0
26 February 2020	17.9	25.9	5.2
27 February 2020	15.8	30.5	11.4
28 February 2020	13.9	22.1	0.2
29 February 2020	11.9	26.2	0.0
17 August 2020	4.1	11.9	0.2
18 August 2020	4.0	14.0	0.2
19 August 2020	6.2	15.6	0.0
20 August 2020	5.6	10.9	0.0
21 August 2020	3.3	11.6	0.4

[1] Recorded at Murrurundi Gap AWS, BOM station 061392

4.1.3 PCT confirmation and condition classification

Vegetation confirmed within the site was classified using the BioNet Vegetation Classification application and stratified according to broad condition state to map vegetation zones across the development footprint. Each PCT and associated condition class was mapped for the development footprint as a separate vegetation zone based on vegetation structure and condition attributes. In accordance with Section 4.3.1of the BAM, condition classes were assigned from recorded observations of tree, shrub and ground cover, grazing pressure and weed extent. The factors used to assign a condition class to each PCT are described in Table 19.

Table 19 Criteria used to assign vegetation condition class

Condition class	Criteria
Non-native exotic grassland	Ground layer dominated by exotics, no native overstorey present. If trees are present in the overstorey they are non-native or outside of known species range.
Non-native planted/urban vegetation	Clearly modified vegetation that is subject to regular maintenance, such as slashing. Vegetation species composition not composed of locally occurring species.
Derived Native Grassland (DNG)	Trees and shrubs absent to very sparse and ground layer dominated native grass (and/or other groundcover) species.

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Condition class	Criteria
Native vegetation – Low condition	Low canopy cover, young age class of trees (regrowth), moderate shrub and ground layer diversity. No old growth canopy trees. Grazing pressure moderate to high. Moderate to high presence of exotic species.
Native vegetation – moderate condition	Generally intact canopy cover, advanced tree age class, moderate to high shrub and ground layer diversity. Limited old growth canopy trees with hollows Grazing pressure low. Low cover of exotic species.
Native vegetation – High condition	High structural and floristic diversity. Old growth canopy trees with hollows present. Grazing pressure very low to absent.

Preliminary mapping of native and non-native vegetation communities was conducted in the field using tablet computers (Samsung Galaxy Tab 3) running the ArcGIS Collector application in the field, with spatial data collection on the boundaries of each PCT and attribute data collected on dominant flora species and vegetation condition. A PCT and vegetation zone maps was prepared using the data collection from the field verification surveys and aerial photograph interpretation. The mapping process involved using ArcMap to draw vegetation polygons around areas of vegetation using aerial photograph interpretation, then assigning each polygon a PCT and condition class. Aerial photographs utilised included a high resolution photograph captured by drone.

Areas of native vegetation for which a PCT could validly be assigned were identified and delineated in the field, and their condition determined. Identification of PCTs within the assessment area was confirmed with reference to the community profile descriptors held within the OEH (2012) mapping Project and the NSW the BioNet Vegetation Classification).

General classification of native vegetation in NSW used in this report is based on the classification system in Keith (2004) which uses three groupings of vegetation: vegetation formation, vegetation class and vegetation type (PCT), with vegetation type the finest grouping. The grouping referred to in this report is PCT.

4.1.4 Vegetation condition plots

Vegetation zones and minimum plot requirements are detailed in Table 20, based on the development footprints.

In consideration of this, a total of 49 vegetation integrity plots carried out in accordance with the BAM (Figure 6), including 24 additional vegetation integrity plots were completed in March 2021, to support the improved PCT and vegetation zone mapping in this Updated BDAR. This additional data was used to improve the assignment of PCTs to vegetation zones and to provide a more accurate dataset on the vegetation integrity score of the vegetation zones within the development footprint.

Where minimum plot requirements have not been met under the BAM, benchmark condition has been assumed for the required plots and for relevant PCTs that were not mapped as derived native grasslands. Where derived native grasslands were mapped and no plot data existed, the required vegetation condition scores were amended so that benchmark values for grasses where used, but no shrub or canopy trees were recorded in the plot data.

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This approach assumes the best possible vegetation integrity score is allocated to vegetation zones that do not have sufficient plot data. By including benchmark data where there are insufficient BAM plots, the vegetation condition scores obtained in the BAM Calculator reflect the highest possible condition value.

The assessment of plot requirements summarised in Table 20 is only calculated on the area of impact within the development footprint to those vegetation communities that can be allocated to a PCT. It does not include vegetation communities that have been mapped as excluded from the BAM assessment.

Table 20 Vegetation zones and BAM plot requirements

Vegetation Zones (PCT and condition class)	Vegetation zone impact area (ha)	Minimum plot requirements	No. plots surveyed
433 - Moderate	0.01	1	0
434 - Low	0.01	1	0
486 - High	0.52	1	0
486 - Moderate	1.47	1	0
486 - Low	0.06	1	0
486 - DNG	0.07	1	0
490 - Low	1.84	1	0
492 - High	2.60	2	3
492 - Moderate	0.55	1	2
492 - Low	0.58	1	1
492 - DNG	0.89	1	0
507 - Moderate	0.09	1	1
526 - High	0.43	1	0
526 - Moderate	0.69	1	0
540 - High	10.01	3	3
540 - Moderate	21.19	4	4
540 - Low	5.34	3	1
540 - DNG	4.10	2	1
541 - High	3.45	2	4
541 - Moderate	3.35	2	2
541 - Low	2.51	2	2
541 - DNG	2.06	2	0
586 - Low	2.56	2	3
599 - High	0.36	1	0

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Vegetation Zones (PCT and condition class)	Vegetation zone impact area (ha)	Minimum plot requirements	No. plots surveyed
599 - Moderate	0.09	1	0
599 - Low	0.98	1	0
931 - High	1.10	1	1
931 - Moderate	1.89	1	3
931 - Low	0.22	1	1
934 - High	5.59	3	2
934 - Moderate	0.29	1	0
934 - Low	0.40	1	0
934 - DNG	16.53	3	2
954 - High	1.23	1	0
1194 - High	12.62	3	6
1194 - Moderate	16.56	3	3
1194 - Low	4.70	2	3
1194 - DNG	5.42	3	2
1604 - Low	0.02	1	0
1691 - Low	0.04	1	0

During the planning and implementation of the field survey, BAM plots have been located as much as possible within the development footprint. Due to the multiple revisions to the development footprint, there are some instances where plots are no longer located within the final development footprint assessed in this Updated BDAR (Figure 6). Where BAM plots have not been located within the development footprint, they have been located within a contiguous and/or representative patch of vegetation suitable for collection of data commensurate with the impacted vegetation zone. This allows the vegetation integrity scores to be included in the BAM-Calculator to be consistent with the area impacted in the development footprint. Table 21 provides additional justification of the suitability of BAM plots located outside the final development footprint to represent the vegetation directly impacted by the project. All but two plots occur within patches of vegetation directly impacted by, or ≤1 metre from, the final development footprint. Additional justification is also provided for those two plots that occur further from the footprint.

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Table 21 BAM plots captured outside final development footprint

BAM plot #	Dist. to footprint	Dist. of patch to footprint	Justification
1	70m	1m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not.
5	170m	0m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not.
6	305m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
8	200m	0m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not.
9	50m	0m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not.
10	20m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
12	60m	0m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not. Plot also located in a patch of vegetation contiguous with the development footprint.
13	30m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
15	15m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.

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BAM plot #	Dist. to footprint	Dist. of patch to footprint	Justification
17	10m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
18	30m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
21	150m	150m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not. Plot data shows vegetation patch supports a similar total cover and species richness across all growth form groups as other plots in this vegetation zones (Plots 18 and 38). Floristic composition is also similar between plots, with species characteristic to the PCT throughout, despite the lower condition nature of the vegetation.
24	210m	135m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not. Plot located under transmission line alignment, and was within footprint prior to re-assessment of spanning impacts from AECOM (Appendix I)
25	20m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
26	170m	0m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not. Plot also located in a patch of vegetation contiguous with the development footprint.
32	40m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
33	160m	0m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not.

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BAM plot #	Dist. to footprint	Dist. of patch to footprint	Justification
39	30m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
43	15m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint..
45	15m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint
48	110m	1m	Plot located within an earlier iteration of the development corridor. Vegetation mapping was completed in this area as part of the overall project vegetation mapping, and therefore was mapped to the same standard and criteria as the vegetation within the remainder of the subject land, whether it occurred within the final development footprint or not.
49	70m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.
50	10m	0m	Plot located immediately adjacent to, and within a patch contiguous with, vegetation present within the development footprint.

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4.1.5 Plant identification and nomenclature

All vascular flora recorded during vegetation surveys were identified to species level where possible. Species that could not be identified in the field were recorded to the nearest possible family or genus and collected for later identification. Where they could not be identified confidently, specimens were lodged with the NSW Herbarium for identification.

Nomenclature, including common names, follows Harden (1990-1993, and revised editions 2000-2002). Recent taxonomic revisions were identified using the PlantNET website, developed by the Royal Botanic Gardens (n.d.).

4.2 Vegetation communities

4.2.1 Exotic vegetation

Section 6.8(3) of the *Biodiversity Conservation Act 2016* (BC Act) provides that the Biodiversity Assessment Method (BAM) is to exclude the assessment of the impacts of clearing of native vegetation on Category 1-Exempt Land (within the meaning of Part 5A of the *Local Land Services Act 2013*).

- **BC Act s6.8(3):** The biodiversity assessment method is to exclude the assessment of the impacts of any clearing of native vegetation and loss of habitat on Category 1-Exempt Land (within the meaning of Part 5A of the LLS Act), other than any impacts prescribed by the regulations under section 6.3;
- **BAM cl1.5 (BAM2020):** Biodiversity values not assessed under the BAM include: (d) biodiversity values associated with the assessment of the impacts of any clearing of native vegetation and loss of habitat on category 1-Exempt Land (within the meaning of Part 5A of the LLS Act), other than the additional biodiversity impacts in accordance with clause 6.1 of the BC regulation; (that being prescribed impacts).

Boundaries mapping Category 1-Exempt Land on the NVR Map are not yet publicly available. During the current transitional period, or until the maps are publicly released, accredited assessors may establish the categorisation of land for the agency head or consent authority to consider, following the method utilised to develop the NVR Map as far as practicable. Due to the complexities of the development, and in conjunction with multiple field investigations, Table 22 demonstrates the overall methods used to determine potential land categories and to further determine and map areas of exotic vegetation.

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Table 22 Summary of methods utilsed to dertemine land categories and exotic vegetation

Data Sources	Category 1 – Exempt Land	Category 2 – Regulated Land	Excluded Land
2017 Land Use Dataset	Land use identified as; • Grazing modified pastures (excluding woody vegetation) where clear evidence of significant groundcover modification has occurred post 1990 • Grazing native vegetation where clear evidence of significant groundcover modification has occurred post 1990 and dominated by exotic species as evidenced by field data • Cropping • Grazing irrigated modified pasture • Intensive animal production • Irrigated perennial horticulture • Manufacturing and industrial • Residential and farm infrastructure • Services • Mining • Reservoir/dam • Exotic areas >90% areas identified as vulnerable regulated land in relation to slope • Areas observed (or assumed) to be recently cleared under rural allowable activities	Land use identified as; • Managed resource protection • Other minimal use • Grazing native vegetation • Grazing modified pastures where evidence of significant groundcover modification is absent (precautionary principle applied) • Transport and communication • Rivers	N/A
NSW Woody vegetation extent	Areas of woody vegetation regrowth that has occurred post 1990 following previous clearing events	Woody vegetation present as at 1990 in conjunction with historic aerial imagery	N/A
Native regulatory map **Sensitive regulated land** **Vulnerable regulated land** **Excluded land**	N/A	Native dominated areas identified as vulnerable regulated land All areas identified as sensitive regulated land	Areas identified as excluded on the native regulatory maps such, National Parks, as well as nature conservation

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Data Sources	Category 1 – Exempt Land	Category 2 – Regulated Land	Excluded Land
			and production native forestry land use

Exotic grassland vegetation was mapped were it was considered to meet the criteria for Category 1 – Exempt Land in accordance with the table above, and in areas where non-native species were clearly dominant in the ground layer. This includes paddocks that have undergone a long history of moderate to high intensity grazing leading to a dominance of non-native species, nutrification and compaction, further reducing the resilience and regeneration potential of native grass species. Large areas of exotic grassland were found to be present along the top of the ridge line, which has been subject to vegetation clearing followed by use for ongoing access and grazing over the recent past. Areas away from retained trees hold little natural resilience and are dominated by exotic species such as Praire Grass *Bromus catharticus*, Cocksfoot *Dactylis glomerata*, Ryegrass *Lolium spp*, Sweet Vernal Grass *Anthoxanthum odoratum*, White Clover *Trifolium repens*, Broad-leaved Carpet Grass *Axonopus compressus,* Squirrel Tail Fesque *Vulpia bromoides,* Red-flowered Mallow *Modiola caroliniana* and Lamb's Tongues *Plantago lanceolata.* Where native grasses and other groundcover species made up more than a minor/negligible component of the vegetation cover, the vegetation was mapped as a Low, or Derived Native Grassland (DNG) condition PCT.

4.2.2 Development footprint

Within the total combined development footprint, a total of 297.15 hectares of vegetation was mapped, which includes vegetation communities classified as native vegetation, exotic grassland and planted/urban vegetation.

The majority (55.5% or 164.72 ha) of the mapped vegetation within the development footprint is composed of exotic grassland or planted/urban vegetation, with 44.5% of the mapped vegetation being classified as native (Table 23). As outlined below, the Project has been designed and optimised to ensure Project infrastructure is located predominately within non-native vegetation, with Project elements being located outside of native vegetation where practicable.

The 132.43 ha of mapped native vegetation within the development footprint, occurs across 17 separate PCTs with varying levels of disturbance and condition, stratified into 43 vegetation zones.

The native vegetation within the development footprint comprises isolated patches of vegetation in a predominantly agricultural land-use matrix. While isolated, patches were generally within 100m of other patches of native vegetation and in some locations directly connected to areas of larger, contiguous areas of native vegetation.

The condition of these patches of native vegetation ranges from low, with heavy weed infestation (especially Blackberry, *Rubus* spp.) supporting little native species richness or diversity, to high condition areas with high native species floristic and structural diversity and low weed infestation. Zones in lower condition also show high levels of modification and fragmentation.

Poor condition vegetation zones are characterised by a canopy of mature and semi mature native trees over an understorey dominated by exotic pasture grasses. Resilience in the understory in these zones was seen to be low, with a low cover and abundance of native species. Higher condition vegetation condition zones are

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characterised by complex vegetation structure with a high diversity and abundance of native species within each strata.

Table 23 Vegetation condition class within combined development footprint

Vegetation condition class	2020 BDAR Area (ha)	Updated BDAR Area (ha)	% Reduction	% of mapped vegetation
Planted or urban vegetation	7.39	0.24	97	0.08
Exotic grassland	272.36	164.48	40	55.35
Derived Native Grasslands	30.91	29.06	6	9.78
Native vegetation – Low condition	37.11	19.28	48	6.49
Native vegetation – Moderate condition	73.8	46.18	37	15.54
Native vegetation – High condition	64.88	37.92	42	12.76
Total	**486.45**	**297.15**	**39**	**100%**

4.2.3 Vegetation communities and infrastructure type

There is also substantial variation in the composition of the vegetation communities within the infrastructure types that compose the development footprint. To show the contribution that each infrastructure element has to the overall impacts within the development footprint, a breakdown of the area of each condition class of vegetation is provided in Table 24.

This summary shows that the majority of the impacts associated with the wind turbines (74%), internal roads (61%) and transmission line access tracks (69%), are to non-native vegetation, with exotic grassland being the most common vegetation community mapped in these areas. This reflects both the ongoing efforts made to design the Project to avoid areas of native vegetation to the extent practicable and the history of disturbance on the ridgeline from the historical and ongoing use as a grazing property. The concept alignment for the transmission line access tracks have also followed existing farm tracks and trails as much as practicable to minimise impacts on native vegetation.

Within the transmission line corridor, most of the vegetation (63%) has been mapped and classified as native vegetation. This is due to the requirement for the transmission line to traverse steeper areas of terrain where open eucalypt forest and woodland has been retained. The original concept design had proposed complete clearing of the required 60m corridor along the transmission line, however this has been revised during ongoing detailed design and clearing limited where practicable and where required operational and safety clearances to the wires can be achieved.

In particular, the expected ability to avoid impact along stretches of the transmission line that have adequate separation to avoid impacts to native vegetation from the proposed line and removal of two turbines has been assessed, as well as other design refinements to access tracks to minimise impacts. This has resulted in an overall material reduction in the extent of clearing required of 70.43 hectares of native vegetation.

There is also a majority of native vegetation mapped within the road upgrade works proposed on the transport route component of the development footprint. Most of these impacts are associated with works required on Morrisons Gap Road and Barry Road, where curve realignments are necessary to address safety risks and transport the turbine infrastructure up the existing steep roads.

Table 24 below provides a summary of vegetation impacts broken down by infrastructure type. It can be seen that five of the seven different infrastructure types will impact more on exotic vegetation than native, with only the transmission line and transport route upgrades predominantly impacting native vegetation. This is

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largely due to the nature of the footprint along the transmission line, where impacts are generally associated more with areas of native vegetation that requires removal, with areas or exotic grassland not required to be cleared. Furthermore the nature of the transport route upgrades relate to predominantly vegetated areas adjacent to existing roads, and the need to bypass steep curves along Barry Road.

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Table 24 Summary of vegetation and condition type for each infrastructure type

Vegetation condition class	Infrastructure element vegetation extent (ha and percentage within each infrastructure type)						
	Temporary construction footprint	Wind turbine infrastructure	Internal roads	Transmission line	Transmission line access tracks	Transport route upgrades	Ancillary
Planted or urban vegetation	-	-	-	-	-	0.23 (3%)	-
Exotic grassland	62.68 (68%)	32.14 (68%)	27.68 (58%)	16.93 (27%)	14.44 (69%)	1.18 (17%)	9.44 (52%)
Derived Native Grasslands	7.44 (8%)	5.69 (12%)	1.67 (3%)	4.43 (7%)	1.56 (7%)	0.5 (7%)	7.76 (43%)
Native vegetation – Low condition	1.88 (2%)	1.2 (3%)	4.78 (10%)	9.35 (15%)	1.76 (8%)	0.2 (4%)	0.1 (1%)
Native vegetation – Moderate condition	11.45 (12%)	3.37 (7%)	11.28 (24%)	16.21 (25%)	2.15 (10%)	0.96 14%)	0.75 (4%)
Native vegetation – High condition	8.66 (9%)	4.79 (10%)	2.57 (5%)	16.91 (26%)	1.07 (5%)	3.91 (56%)	0.01 (<1%)
Total native vegetation (ha)	**29.43 (32%)**	**15.05 (32%)**	**20.29 (42%)**	**46.9 (73%)**	**6.55 (31%)**	**5.58 (80%)**	**8.62 (48%)**
Total area planted or exotic (ha)	**62.68 (68%)**	**32.14 (68%)**	**27.68 (58%)**	**16.93 (27%)**	**14.44 (69%)**	**1.42 (20%)**	**9.44 (52%)**

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4.2.4 Vegetation zones within the combined development footprint

Table 25 provides a detailed summary of the PCTs, vegetation zones, condition, extent, vegetation integrity score and associated TECs for the total combined development footprint, which has been used in assessing the impacts of the project. This information was used as the basis for a combined native vegetation map for the entire development footprint (Figure 6).

PCT descriptions, justifications, characteristic species and photographs are provided in Appendix B.

As outlined in Section 4.1.4 where minimum plot requirements have not been met under the BAM, benchmark condition has been assumed for the shortfall in required plots and for relevant vegetation zones. This is a conservative approach that ensures the best possible vegetation integrity score is allocated to vegetation zones lacking sufficient plot data. By including benchmark data where there are insufficient BAM plots, the vegetation condition scores generated by the BAM Calculator reflect the highest possible condition value.

The use of benchmark data has had the effect of skewing the resultant Vegetation Integrity (VI) scores, as presented in Table 25, whereby vegetation zones that represent ground-validated vegetation in lower condition, may present benchmark or near benchmark VI scores. This is particularly evident where, as a result of the use of benchmark plot data, a Moderate condition zone presents a higher VI score than a High condition zone for the same PCT (i.e. PCT 540 Moderate and PCT 540 High vegetation zones). This increase in VI scores ensures impacts and threatened species associates are over-estimate as a result of a shortfall in plot data, and ensures a more conservative impact assessment.

All vegetation within the subject land has been mapped and stratified in accordance with the BAM, and as detailed in Table 19 above, however the use of benchmark plot data has resulted in misrepresentation of expected VI scores (and therefore inferred condition). Condition states (and therefore vegetation zones) were assigned in the field, based on the presence of *relatively homogeneous areas of native vegetation that were the same PCT and in the same broad condition state* (DPIE 2020). Whilst it is acknowledged that condition classes for vegetation zones within which BAM plot data has not been collected have not been assessed against this floristic data, the on-ground mapping undertaken by experienced botanists during the field campaign was accurate, detailed, and sufficient to define vegetation zones as required by the BAM. All layout decisions relevant to avoidance of impacts (or conversely locating impacts in areas of lower condition) have been based on the ground-validated condition of the vegetation zones, not the artificially inflated VI scores. Furthermore any effect that inflated VI scores may have on threatened species associations are conservative in nature and would mean more species are required to be addressed, rather than less. Vegetation condition classes that inform the vegetation zones for this assessment reflect the ground-validated condition of the vegetation, not the inflated VI scores.

Vegetation zones that have had their VI scores calculated using benchmark data, to supplement a shortfall in data of one or more BAM plots (and thus their VI scores artificially inflated), are highlighted in Table 25 below for additional context.

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Table 25 Vegetation zones within the development footprint

PCT	TEC	Vegetation Zones (PCT and condition)	VI score by IBRA/sunregion	Vegetation zone impact area (ha)	Change since 2020 BDAR
433 - White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion	*White Box Yellow Box Blakely's Red Gum Woodland*	433 - Low	Nandewar-Peel 99.9	0.01	
		433 – Moderate*	Nandewar-Peel 99.9	0.01	
		Total		**0.02**	**-0.06**
486 - River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range		486 – High*	Nandewar-Peel 99.1 NSW NC- Tomalla 99.8	0.10 0.42	
		486 – Moderate*	Nandewar-Peel 99.1 NSW NC- Tomalla 99.8	1.30 0.17	
		486 – Low*	Nandewar-Peel 99.1	0.06	
		486 – DNG*	Nandewar-Peel 69.2	0.07	
		Total		**2.12**	**-5.43**
490 - Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion		490 – Low*	Nandewar-Peel 98.3	1.84	
		Total		**1.84**	**-1.26**
492 - Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion	*White Box Yellow Box Blakely's Red Gum Woodland*	492 - High	Nandewar-Peel 93	2.60	
		492 - Moderate	Nandewar-Peel 93 NSW NC- Tomalla 89.1	0.02 0.53	
		492 - Low	Nandewar-Peel 60.3	0.58	
		492 – DNG*	Nandewar-Peel 59.9	0.89	
		Total		**4.62**	**-5.19**

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PCT	TEC	Vegetation Zones (PCT and condition)	VI score by IBRA/sunregion	Vegetation zone impact area (ha)	Change since 2020 BDAR
507 - Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion		507 - Moderate	NSW NC- Tomalla 57.6	0.09	
		Total		**0.09**	**-0.06**
526 - Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion		526 – High*	NET- Walcha 99.3	0.43	
		526 – Moderate*	NET- Walcha 99.3	0.69	
		Total		**1.12**	**0.62**
540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	*Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion***	540 - High	Nandewar-Peel 80.3 NET- Walcha 73.3 NSW NC- Tomalla 72.9	5.0 0.49 4.50	
		540 - Moderate	Nandewar-Peel 86.1 NET- Walcha 82.1 NSW NC- Tomalla 78	8.90 0.89 11.4	
		540 – Low*	Nandewar-Peel 95.9 NET- Walcha 95.4 NSW NC- Tomalla 94.9	2.70 0.03 2.60	
		540 – DNG*	Nandewar-Peel 45.9 NSW NC- Tomalla 28.6	3.0 1.1	
		Total		**40.61**	**-28.96**
541 - Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion		541 - High	Nandewar-Peel 88.7 NSW NC- Tomalla 79.9	2.4 1.1	
		541 - Moderate	Nandewar-Peel 83.6 NSW NC- Tomalla 76.9	1.5 1.8	
		541 - Low	Nandewar-Peel 69.4 NSW NC- Tomalla 61.5	1.7 0.8	
		541 – DNG*	Nandewar-Peel 54.7	2.1	

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PCT	TEC	Vegetation Zones (PCT and condition)	VI score by IBRA/sunregion	Vegetation zone impact area (ha)	Change since 2020 BDAR
		Total		**11.37**	**-18.63**
586 - Snow Grass - Swamp Foxtail tussock grassland sedgeland of cold air drainage valleys of the New England Tableland Bioregion		586 - Low	NET- Walcha 59.6	2.56	2.56
		Total		**2.56**	**2.56**
599 - Blakelys Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion	*White Box Yellow Box Blakely's Red Gum Woodland*	599 – High*	Nandewar-Peel 99.9	0.36	
		599 – Moderate*	Nandewar-Peel 99.9	0.09	
		599 – Low*	Nandewar-Peel 99.9	0.98	
		Total		**1.43**	**-1.92**
931 - Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion		931 - High	NET- Walcha 44.4	1.10	
		931 - Moderate	NET- Walcha 55.1 NSW NC- Tomalla 45	1.40 0.47	
		931 - Low	NET- Walcha 26.9	0.22	
		Total		**3.20**	**-2.41**
934 - Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion		934 – High*	NET- Walcha 91.2 NSW NC- Tomalla 87	2.30 3.30	
		934 – Moderate*	NET- Walcha 99.6 NSW NC- Tomalla 99.7	0.13 0.17	
		934 – Low*	NET- Walcha 99.6	0.40	
		934 – DNG*	NET- Walcha 20.7 NSW NC- Tomalla 19.1	16.5 0.17	
		Total		**22.97**	**7.30**
954 - Mountain Ribbon Gum - Messmate		954 – High*	NSW NC- Tomalla 99.8	1.23	

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PCT	TEC	Vegetation Zones (PCT and condition)	VI score by IBRA/sunregion	Vegetation zone impact area (ha)	Change since 2020 BDAR
open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion		**Total**		**1.23**	**-0.17**
1194 - Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion	*Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion***	1194 - High	NET- Walcha 63.1 NSW NC- Tomalla 64.9	5.6 7.1	
		1194 - Moderate	NET- Walcha 64.6 NSW NC- Tomalla 65.7	7.6 9	
		1194 - Low	NET- Walcha 37.5 NSW NC- Tomalla 38	3.1 1.6	
		1194 – DNG*	NET- Walcha 7.4 NSW NC- Tomalla 7.8	1.9 3.6	
		Total		**39.29**	**-17.21**
1604 - Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter		1604 – Low*	Sydney – Hunter 99.7	0.02	
		Total		**0.02**	**-0.01**
1691 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter		1691 – Low*	Sydney – Hunter 99.7	0.04	
		Total		**0.04**	**0.01**

*Note: Vegetation zones with VI score affected by inclusion on benchmark plot data have been marked with an asterisk *

*Note: PCT 540 and PCT1194 represent the Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest TEC only when the PCT is present within, or as part of a patch contiguous with, the New England Tableland IBRA Bioregion. Refer Section 4.3.1 for more detail.

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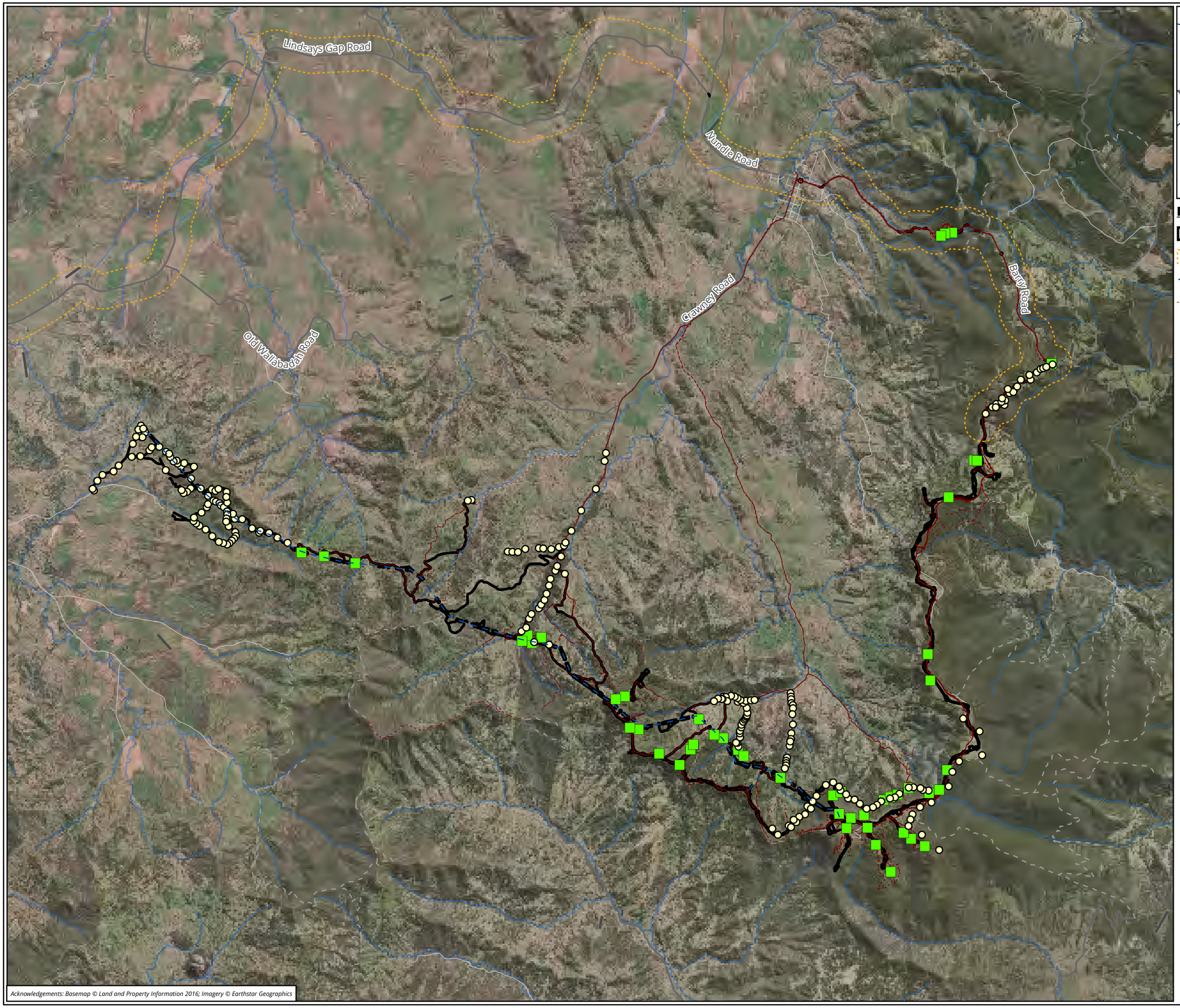

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Survey tracks
- BAM plot
- PCT verification point

Figure 6 Plant community types, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F6_PCT
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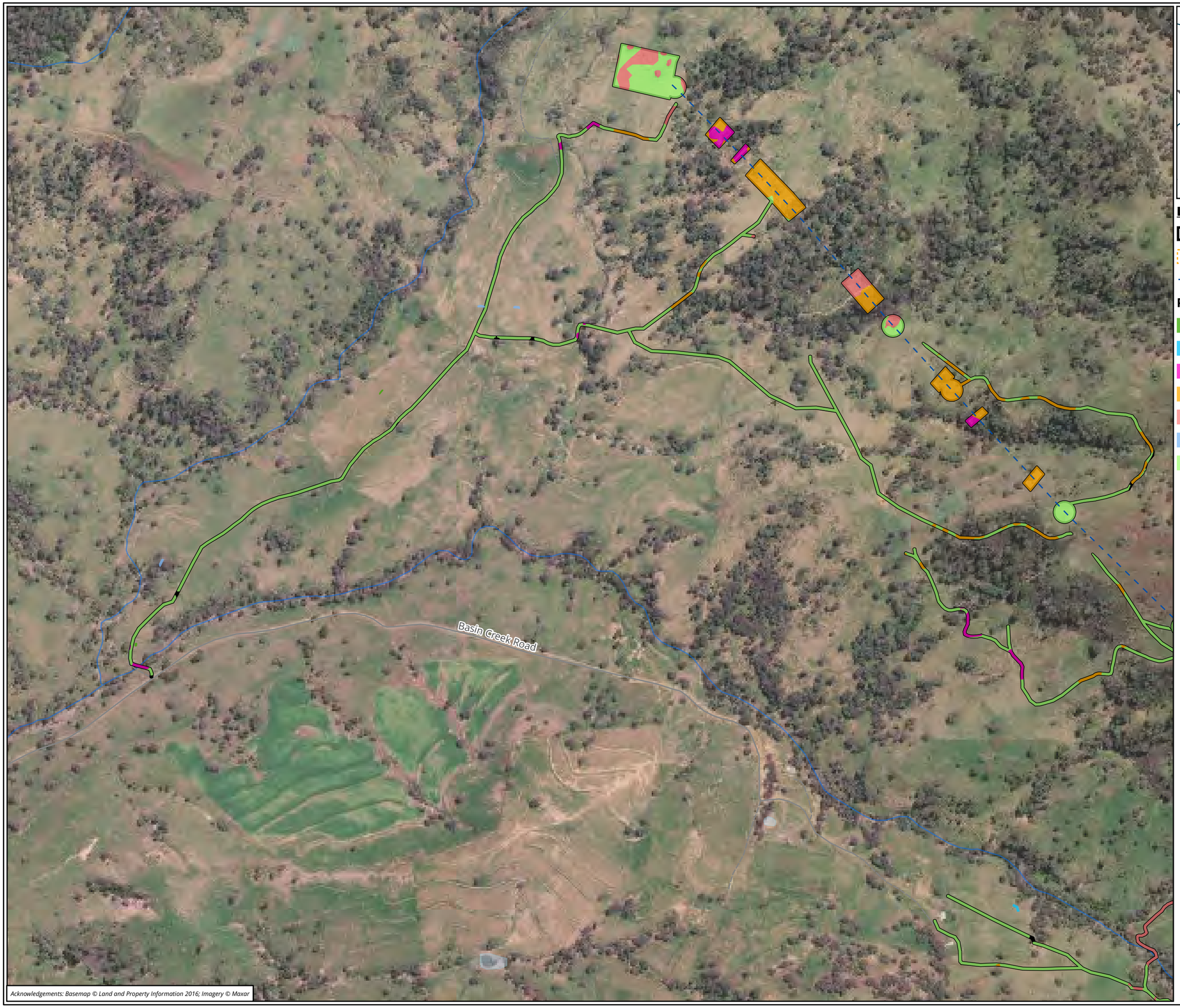

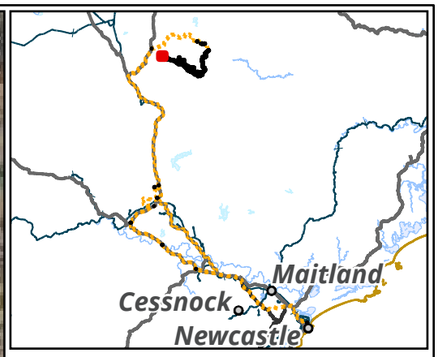

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line

Plant community type

- 433
- 434
- 486
- 540
- 541
- 599
- Exotic grassland

Figure 6 Plant community types, Page 2

0 125 250 375 500 N

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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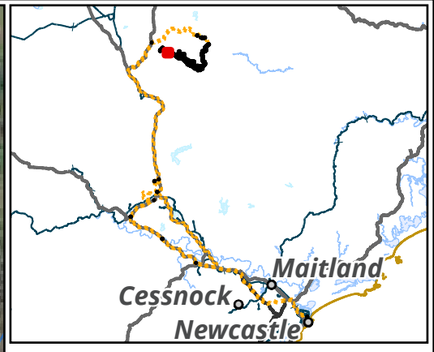

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 540
- 541
- 599
- Exotic grassland

23

Figure 6 Plant community types, Page 3

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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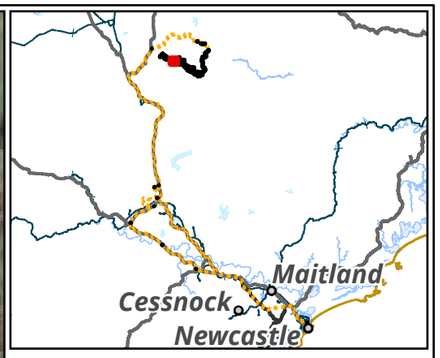

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 486
- 490
- 492
- 540
- 541
- Exotic grassland

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Figure 6 Plant community types, Page 4

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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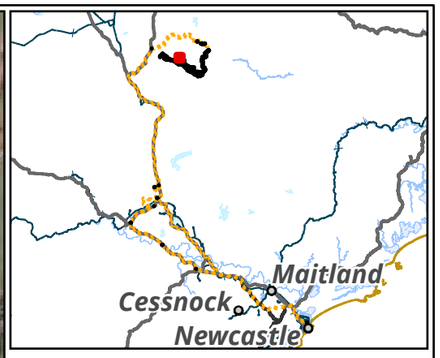

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 540
- Exotic grassland

Figure 6 Plant community types, Page 5

0 125 250 375 500 Meters

N

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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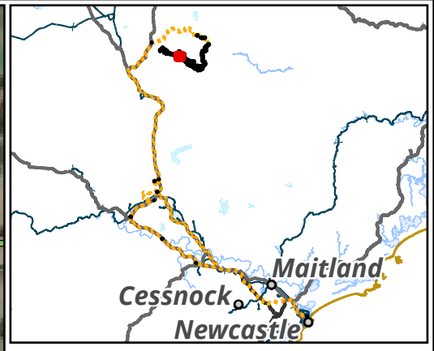

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 486
- 490
- 540
- 541
- Exotic grassland

Figure 6 Plant community types, Page 6

0 125 250 375 500 Meters

N

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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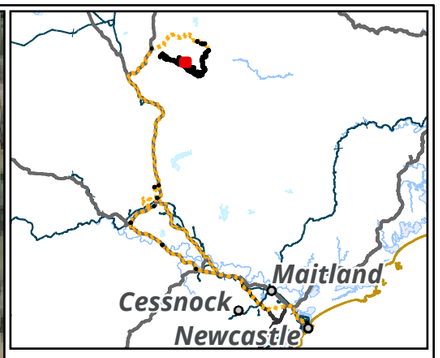

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 486
- 540
- 541
- 599
- Exotic grassland

Figure 6 Plant community types, Page 7

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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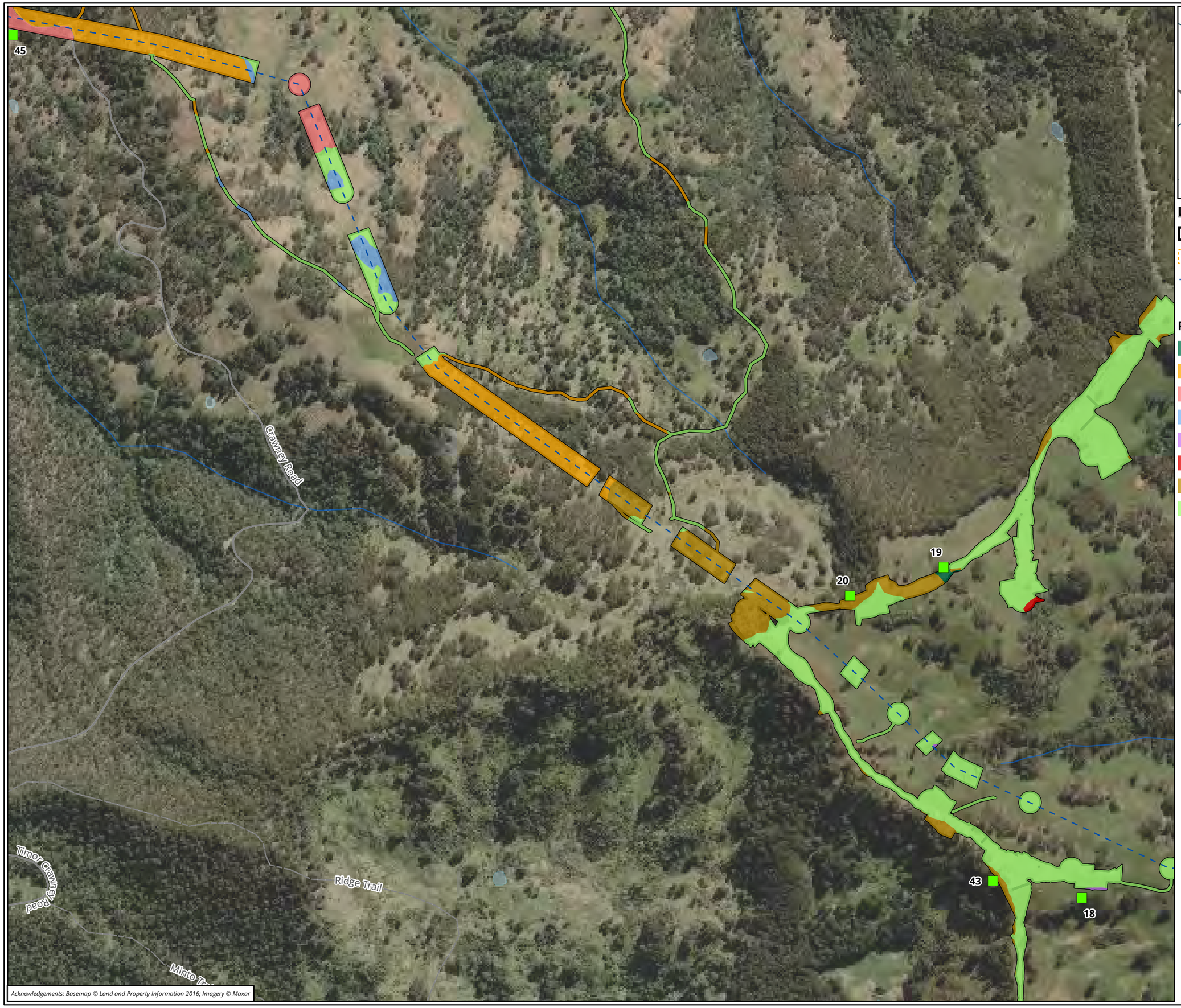

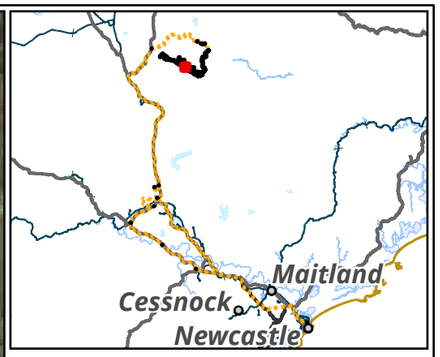

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 507
- 540
- 541
- 599
- 931
- 934
- 1194
- Exotic grassland

Figure 6 Plant community types, Page 8

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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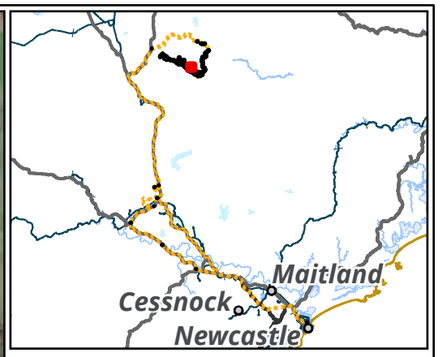

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 486
- 492
- 540
- 541
- 1194
- Exotic grassland

Figure 6 Plant community types, Page 9

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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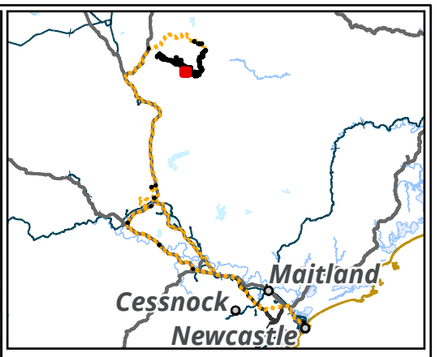

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Plant community type

- 540
- 541
- 931
- 934
- 954
- 1194
- Exotic grassland

Figure 6 Plant community types, Page 10

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
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Layout: 34963_F6_PCT
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

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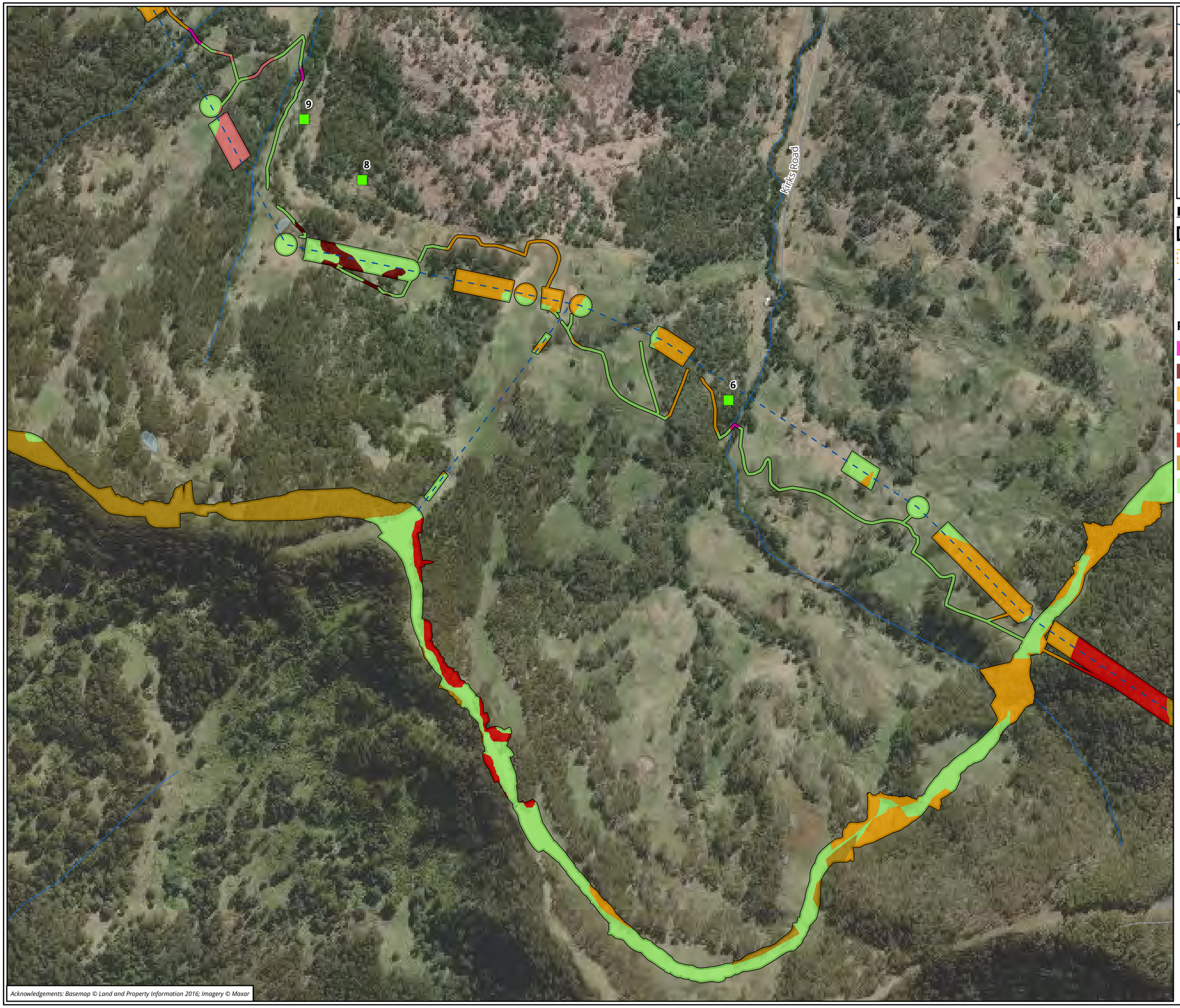

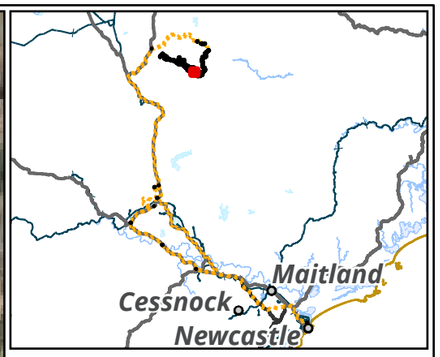

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 486
- 492
- 540
- 541
- 934
- 1194
- Exotic grassland

Figure 6 Plant community types, Page 11

0 125 250 375 500 Meters

N

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

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Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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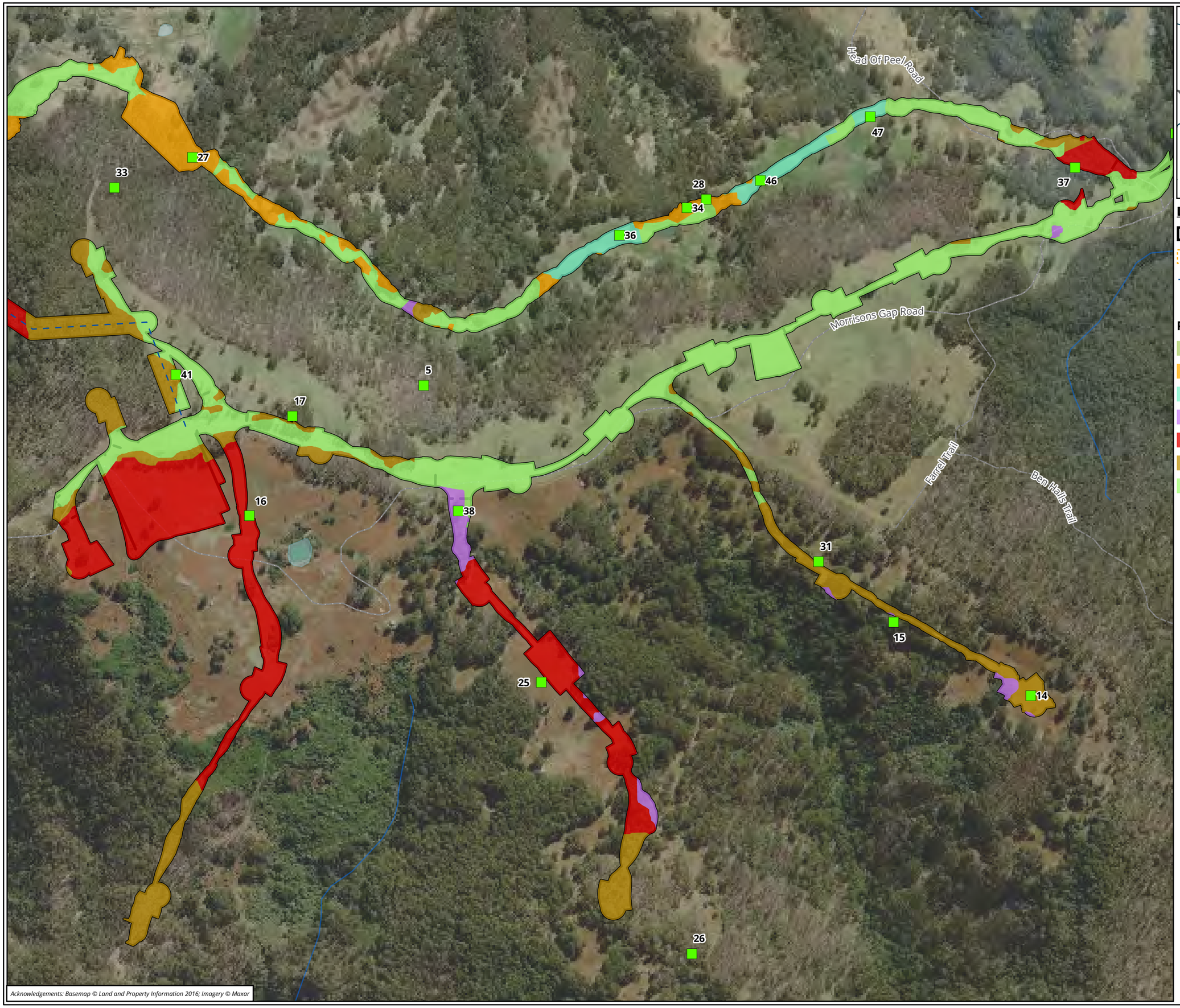

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- BAM plot

Plant community type

- 526
- 540
- 586
- 931
- 934
- 1194
- Exotic grassland

Figure 6 Plant community types, Page 12

0 125 250 375 500 Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

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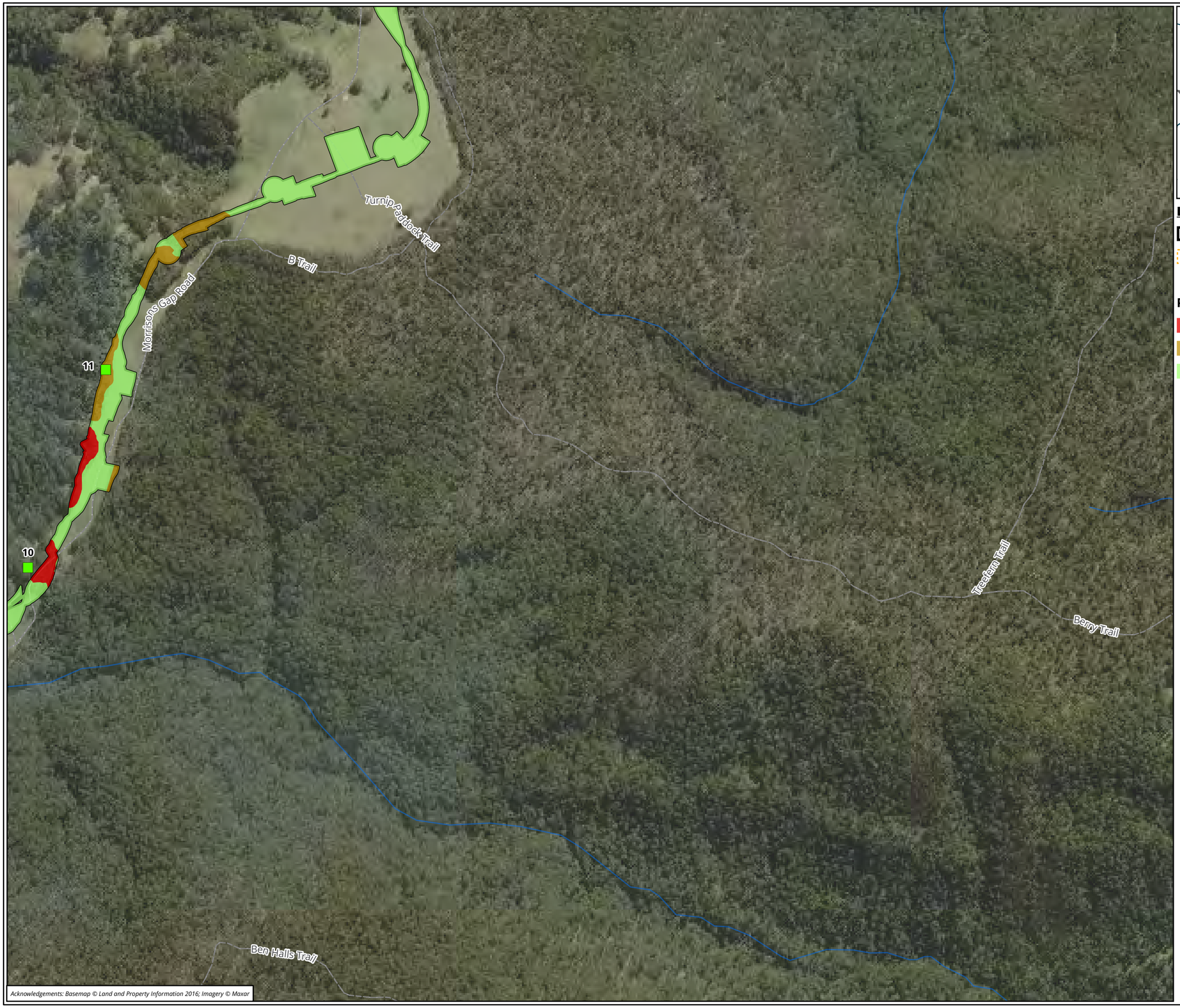

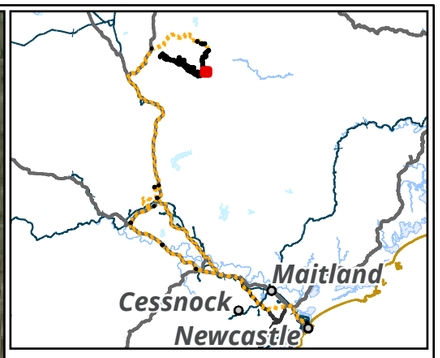

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Plant community type

- 934
- 1194
- Exotic grassland

Figure 6 Plant community types, Page 13

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

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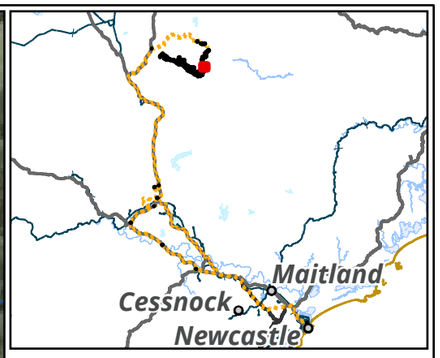

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Plant community type

- 1194
- Exotic grassland

Figure 6 Plant community types, Page 14

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
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Layout: 34963_F6_PCT
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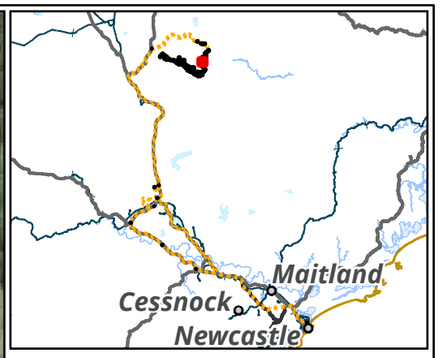

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 1194
- Exotic grassland

Figure 6 Plant community types, Page 15

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

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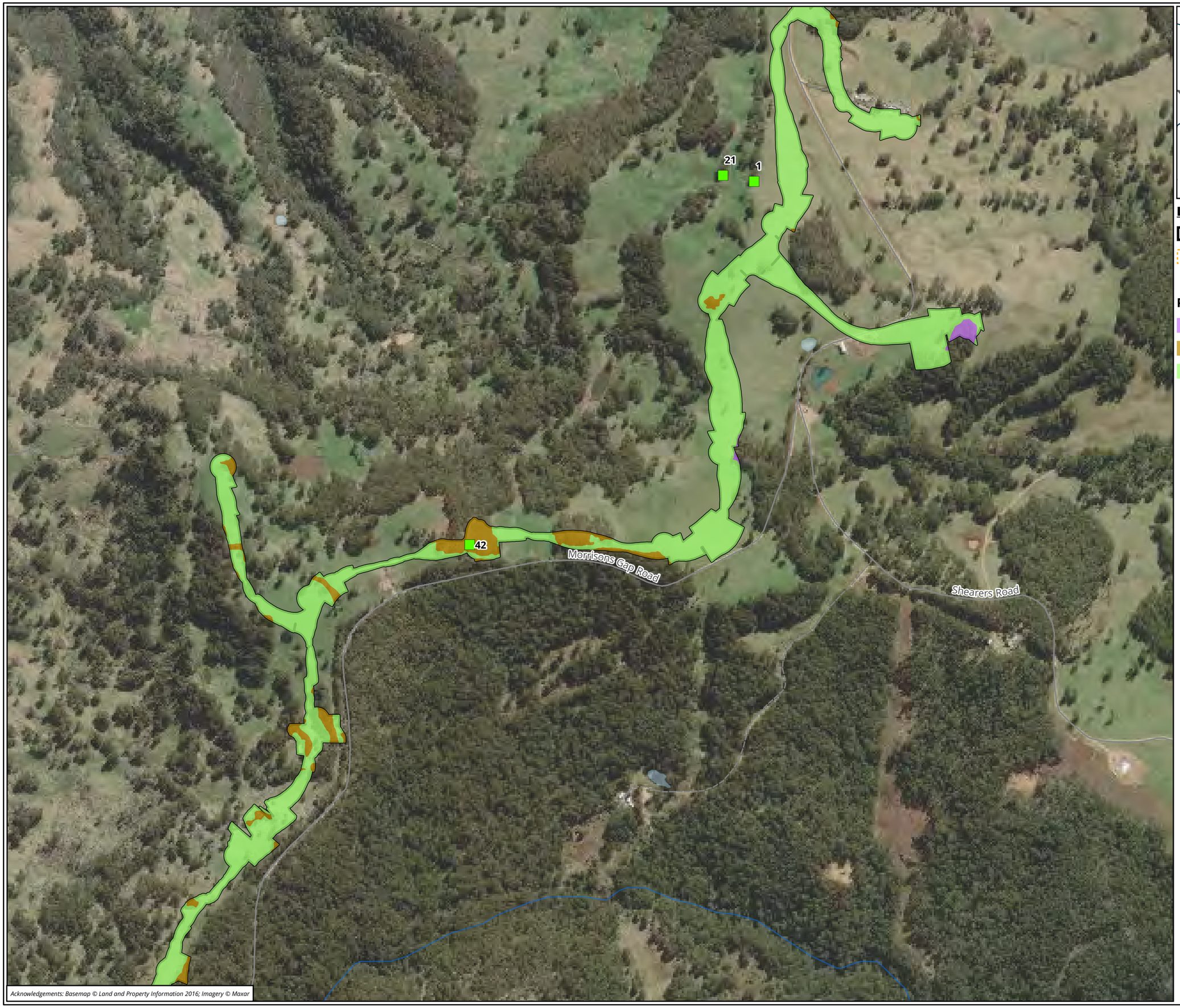

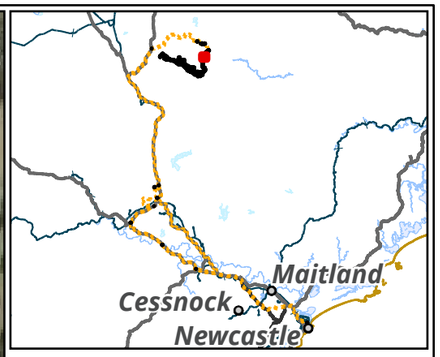

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Plant community type

- 931
- 1194
- Exotic grassland

Figure 6 Plant community types, Page 16

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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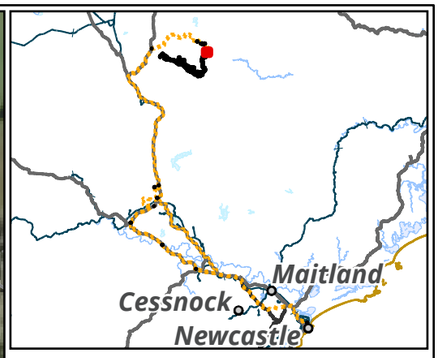

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Plant community type

- 490
- 526
- 931
- 1194
- Urban Native/Exotic
- Exotic grassland

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Figure 6 Plant community types, Page 17

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 492
- Exotic grassland

Figure 6 Plant community types, Page 18

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Matter: 34963,
Date: 05 November 2021 ,
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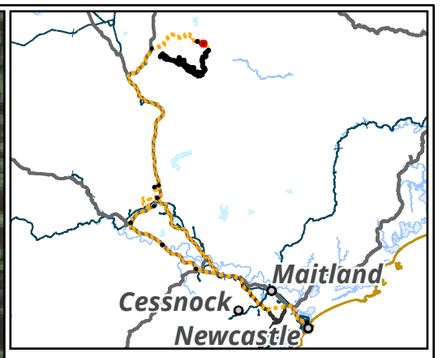

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Plant community type

- 492
- 541
- Urban Native/Exotic

Figure 6 Plant community types, Page 19

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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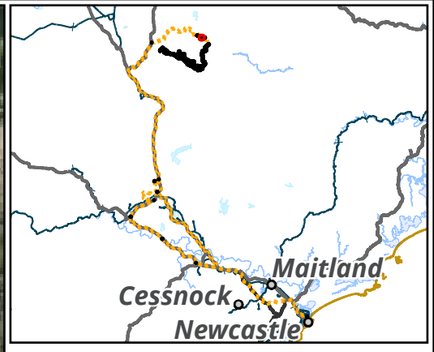

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 541
- 599

Figure 6 Plant community types, Page 20

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
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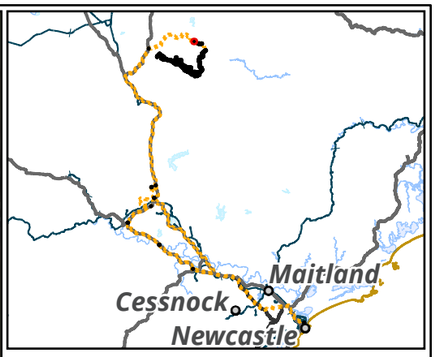

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 599
- Exotic grassland

Figure 6 Plant community types, Page 21

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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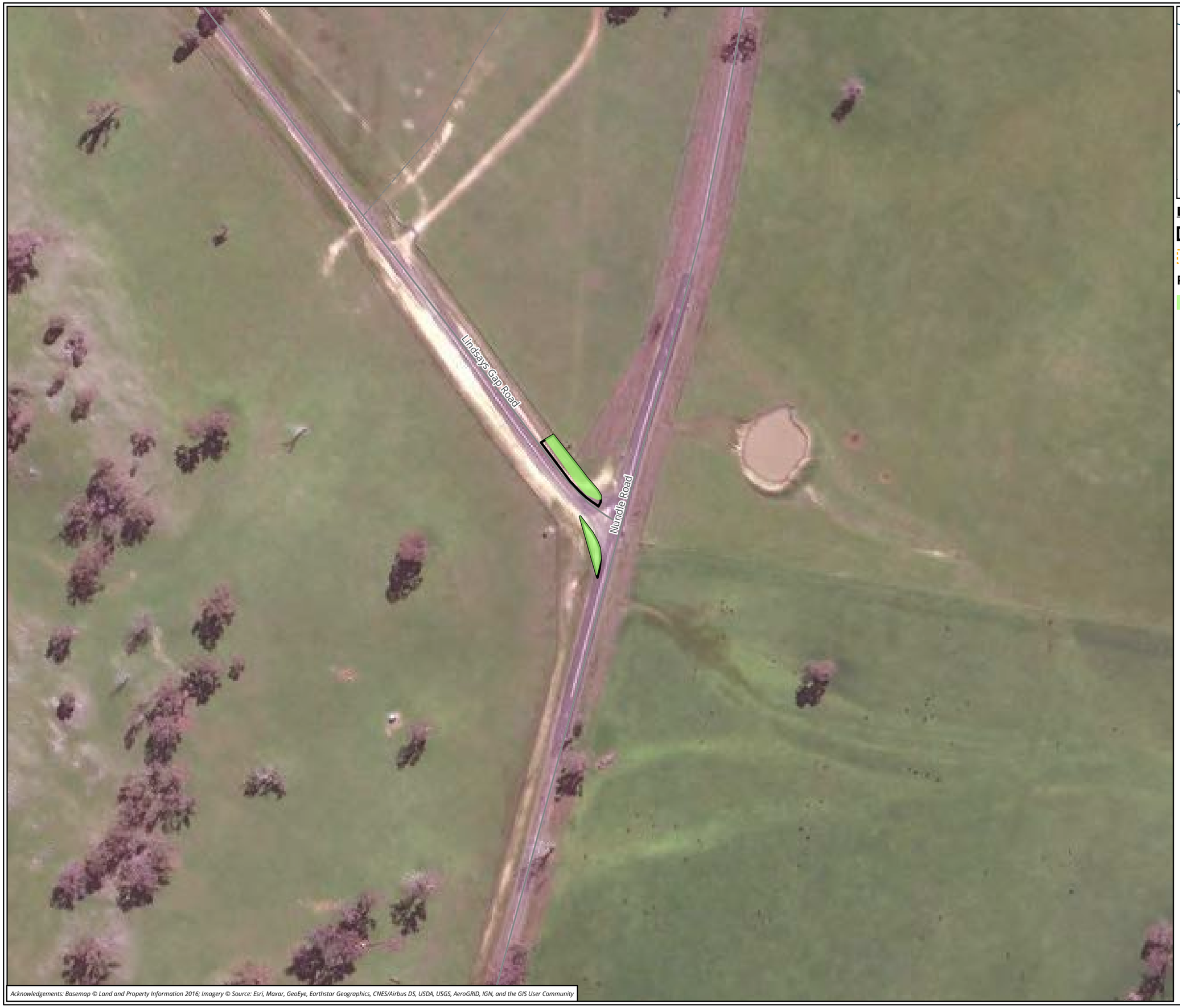

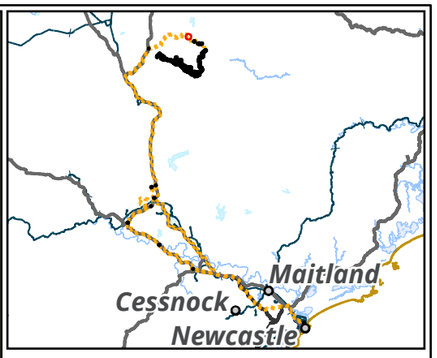

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 22

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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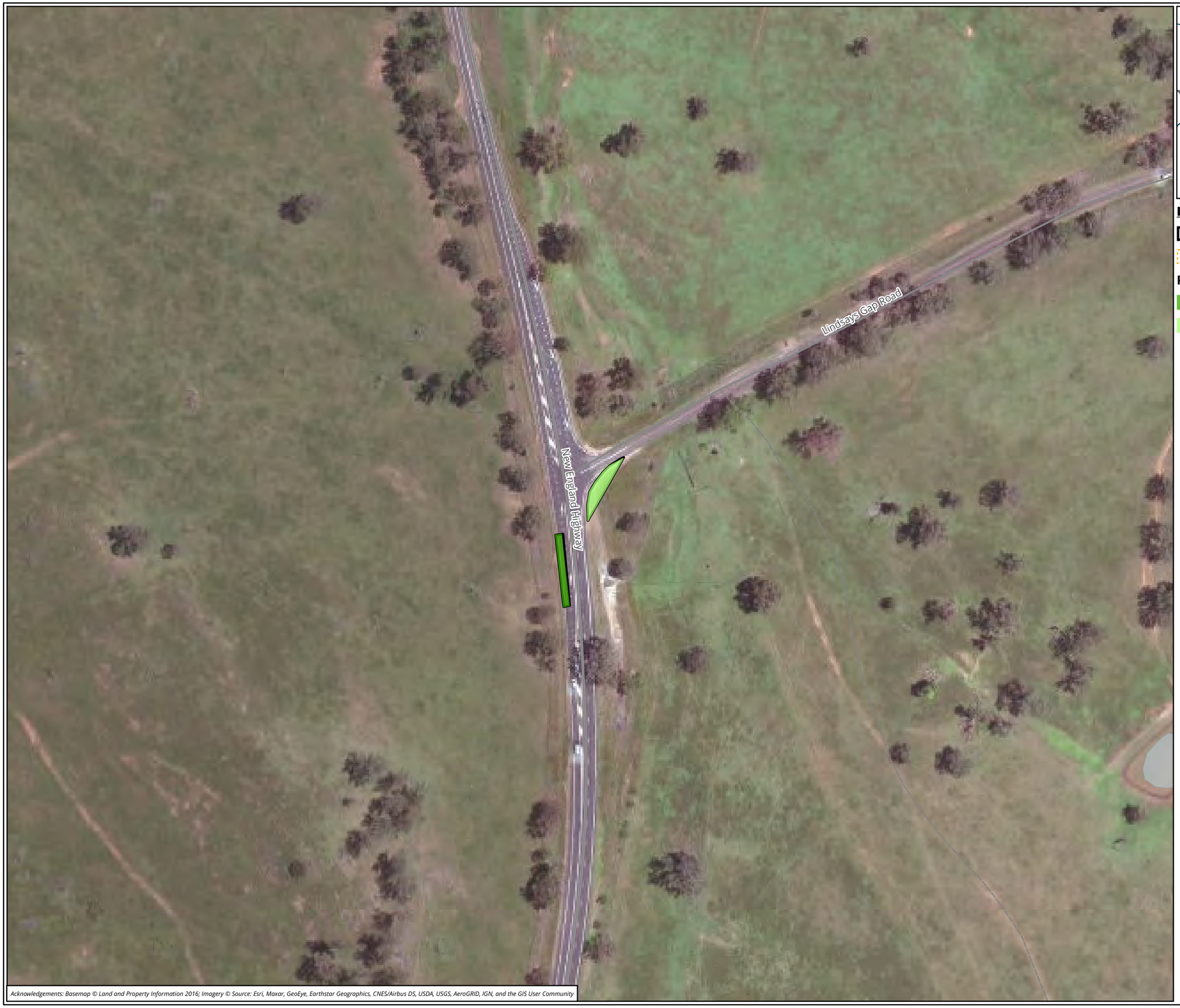

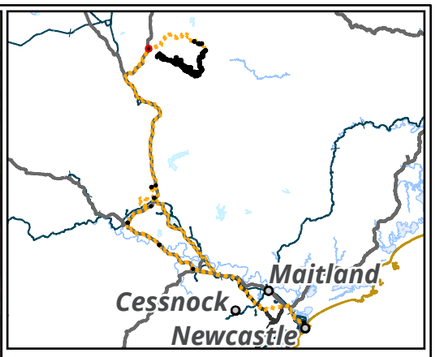

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 433
- Exotic grassland

Figure 6 Plant community types, Page 23

0 25 50 75 100

Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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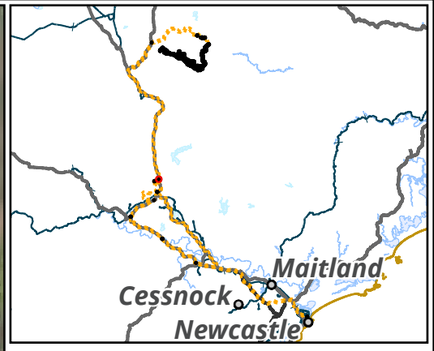

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 24

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Matter: 34963,
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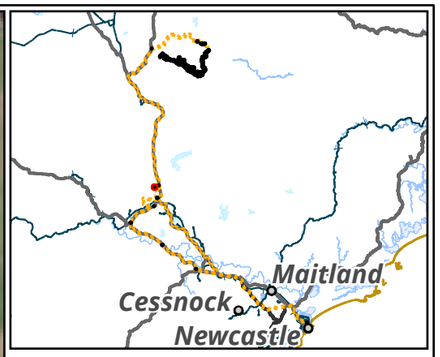

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 25

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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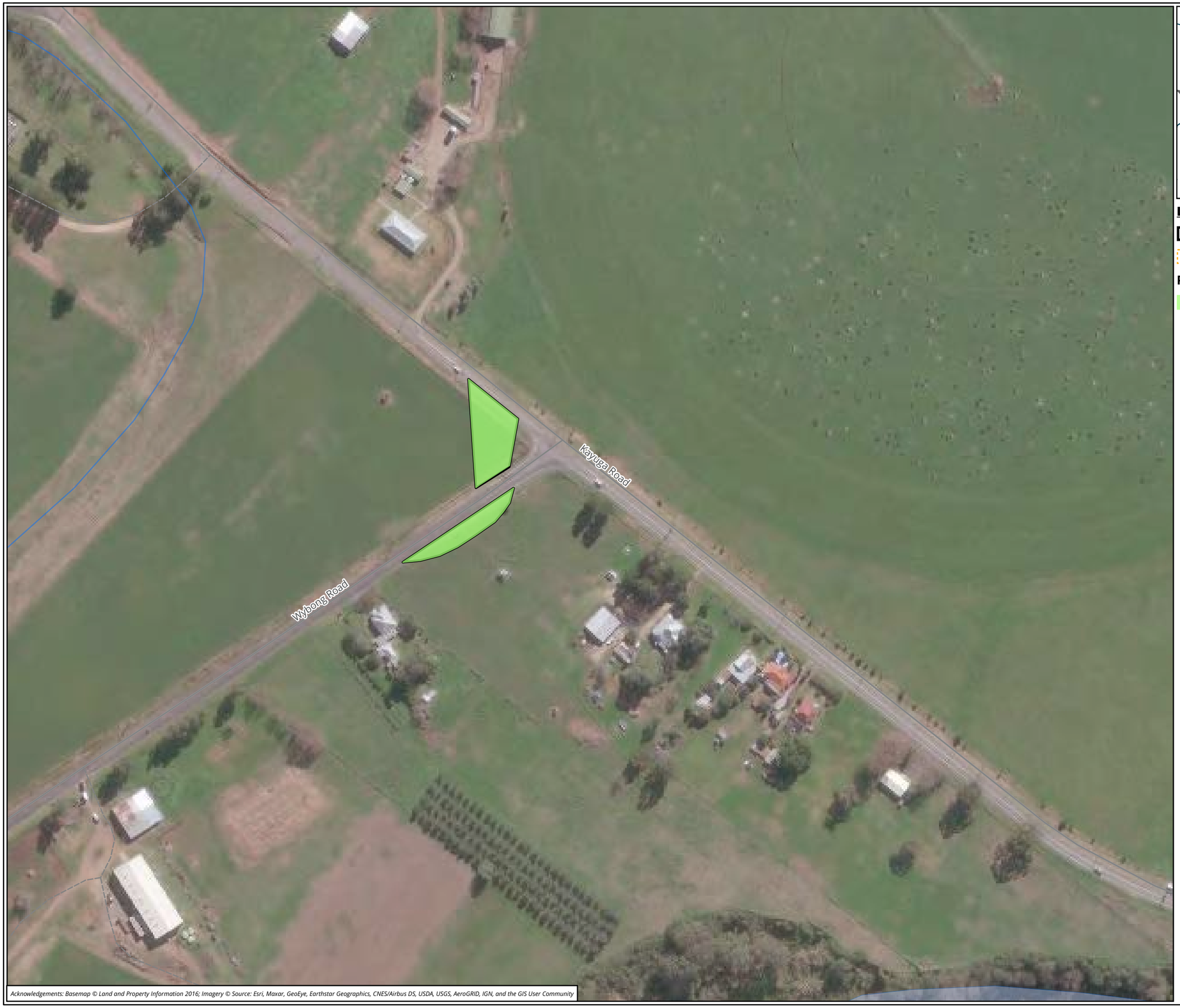

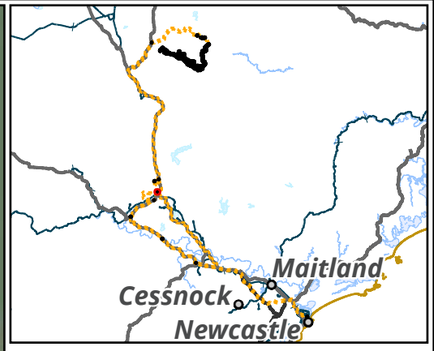

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 26

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Matter: 34963,
Date: 05 November 2021 ,
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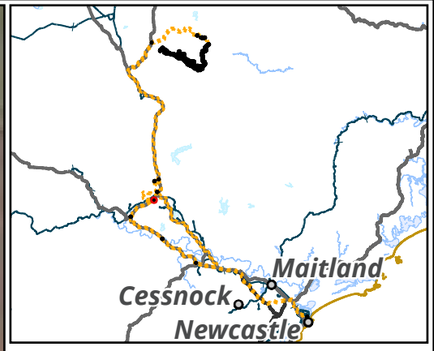

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 1691
- Urban Native/Exotic
- Exotic grassland

Figure 6 Plant community types, Page 27

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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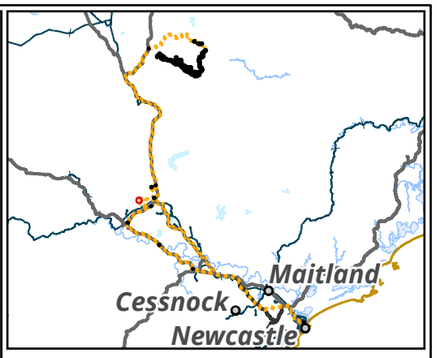

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- 1604
- Exotic grassland

Figure 6 Plant community types, Page 28

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
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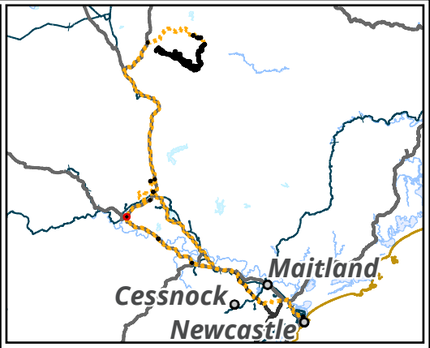

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 29

0 25 50 75 100 Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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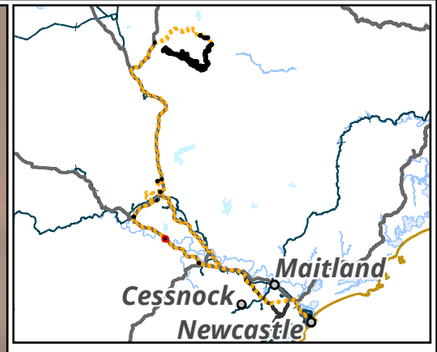

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Urban Native/Exotic
- Exotic grassland

Figure 6 Plant community types, Page 30

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F6_PCT
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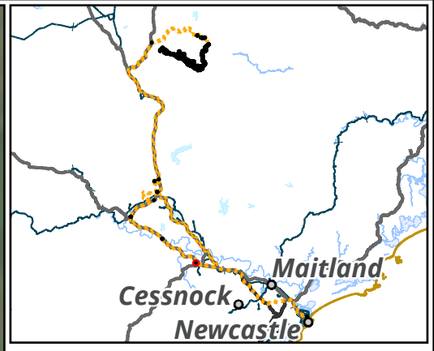

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 31

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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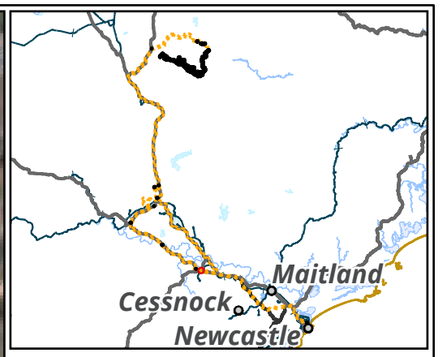

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 32

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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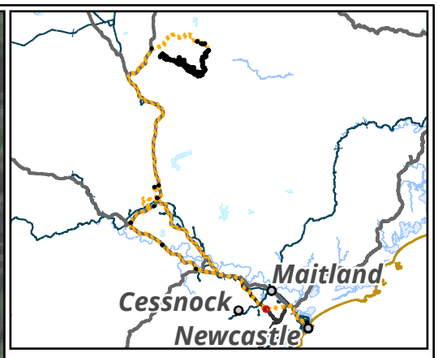

Legend

- Infrastructure footprint
- Transport haul routes

Figure 6 Plant community types, Page 33

0 25 50 75 100 Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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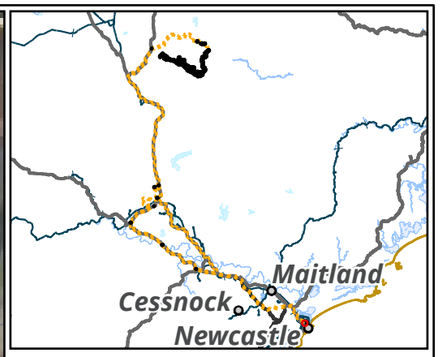

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Exotic grassland

Figure 6 Plant community types, Page 34

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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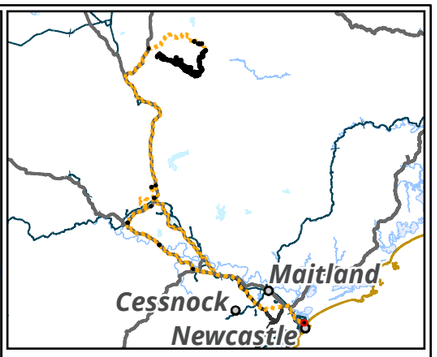

Legend

- Infrastructure footprint
- Transport haul routes

Plant community type

- Urban Native/Exotic
- Exotic grassland

Figure 6 Plant community types, Page 35

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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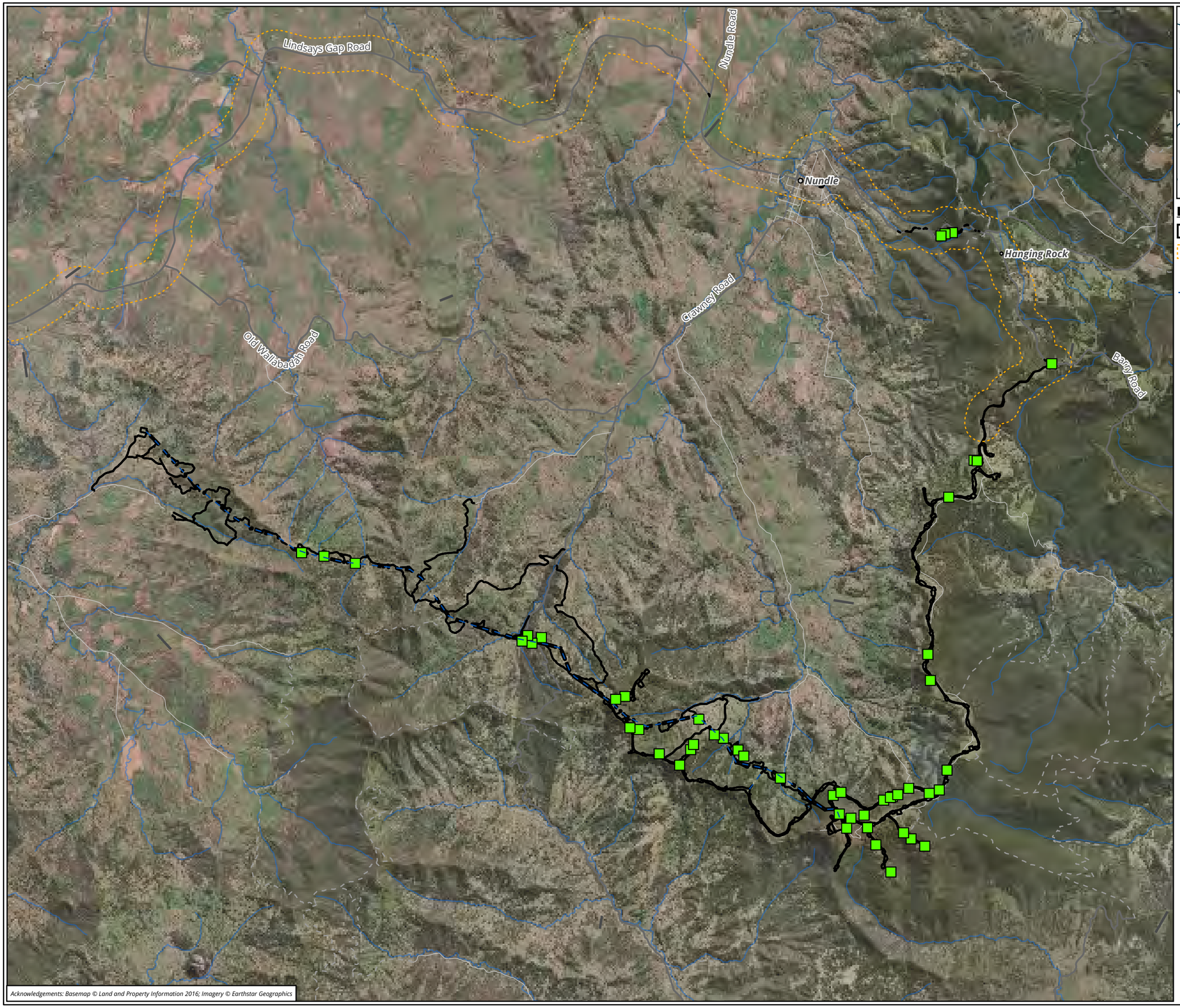

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Figure 7 Vegetation zones within the development footprint, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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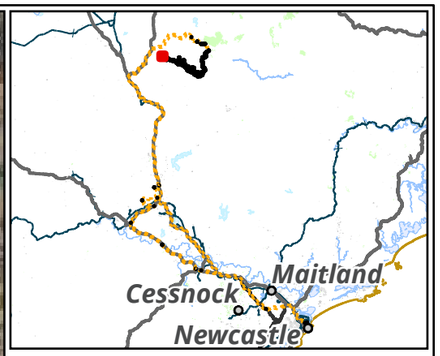

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line

Vegetation zone

- 433,Low
- 434,Low
- 486,DNG
- 486,Low
- 486,Moderate
- 540,DNG
- 540,High
- 540,Low
- 540,Moderate
- 541,DNG
- 541,High
- 541,Low
- 541,Moderate
- 599,Low
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 2

0 125 250 375 500 N

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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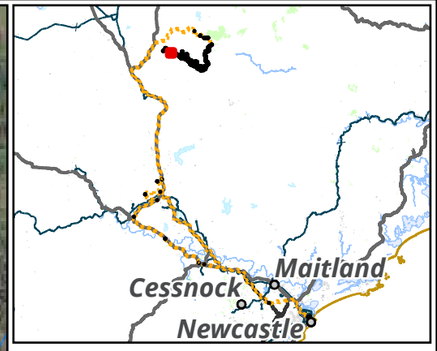

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 540,DNG
- 540,High
- 540,Low
- 540,Moderate
- 541,DNG
- 541,High
- 541,Low
- 541,Moderate
- 599,Low
- 599,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 3

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
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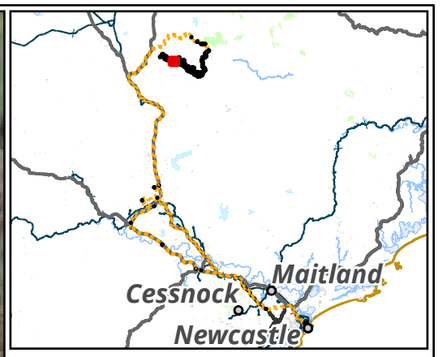

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 486,Moderate
- 490,Low
- 490,Moderate
- 492,DNG
- 492,Low
- 492,Moderate
- 540,DNG
- 540,High
- 540,Low
- 540,Moderate
- 541,Low
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 4

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
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Figure 7 Vegetation zones within the development footprint, Page 5

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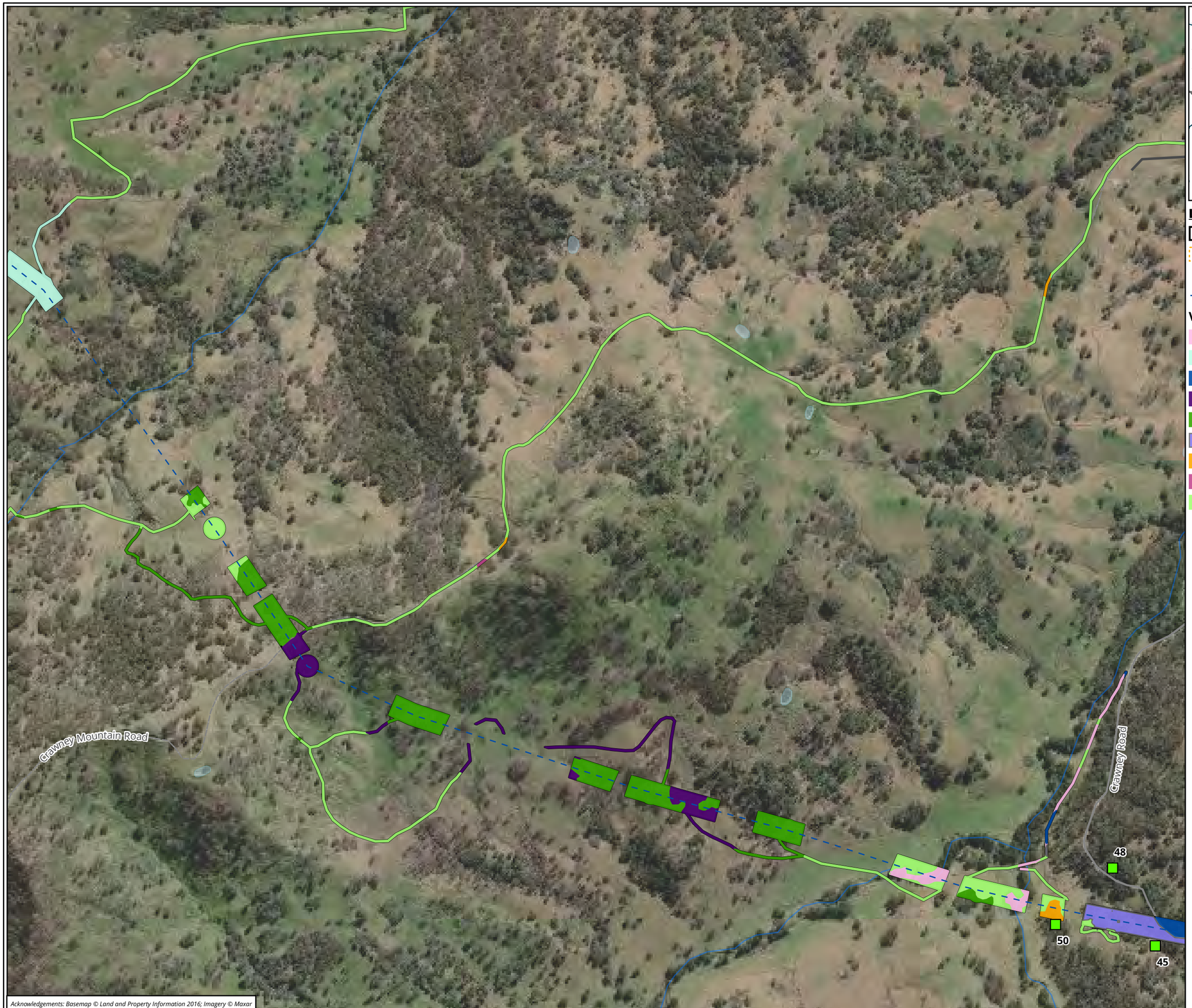

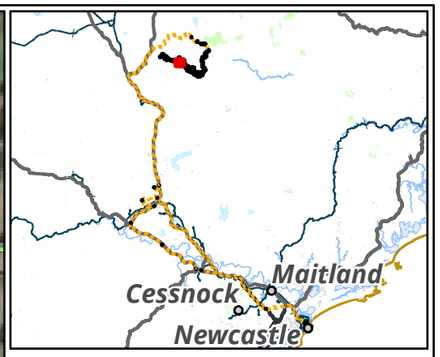

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 486,Moderate
- 490,Low
- 540,High
- 540,Low
- 540,Moderate
- 541,High
- 541,Low
- 541,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 6

0 125 250 375 500 Meters

N

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 486,High
- 486,Moderate
- 540,DNG
- 540,High
- 540,Low
- 540,Moderate
- 541,High
- 541,Low
- 599,High
- 599,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 7

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
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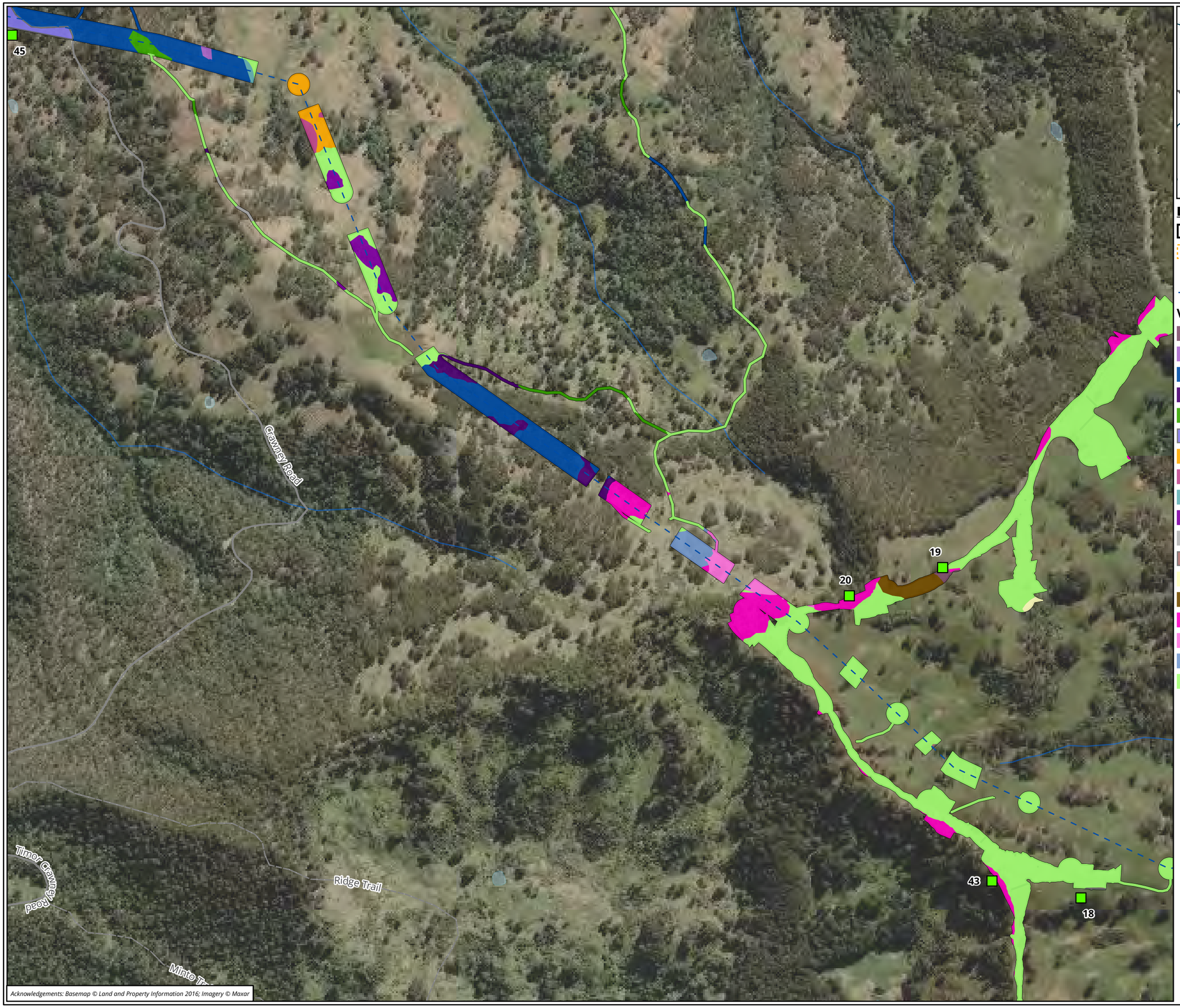

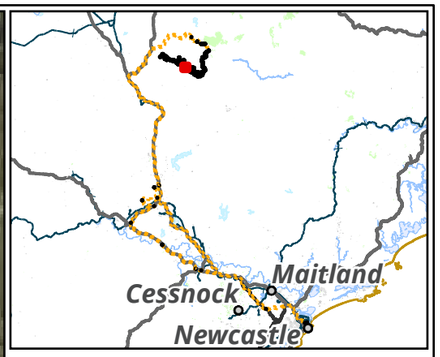

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 507,Moderate
- 540,DNG
- 540,High
- 540,Low
- 540,Moderate
- 541,High
- 541,Low
- 541,Moderate
- 599,High
- 599,Low
- 599,Moderate
- 931,Moderate
- 934,High
- 1194,DNG
- 1194,High
- 1194,Low
- 1194,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 8

0 125 250 375 500

Meters

N

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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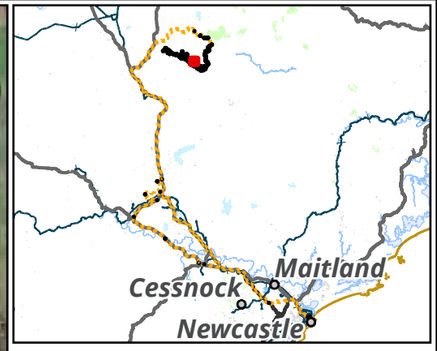

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 486,High
- 486,Low
- 486,Moderate
- 492,Moderate
- 540,DNG
- 540,Low
- 540,Moderate
- 541,Low
- 541,Moderate
- 1194,High
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 9

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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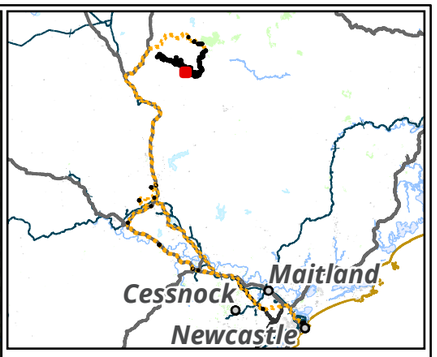

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Vegetation zone

- 540,High
- 541,High
- 541,Moderate
- 931,Moderate
- 934,High
- 954,High
- 1194,DNG
- 1194,High
- 1194,Low
- 1194,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 10

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
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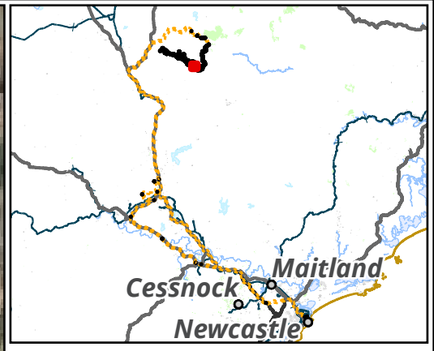

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 486,Moderate
- 492,Moderate
- 540,DNG
- 540,High
- 540,Low
- 540,Moderate
- 541,High
- 934,High
- 934,Moderate
- 1194,High
- 1194,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 11

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
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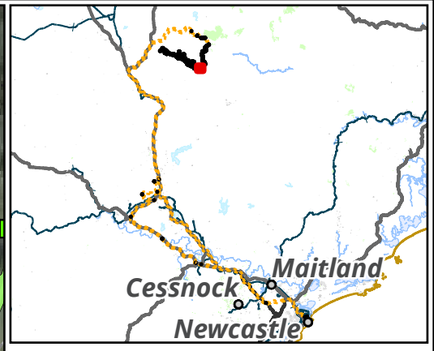

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot
- Transmission line

Vegetation zone

- 526,Moderate
- 540,DNG
- 540,High
- 540,Low
- 540,Moderate
- 586,Low
- 931,High
- 931,Low
- 931,Moderate
- 934,DNG
- 934,High
- 934,Low
- 934,Moderate
- 1194,DNG
- 1194,High
- 1194,Low
- 1194,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 12

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
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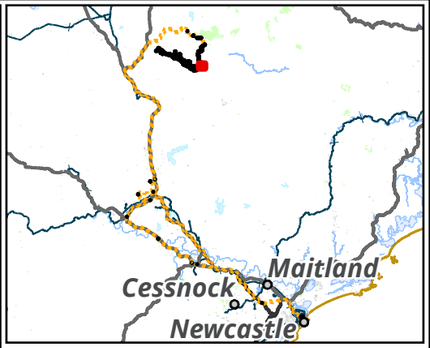

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Vegetation zone

- 934,High
- 1194,Low
- 1194,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 13

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
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Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Vegetation zone

- 1194,High
- 1194,Low
- 1194,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 14

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
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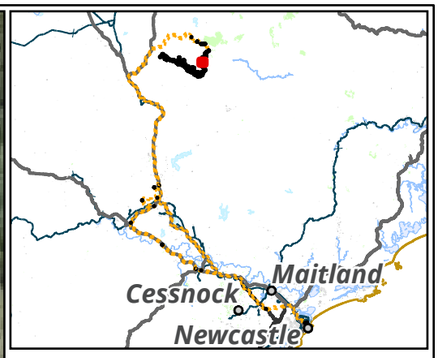

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- 1194,High
- 1194,Low
- 1194,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 15

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

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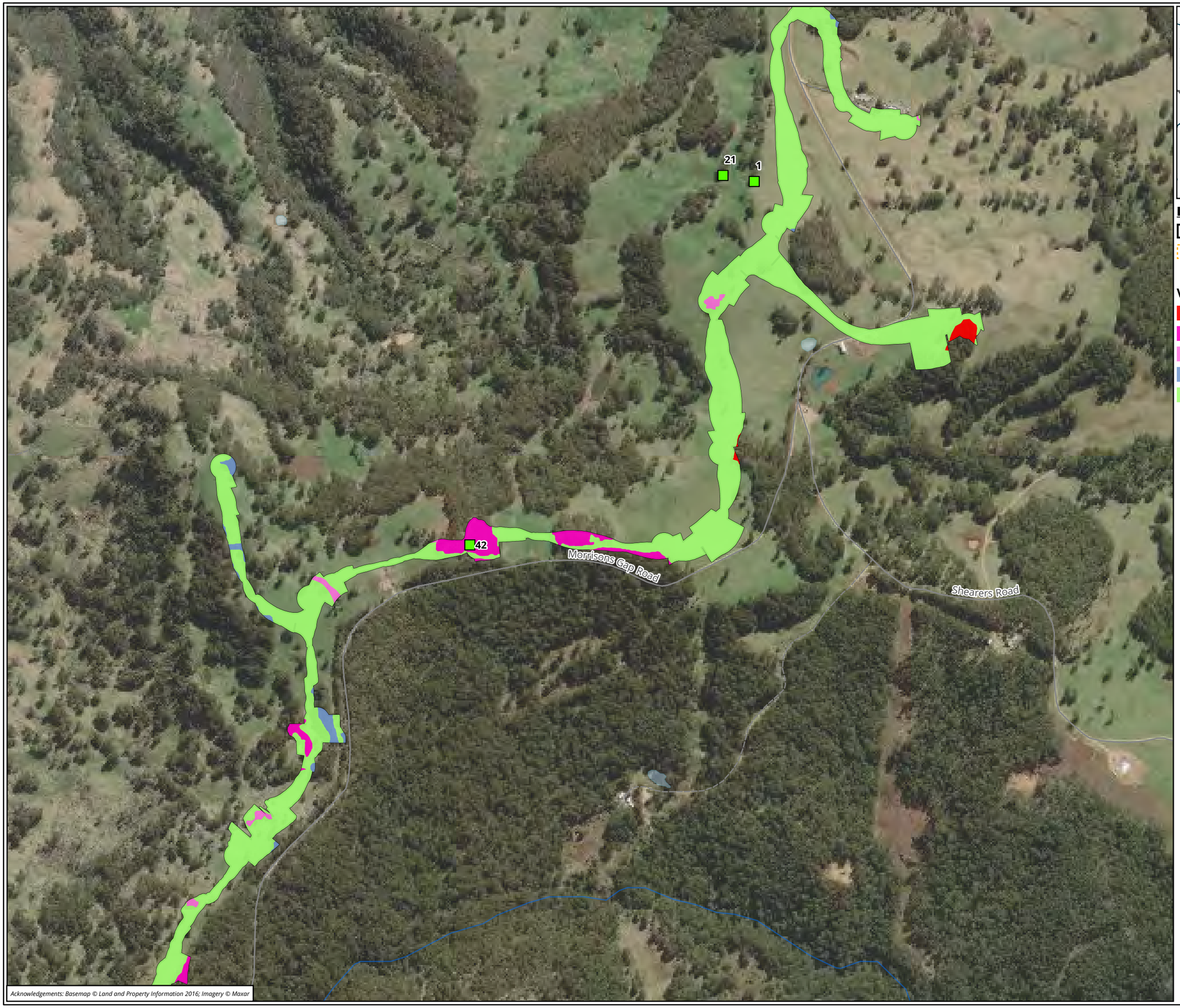
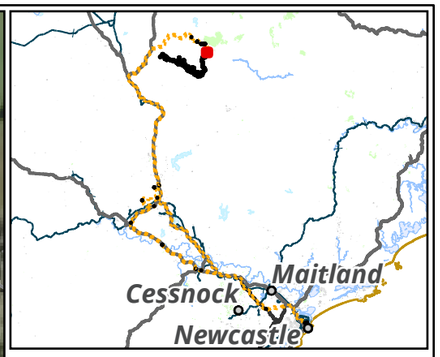


Figure 7 Vegetation zones within the development footprint, Page 16

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx



Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Vegetation zone

- 490,High
- 526,High
- 526,Moderate
- 931,High
- 1194,DNG
- 1194,High
- 1194,Low
- 1194,Moderate
- Urban Native/Exotic
- Exotic grassland

Acknowledgements: Basemap © Land and Property Information 2016; Imagery © Maxar

Figure 7 Vegetation zones within the development footprint, Page 17

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

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Figure 7 Vegetation zones within the development footprint, Page 18

Scale: 1:3,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

Legend

- Infrastructure footprint
- Transport haul routes
- BAM plot

Vegetation zone

- 492,High
- 541,High
- Urban Native/Exotic

Figure 7 Vegetation zones within the development footprint, Page 19

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- 541,High
- 599,High
- 599,Moderate

Figure 7 Vegetation zones within the development footprint, Page 20

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- 599,Low
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 21

0 25 50 75 100

Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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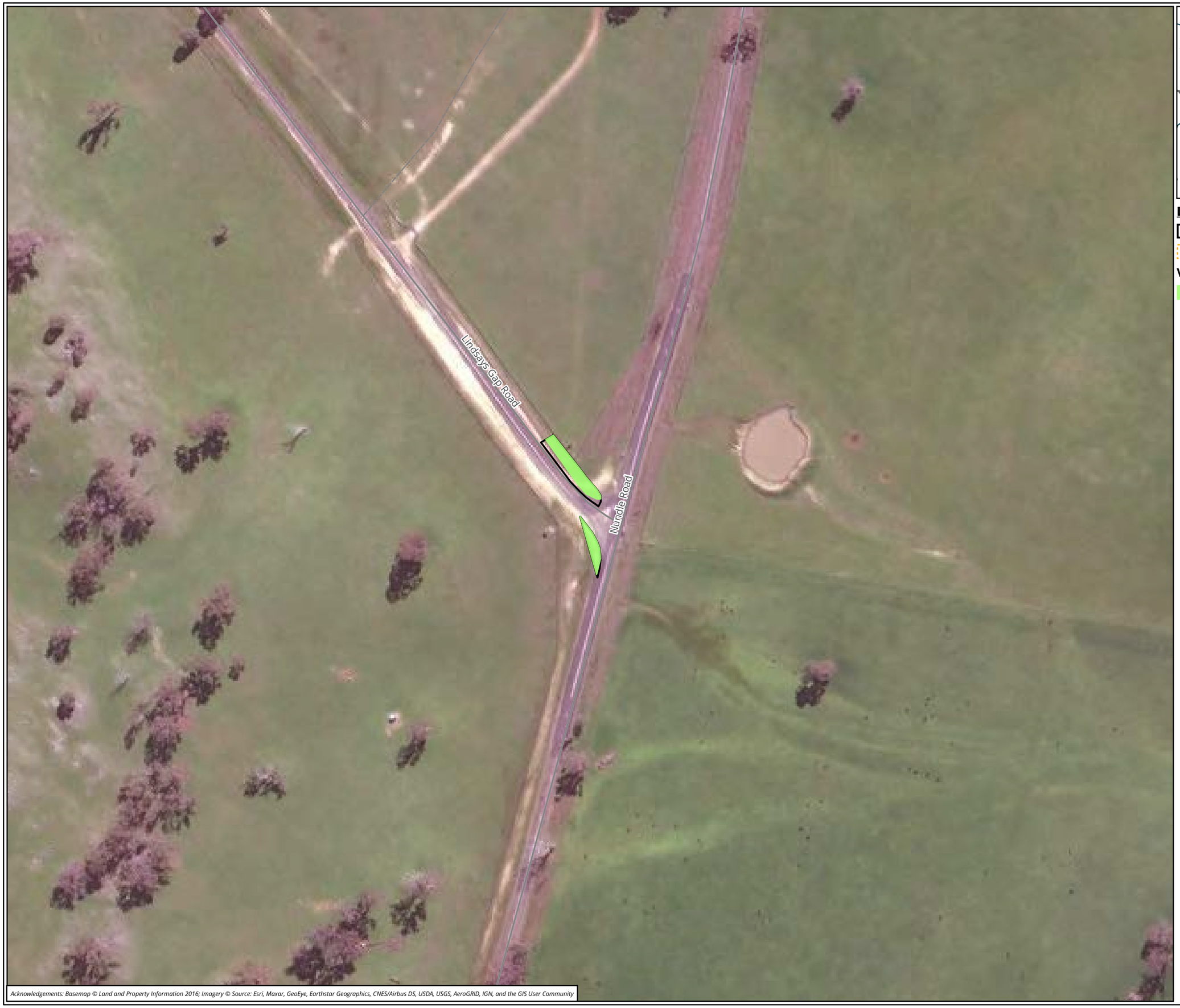
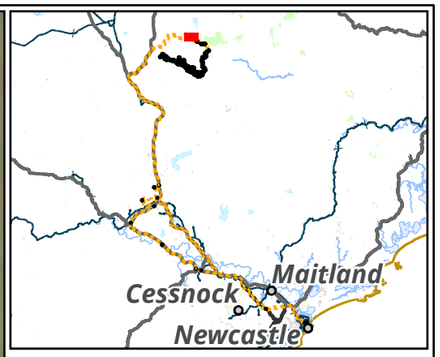
Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx





Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 22

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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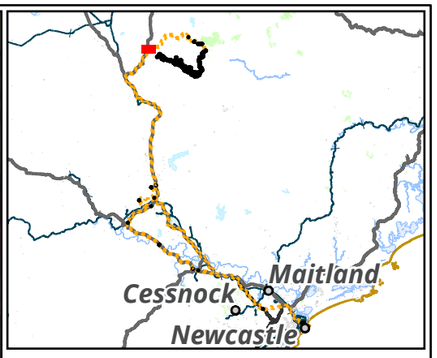

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- 433,Moderate
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 23

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

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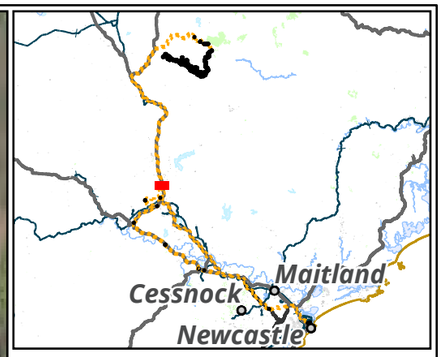

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 24

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 05 November 2021 ,
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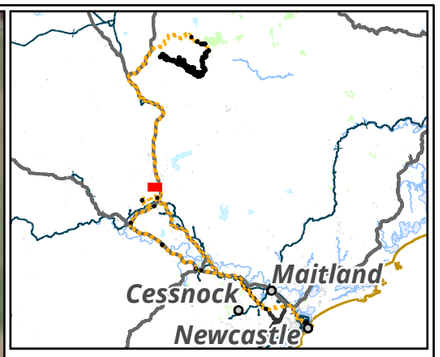
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx



Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 25

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Layout: 34963_F7_VegZones
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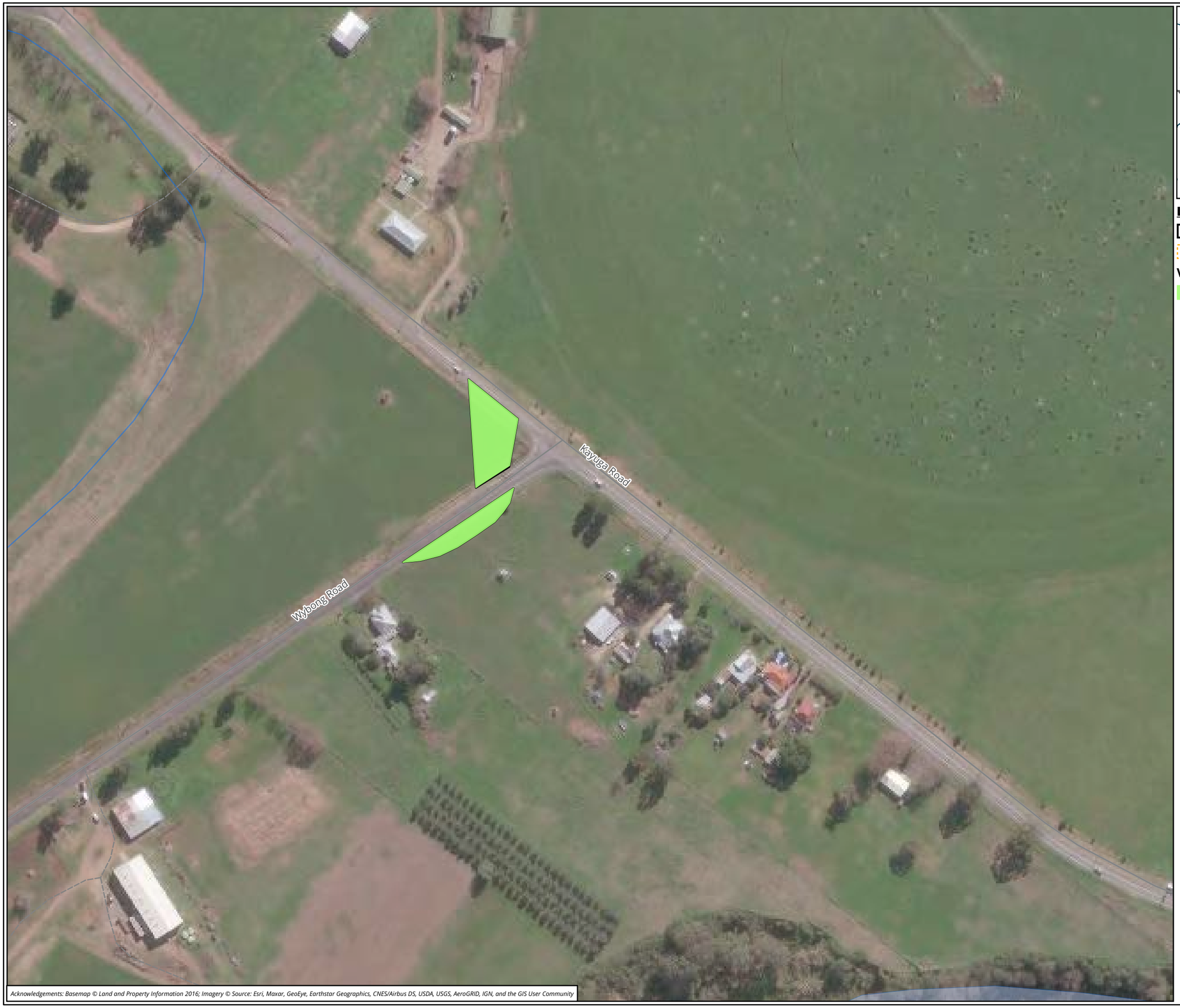

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 26

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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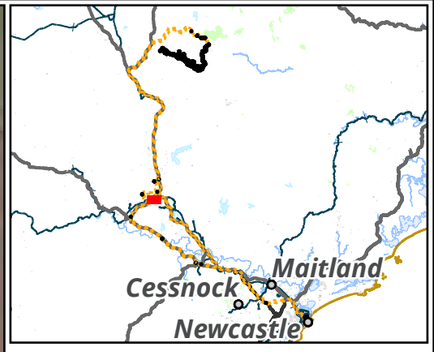
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx



Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- 1691,Low
- Urban Native/Exotic
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 27

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
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Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- 1604,Low
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 28

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
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Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 29

0 25 50 75 100 Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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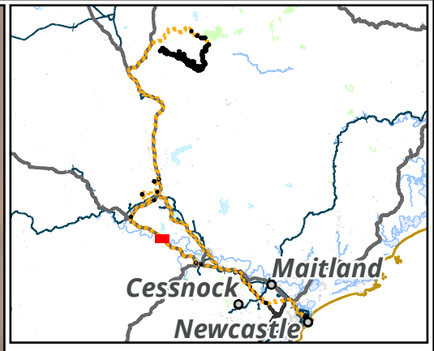

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Urban Native/Exotic
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 30

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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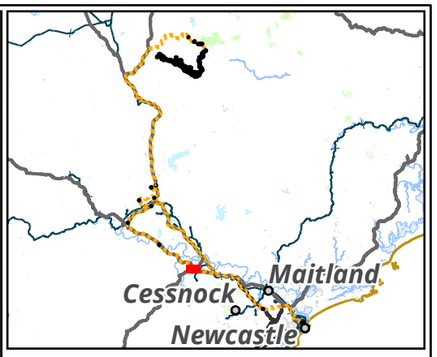

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 31

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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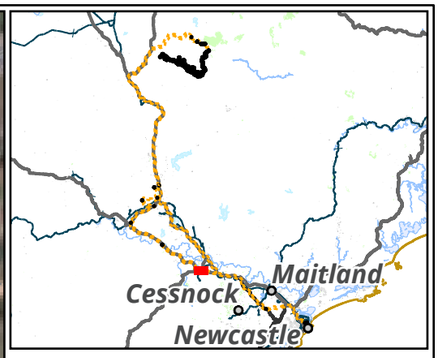

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 32

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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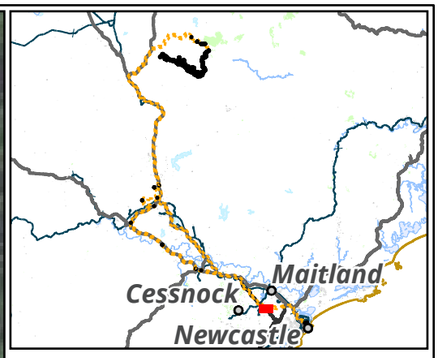

Legend

Infrastructure footprint

Transport haul routes

Figure 7 Vegetation zones within the development footprint, Page 33

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

Figure 7 Vegetation zones within the development footprint, Page 34

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F7_VegZones
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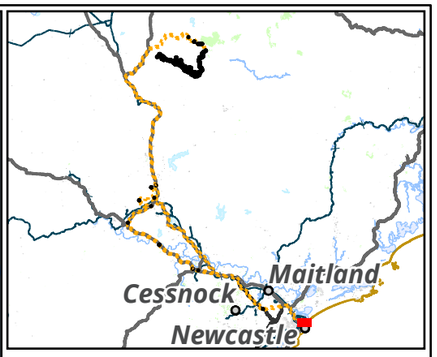

Legend

- Infrastructure footprint
- Transport haul routes

Vegetation zone

- Urban Native/Exotic
- Exotic grassland

Figure 7 Vegetation zones within the development footprint, Page 35

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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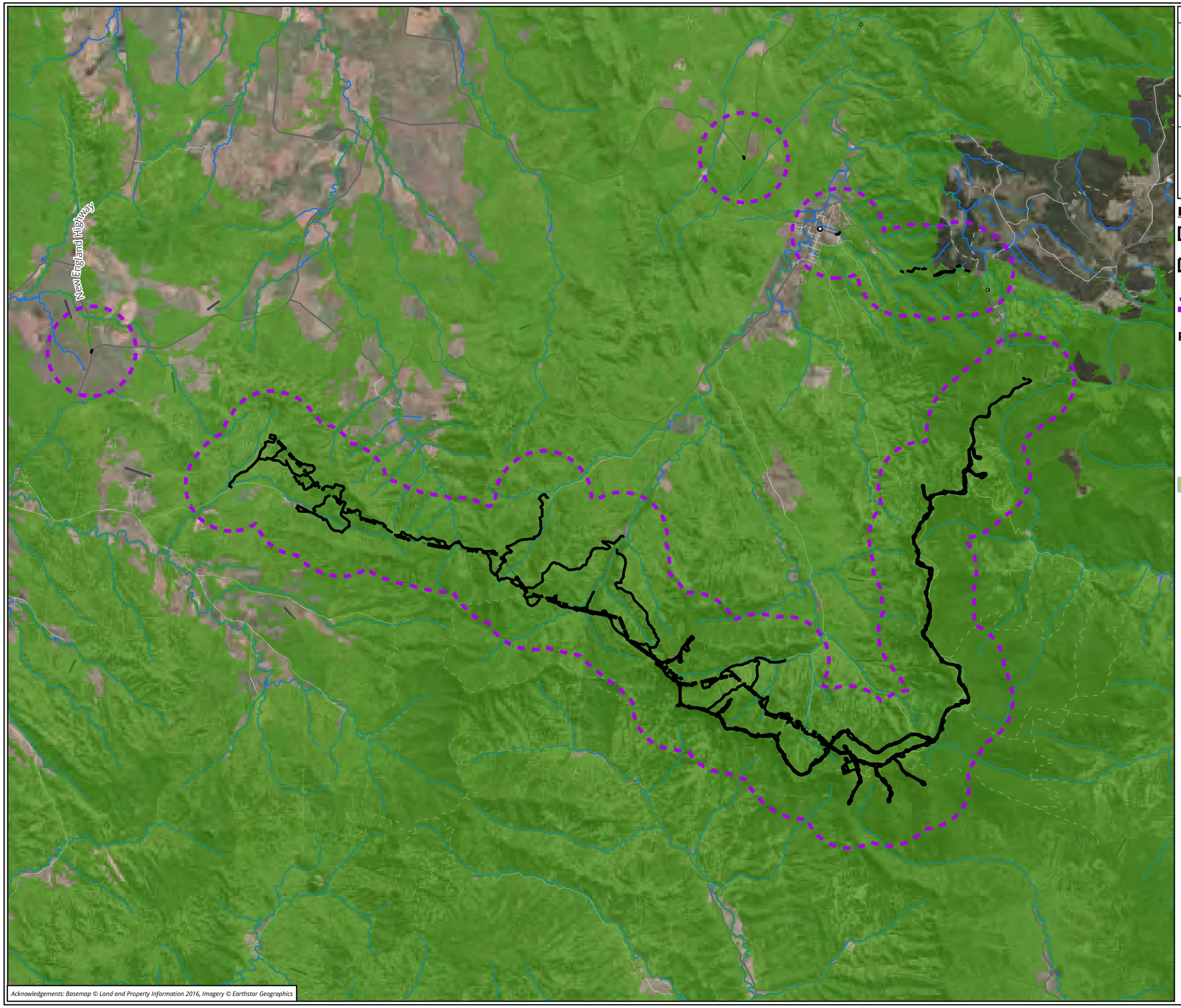

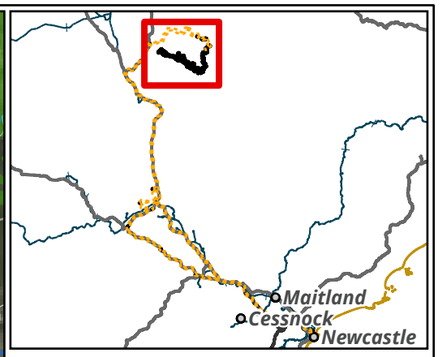

Legend

- Infrastructure footprint
- Development footprint 100km buffer
- Landscape assessment buffer (study area)

Patch sizes

Patch size >=100ha (1194 DNG; 1194 High; 1691 Low; 1194 Low; 1194 Moderate; 1604 Low; 433 Low; 433 Moderate; 434 Low; 486 DNG; 486 High; 486 Low; 486 Moderate; 490 High; 490 Low; 490 Moderate; 492 DNG; 492 High; 492 Low; 492 Moderate; 507 Moderate; 526 High; 526 Moderate; 540 DNG; 540 High; 540 Low; 540 Moderate; 541 DNG; 541 High; 541 Low; 541 Moderate; 586 Low; 599 High; 599 Low; 599 Moderate; 931 High; 931 Low; 931 Moderate; 934 DNG; 934 High; 934 Low; 934 Moderate; 954 High)

Figure 8 Patch size locations, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:120,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 10 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F8_PatchSize
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

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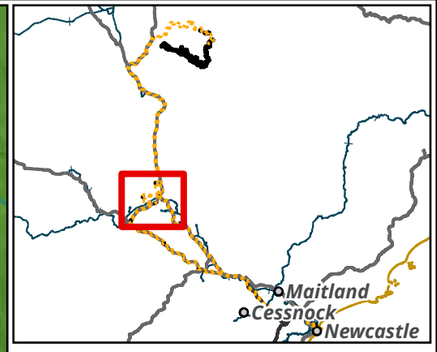


Legend

- Infrastructure footprint
- Development footprint 100km buffer
- Landscape assessment buffer (study area)

Patch sizes

- Patch size >=100ha (1194 DNG; 1194 High; 1691 Low; 1194 Low; 1194 Moderate; 1604 Low; 433 Low; 433 Moderate; 434 Low; 486 DNG; 486 High; 486 Low; 486 Moderate; 490 High; 490 Low; 490 Moderate; 492 DNG; 492 High; 492 Low; 492 Moderate; 507 Moderate; 526 High; 526 Moderate; 540 DNG; 540 High; 540 Low; 540 Moderate; 541 DNG; 541 High; 541 Low; 541 Moderate; 586 Low; 599 High; 599 Low; 599 Moderate; 931 High; 931 Low; 931 Moderate; 934 DNG; 934 High; 934 Low; 934 Moderate; 954 High)

Figure 8 Patch size locations, Page 2

0 1,000 2,000 3,000 4,000

Meters

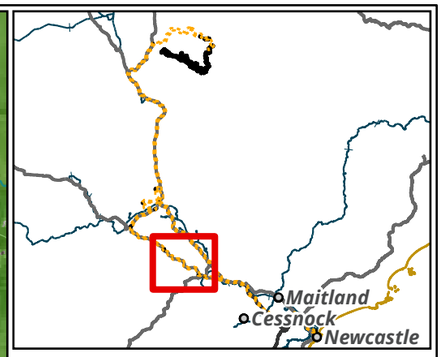
Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 10 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F8_PatchSize
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx



Legend

- Infrastructure footprint
- Development footprint 100km buffer
- Landscape assessment buffer (study area)

Patch sizes

Patch size >=100ha (1194 DNG; 1194 High; 1691 Low; 1194 Low; 1194 Moderate; 1604 Low; 433 Low; 433 Moderate; 434 Low; 486 DNG; 486 High; 486 Low; 486 Moderate; 490 High; 490 Low; 490 Moderate; 492 DNG; 492 High; 492 Low; 492 Moderate; 507 Moderate; 526 High; 526 Moderate; 540 DNG; 540 High; 540 Low; 540 Moderate; 541 DNG; 541 High; 541 Low; 541 Moderate; 586 Low; 599 High; 599 Low; 599 Moderate; 931 High; 931 Low; 931 Moderate; 934 DNG; 934 High; 934 Low; 934 Moderate; 954 High)

Figure 8 Patch size locations, Page 3

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 10 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
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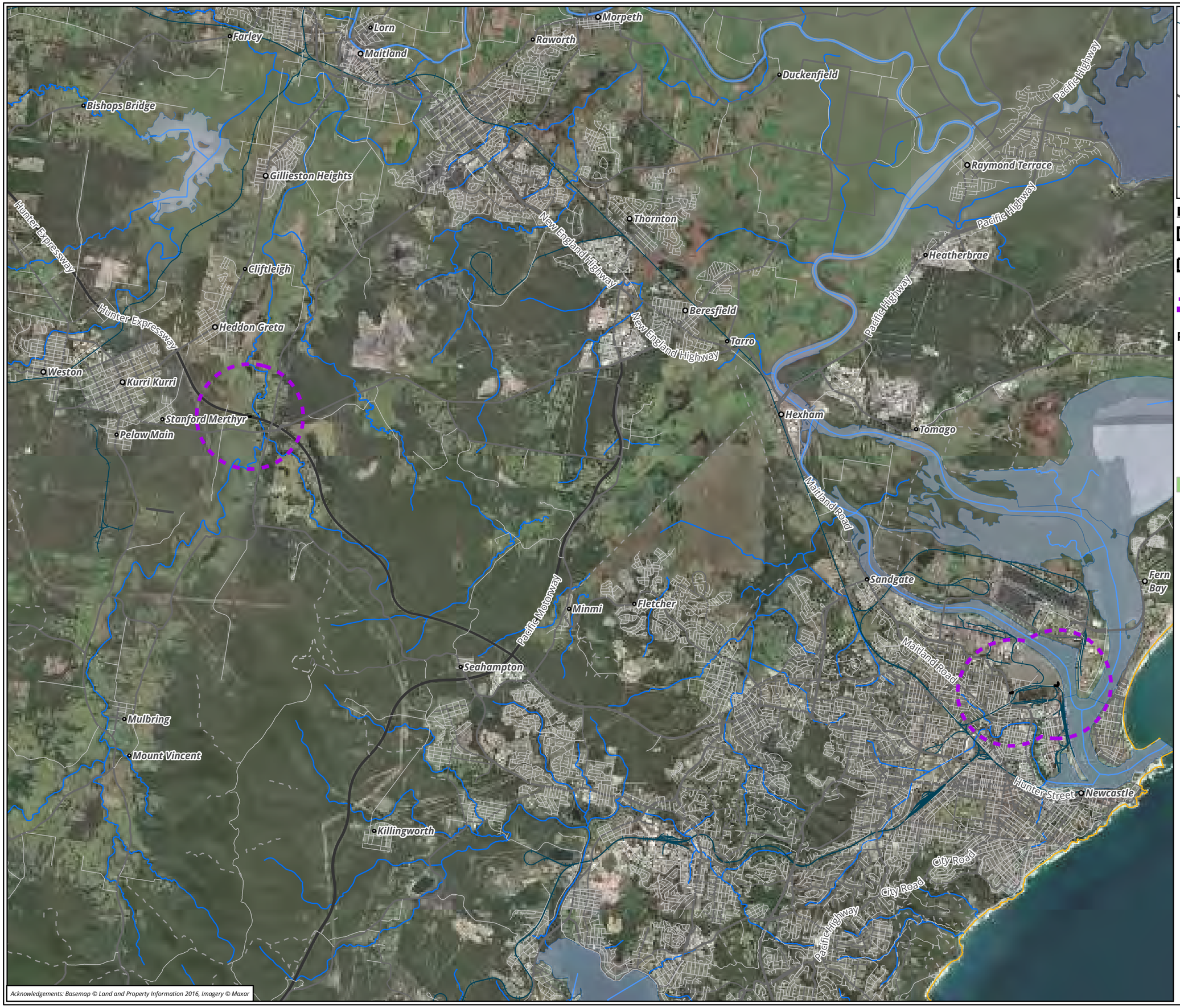

Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Maxar

Legend

- Infrastructure footprint
- Development footprint 100km buffer
- Landscape assessment buffer (study area)

Patch sizes

- Patch size >=100ha (1194 DNG; 1194 High; 1691 Low; 1194 Low; 1194 Moderate; 1604 Low; 433 Low; 433 Moderate; 434 Low; 486 DNG; 486 High; 486 Low; 486 Moderate; 490 High; 490 Low; 490 Moderate; 492 DNG; 492 High; 492 Low; 492 Moderate; 507 Moderate; 526 High; 526 Moderate; 540 DNG; 540 High; 540 Low; 540 Moderate; 541 DNG; 541 High; 541 Low; 541 Moderate; 586 Low; 599 High; 599 Low; 599 Moderate; 931 High; 931 Low; 931 Moderate; 934 DNG; 934 High; 934 Low; 934 Moderate; 954 High)

Figure 8 Patch size locations, Page 4

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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4.3 Threatened ecological communities

Two threatened ecological communities (TEC) were confirmed to occur within and immediately adjacent to the development footprint. These are identified in Table 26, with their occurrence shown in Figure 9.

Table 26 Threatened ecological communities mapped within the development footprint and their conservation status

TEC	PCT	Conservation status[1]		Area (ha)
		EPBC Act	BC Act	
Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	Not listed	E	23.36
	PCT 1194 - Snow Gum – Mountain Gum – Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion			
White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	433 - White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion	CE	CE	6.07
	PCT434 - White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion			
	PCT 492 – Silvertop Stringybark – Yellow Box – Apple Box – Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion			
	PCT 599- Blakely's Red Gum – Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion			

[1] Conservation status – CE: critically endangered; E: endangered

4.3.1 Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland

Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland is listed as an TEC under the BC Act and its occurrence the subject land is strongly influenced by topography and location within the landscape. This TEC occurs at elevations of between approximately 700 metres and 1,500 metres on deep basalt or loam soils.

Within the development footprint the EEC consists of the following PCTs, where they occur within, or as prat of a contiguous patch within, the New England Tablelands IBRA bioregion:

- 540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion

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- PCT 1194 – Snow Gum – Mountain Gum – Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion.

As outlined in the *Guidelines for interpreting listing criteria for species, populations and ecological communities under the NSW Biodiversity Conservation Act 2016 Version 2* (NSW TSSC 2018), an ecological community as defined by the BC Act (section 1.6) is 'an assemblage of species occupying a particular area'. For Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland this includes the list of species provided in Part 2 of the community's Final Determination for listing under the BC Act, and the occurrence of those species in the ew England Tableland Bioregion.

As outlined in the EEC's final determination for listing under the BC Act, the listed community can occurred in degraded states including areas that persist as native grassland where the woody component of the community has been eliminated by clearing. As such the above PCTs occurring in all condition states were considered to conform to the listed EEC.

The location of this EEC within the development footprint is predominantly associated with the upper ridgelines and more shallow slopes at the top of the escarpment (Figure 9). Where it does occur away from the ridgelines the EEC generally exists in in a low or moderate condition and fragmented spatial distribution due to the history of land clearing and grazing.

Due to these topography and soil constraints, the majority of the EEC within the development footprint is impacted by the wind farm and internal road infrastructure type, with the internal roads contributing to the majority of these impacts (Table 27). As much as possible the placement of wind farm infrastructure avoided these areas of TEC, however engineering constraints with steeper slopes and ridgelines require internal access roads to have a concept earthworks design that increases the footprint.

Field surveys also confirmed substantial areas of high quality Ribbon Gum-Mountain Gum-Snow Gum TEC within the adjacent Ben Halls Gap Nature Reserve. These areas were in much higher condition than the patches of this TEC within the development footprint, largely due to the exclusion of cattle grazing pressure and weed management along fence lines. These areas also contained a much higher density of larger eucalypt trees supporting various sized hollows, containing improved habitat resources for native fauna.

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Table 27: Distribution of Ribbon Gum-Mountain Gum-Snow Gum EEC within each infrastructure type in the development footprint.

Vegetation condition class	Ribbon Gum-Mountain Gum-Snow Gum EEC area in each infrastructure type (ha)						
	Wind turbine infrastructure	Internal roads	Temporary construction footprint	Ancillary infrastructure	Transmission line	Transmission line access tracks	Transport route road upgrades
High condition	2.56	0.99	4.23	-	1.61	-	0.07
Moderate condition	2.24	1.83	3.90	0.72		-	0.24
Low condition	1.18	0.60	1.28			-	0.05
DNG	0.68	0.22	0.45			-	0.50
Total (ha)	**6.67**	**3.64**	**9.86**	**0.72**	**1.61**	-	**0.86**

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4.3.2 White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland (Box Gum Woodland) is a CEEC listed under both the EPBC Act and the BC Act. Its distribution is strongly associated with more fertile soils on lower elevations across the known range in Queensland, New South Wales and Victoria. Over much of its range, this CEEC has been subject to extensive clearing and modification for agriculture and grazing, so it often occurs as derived native grasslands with no overstorey.

Within the development footprint, the CEEC consists of the following PCTs:

- PCT 433 - White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, Brigalow Belt South Bioregion.
- PCT434 - White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion
- PCT 492 - Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion.
- PCT 599- Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion.

It has been conservatively assumed that all condition states of the above listed PCTs support the required floristic diversity to represent the CEEC. Based on this conservative assumption, within the revised development footprint, there is a total of 6.07 hectares of Box Gum Woodland, which meets the listing requirements of both the EPBC Act TEC and the BC Act.

The CEEC was found to occur along the transmission line corridor, mainly to the west of the wind farm, with a small area in the central portion of the development site downslope (and north) of the wind farm itself. Furthermore the CEEC was found to occur at the far northern end of the access track servicing the central portion of the transmission line, and within two areas requiring upgrades for the transport route including just east of Nundle, and at Devils Elbow (Figure 9).

Consistent with the topographic, geological and soils requirements of this CEEC, it was not recorded across the ridgelines where the wind turbines and internal roads are located (Table 28), however the occurrence of the CEEC at Devils Elbow would not be considered its typical grassy woodland form. PCT492 vegetation in this area occurs on thinner rockier soils, with a relatively high shrubby understorey cover, however floristically it matches both BC Act and EPBC Act requirements well, based on plot data, and the PCT is noted as 'Equivalent' to the TEC in the BioNet Vegetation Classification Database, and as such the vegetation in this area has been conservative assessed as representing Box Gum Woodland CEEC.

Table 28 provides a summary of the condition states which the CEEC was recorded in within the footprint. As it can be seen over 40% of the CEEC occurs in Low of DNG condition, with the majority of the areas mapped as occurring in moderate condition occurring as small fragmented and isolated patches within a generally highly disturbed landscape (Figure 9).

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Table 28 Distribution of Box Gum Woodland CEEC within each infrastructure type in the development footprint

Vegetation condition class	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC area in each infrastructure type (ha)						
	Wind turbine infrastructure	Internal roads	Temporary construction footprint	Ancillary infrastructure	Transmission line	Transmission line access tracks	Transport route road upgrades
High condition	-	-	-	-	0.06	-	2.90
Moderate condition	-	-	-	-	0.48	0.13	0.04
Low condition	-	-	-	-	1.29	0.21	0.08
DNG	-	-	-	-	0.71	0.17	-
Total (ha)	-	-	-	-	**2.54**	**0.51**	**3.02**

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4.3.3 Sphagnum Moss Cool Temperate Rainforest

In addition to the TECs that have been mapped within the development footprint and subject land, desktop investigations have also mapped patches of the endangered Ben Halls Gap Nature Reserve Sphagnum Moss Cool Temperate Rainforest. This TEC is listed as endangered under the BC Act however, is also subject to draft conservation advice under the EPBC Act for potential Endangered or Critically Endangered listing. The community is mapped within Ben Halls Gap Nature Reserve, over 135 metres outside the closest extent of the development footprint. The project will not result in any direct impacts to this TEC and indirect impacts associated with the construction and operation of the Project are highly unlikely, but will be considered in the Erosion and Sediment Control Plan which will include specific actions to identify and protect sensitive receptors associated with the National Park estate, including waterways and the adjacent Sphagnum Moss TEC. Additionally, specifically actions relating to bushfire management, with inappropriate fire regimes a proposed key threatening process in the EPBC listing advice, have been addressed with mitigation listed in Section 8.5 and Section 8.9 (B9) and within the detailed bushfire risk assessment and management strategy.

An updated assessment of site gradients and risk to this TEC is provided in the updated Soil and Water report including project commitments to avoid impact in the Amendment Report.

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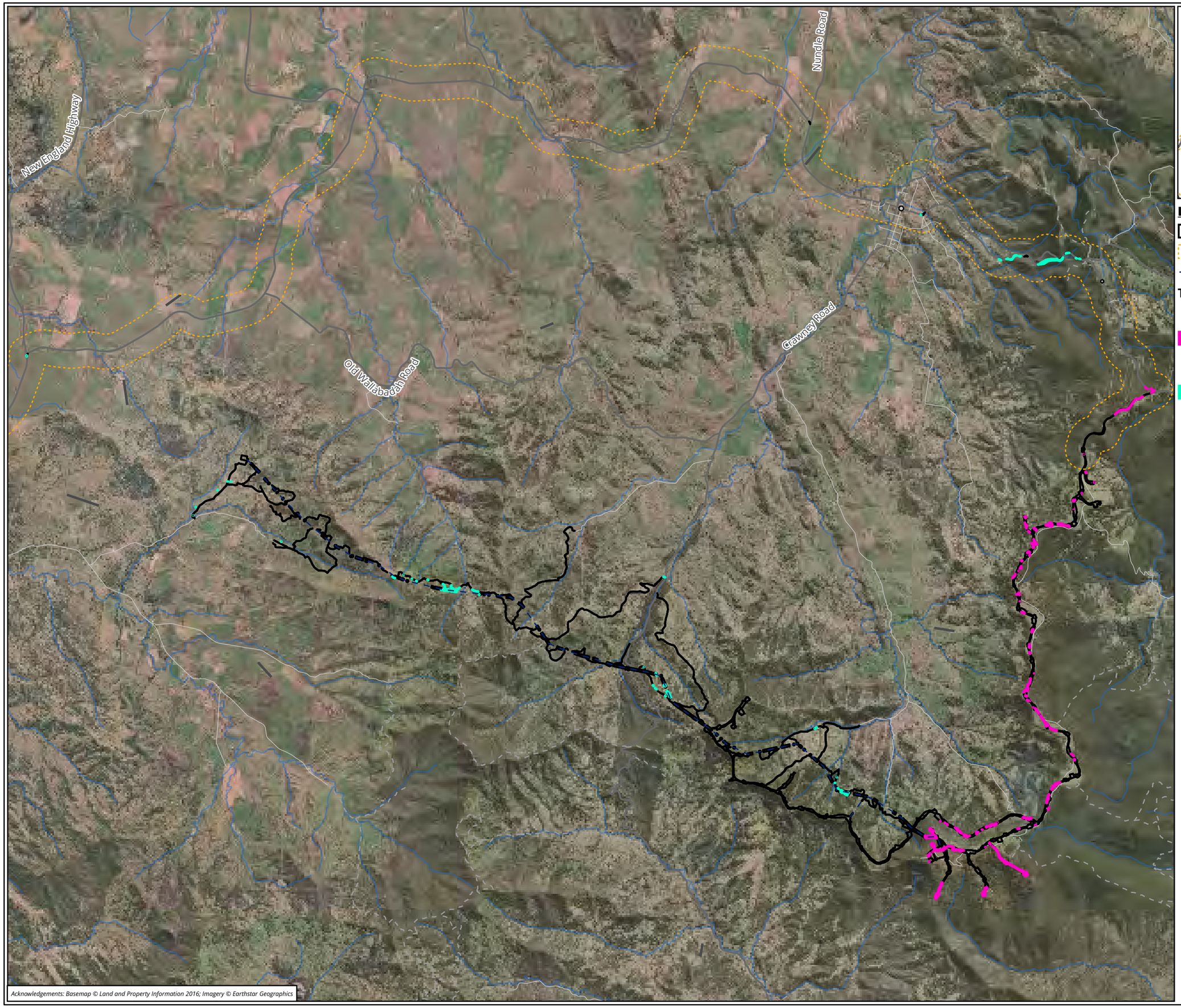

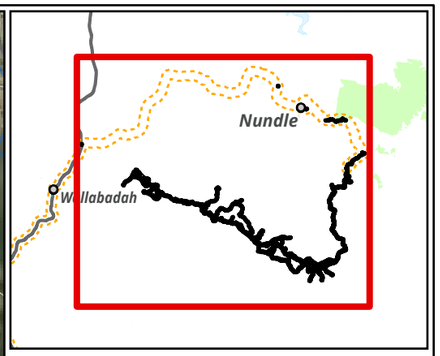

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line

Threatened ecological community

- Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/ Woodland of the New England Tableland Bioregion
- White Box Yellow Box Blakely's Red Gum Woodland

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Figure 9 Threatened ecological communities, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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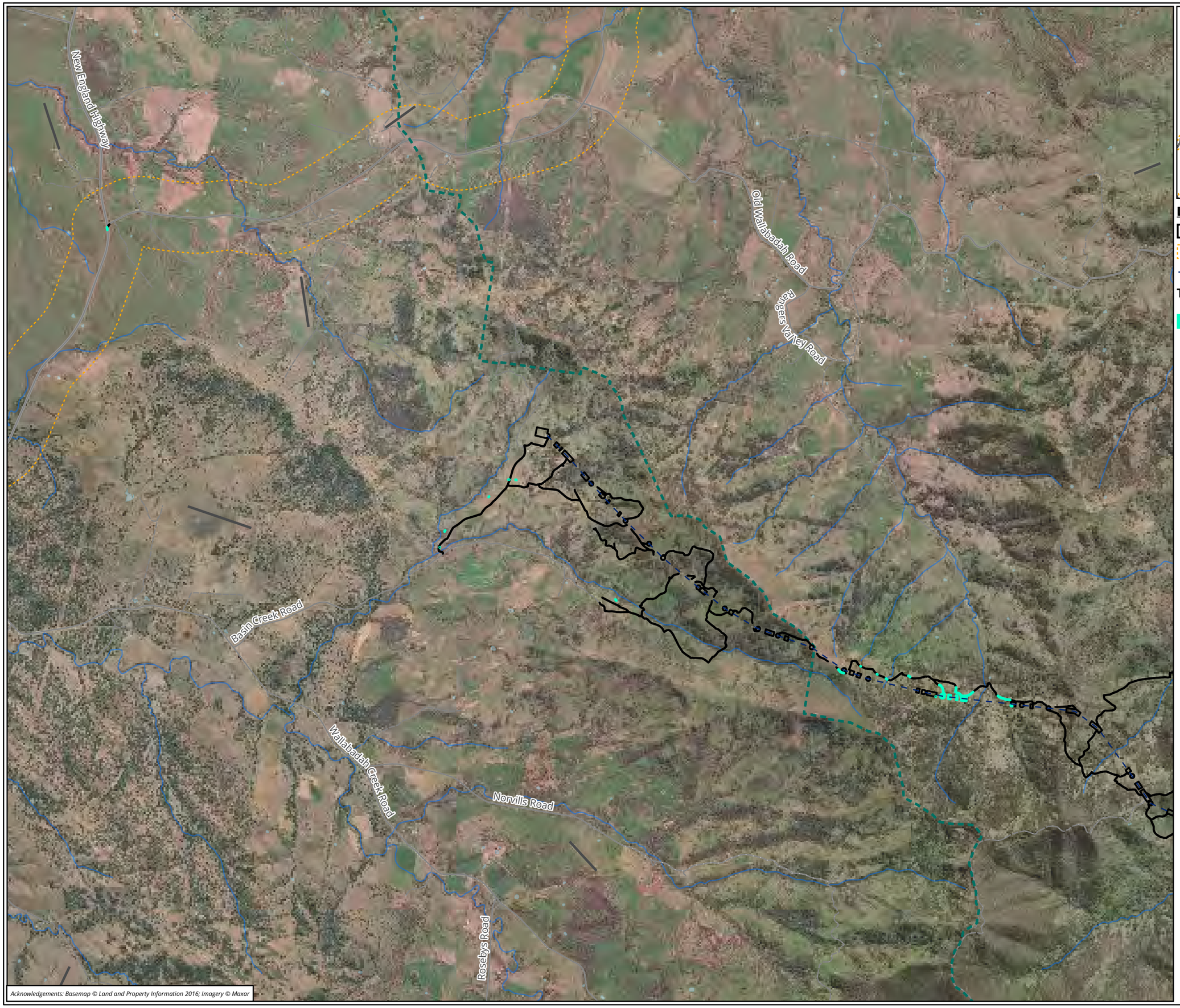

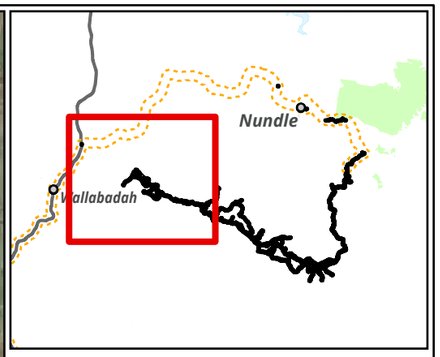

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line

Threatened ecological community

- White Box Yellow Box Blakely's Red Gum Woodland

Figure 9 Threatened ecological communities, Page 2

0 500 1,000 1,500 2,000

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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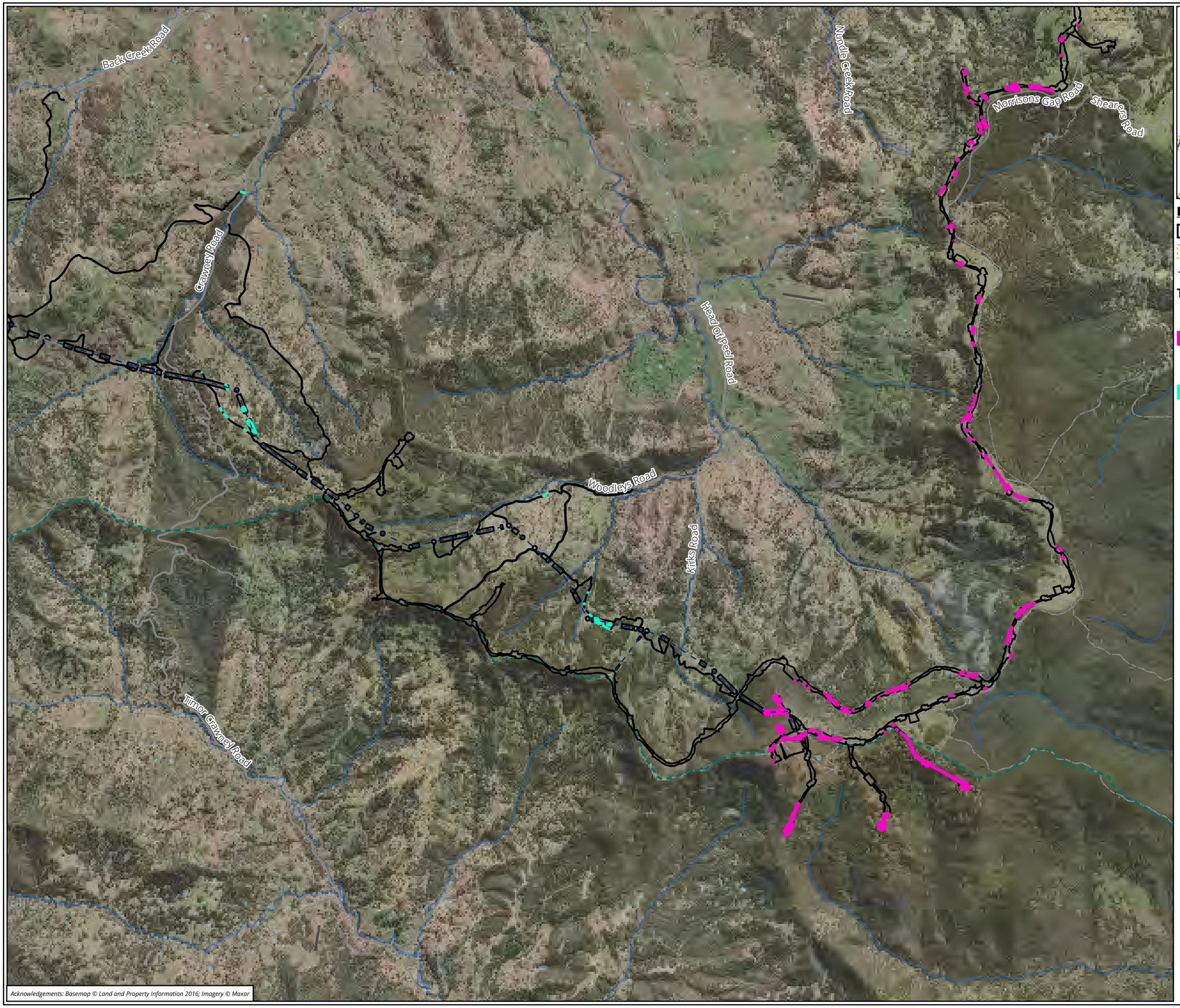

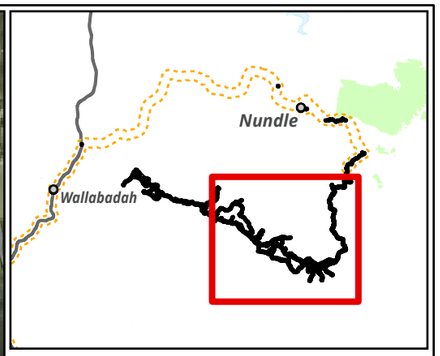

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line

Threatened ecological community

- Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/ Woodland of the New England Tableland Bioregion
- White Box Yellow Box Blakely's Red Gum Woodland

Figure 9 Threatened ecological communities, Page 3

0 500 1,000 1,500 2,000

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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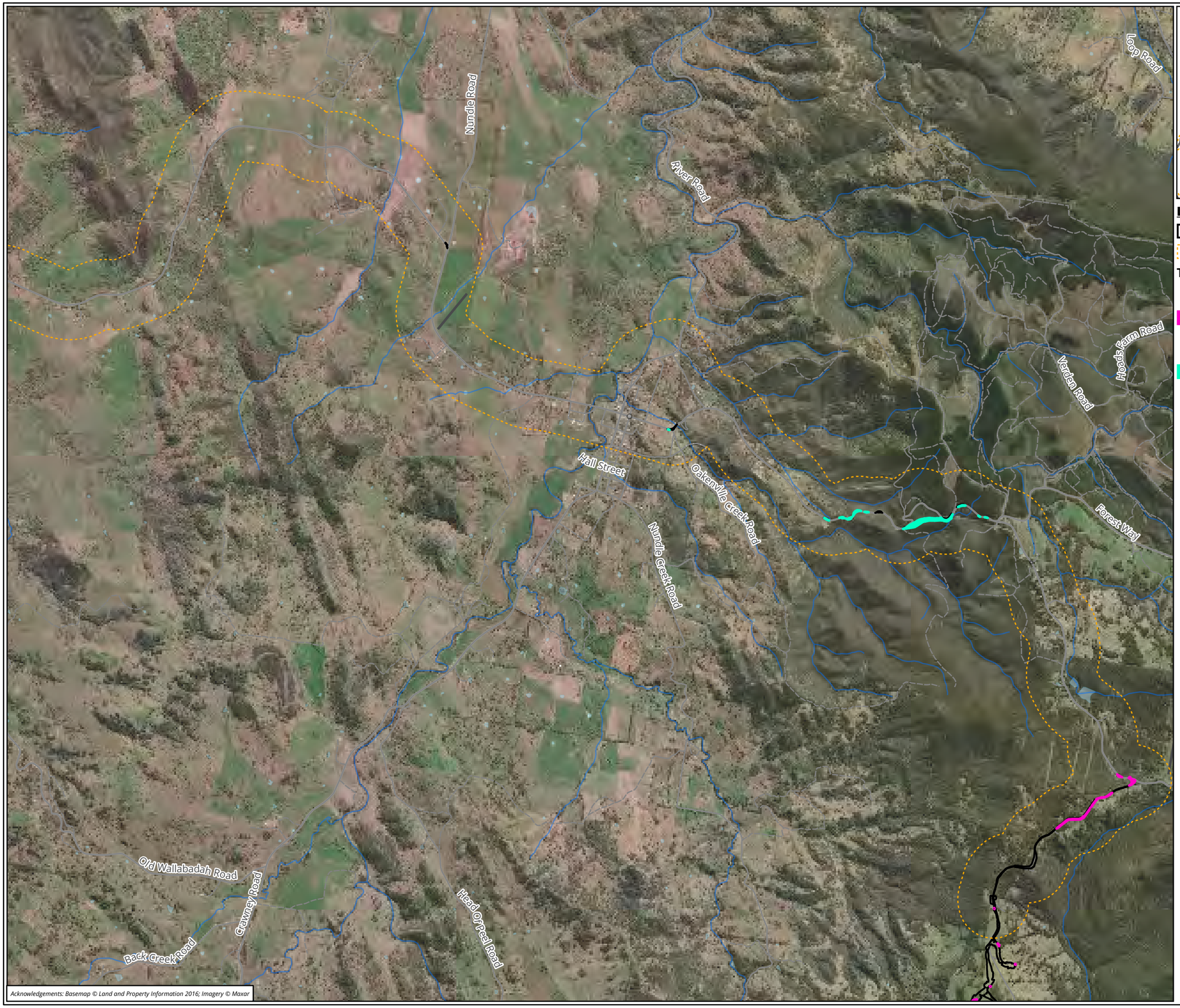

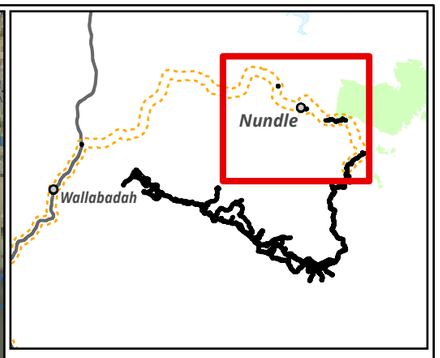

Legend

- Infrastructure footprint
- Transport haul routes

Threatened ecological community

- Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/ Woodland of the New England Tableland Bioregion
- White Box Yellow Box Blakely's Red Gum Woodland

Figure 9 Threatened ecological communities, Page 4

0 500 1,000 1,500 2,000

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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4.4 Groundwater dependent ecosystems

Review of the Groundwater Dependent Ecosystem (GDE) Atlas (BOM, 2020) indicates the presence of low, moderate and high potential GDEs within and immediately adjacent to the development footprint. High potential GDEs identified for the development footprint are detailed in Table 29.

Table 29 Groundwater dependent ecosystems with a high potential of occurring within the development footprint

Groundwater dependent ecosystem name	Extent within the development footprint (ha)
Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion	1.89
Blakely's Red Gum - Yellow Box grassy woodland of the New England Tablelands Bioregion	2.00
Forest Ribbon Gum - Silvertop Stringybark - Mountain Gum tall open forest on basalt on the Liverpool	1.84
Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion	1.06
Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland	0.24
Mountain Gum/ Messmate/ Snow Gum grassy open forest of the New England Tablelands	3.82
Narrow-leaved Peppermint/ Forest Ribbon Gum grassy open forest of the New England Tablelands	2.80
Ribbon Gum - Mountain Gum - Snow Gum grassy open forest or woodland of the New England Tablelands Bioregion	0.59
River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt	0.78
River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range	14.94
Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liver	6.47
Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern land	67.90
Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, south	0.27
Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly	5.48
Silvertop Stringybark/ Tussock Grass grassy open forest of the Northern Tablelands escarpment	3.29
Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of	0.01

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Groundwater dependent ecosystem name	Extent within the development footprint (ha)
the NSW North Coast Bioregion	
Snow Gum - Mountain Gum - Silver Wattle tall open forest of the Liverpool Range, Brigalow Belt South	3.90
Tea-tree riparian shrubland / heathland wetland on drainage areas of Nandewar Bioregion and New England	0.06
White Box - Silvertop Stringybark +/- White Cypress Pine grass shrub open forest of the southern Nan	3.13
White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills	0.01
White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region	0.47

Further assessment of the potential for the vegetation within the assessment area to be a GDE reliant on the subsurface presence of groundwater was undertaken based on the information provided in the GDE Atlas and the rulesets detailed Atlas of Groundwater Dependent Ecosystems (GDE Atlas), Phase 2 Task 5 Report: Identifying and mapping GDEs (SKM 2012).

From the results of the field surveys and observation made of the location and topography, it is considered unlikely that any of these ecosystems are actually dependent on the subsurface or surface expression of groundwater. These PCTs occur on the top of ridgelines or steep slopes. A single spring was observed during the field investigations on top of the ridge, however, it had been historically cleared, modified and utilised for agricultural purposes.

Review of groundwater wells carried out as part of the EIS investigations identified that the groundwater aquifer occurs at depths significantly greater than would be intercepted by earthworks associated with the Project construction. The project has been assessed to not have any material impact on groundwater flows, so impacts to GDEs are considered unlikely to occur.

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5 Threatened species and habitat

This section outlines the field survey methods and results for identifying threatened flora and fauna, and their habitats within the development footprint, in accordance with Section 5 of the BAM. Prior to the detailed assessment, some preliminary descriptions of the broad habitat types and their conditions is provided.

5.1 General habitat types and features

5.1.1 Exotic pasture

The most common habitat type across the development footprint is exotic grasslands, which also has the lowest value to threatened flora and fauna (Photo 1). These areas are prevalent due to the current and historical use of the development footprint and surrounding landscape for grazing and agriculture. Habitat features for native fauna are limited in these areas; however, they may be utilised by common species adapted to disturbance.

Areas of open, exotic pasture can also provide foraging opportunities for large, diurnal raptors who predate on small mammals and birds. Exotic pastures within the development footprint are also used by common, large-bodied birds that do not require forest cover for shelter and foraging. These birds will forage in more open areas, however, will require adjacent forests for breeding.

Other fauna species observed utilising these areas of exotic pasture include bare-nosed wombat *Vombatus ursinus* and red-bellied black snake *Pseudechis porphyriacus*. Wombat burrows are common throughout these cleared areas, as well as areas of derived native grasslands.

Habitat for threatened flora is very limited in areas of exotic grassland due to altered plant community dynamics, with exotic pasture grasses being more completive. Changed light, water and nutrient dynamics in this habitat type will also limit the suitability of this habitat to support threatened flora species.

5.1.2 Derived native grasslands

Derived native grasslands occur where the canopy and shrub layer has been historically cleared and native grasses and forbs have been retained or regenerated within the ground layer (Photo 2).

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Photo 1 Exotic pasture located within the internal road infrastructure footprint

Photo 2 Derived native grassland with Poa spp. dominant with exotic grasses and forbs sub-dominant. Retained eucalypt trees form extremely sparse canopy

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5.1.3 Open eucalypt forest and woodland

Open eucalypt forests and woodlands are the most common, intact habitat type within the development footprint and assessment area (Photo 3). These habitat types represent the dominant important habitat type for threatened native fauna within the development footprint and have a strong influence on the flora and fauna composition observed. Eucalypt forest vegetation types within the development footprint include:

- Grassy woodlands.
- Open eucalypt forest.
- Tall moist eucalypt forest.
- Riparian open forest and woodland with co-dominant river oak *Casuarina cunninghamiana*.

These eucalypt woodlands provide foraging, shelter, movement and breeding resources for native fauna. Within the development footprint, patches of eucalypt forest in a high or moderate condition contained mature eucalypt trees that contained hollows of varying size. These hollows provide roosting and breeding resources for threatened mammals observed on the development footprint, including Greater Glider *Petauroides volans*, Squirrel Glider *Petaurus norfolcensis* and microbat species.

5.1.4 Steep cliffs and rocky outcrops

Adjacent to the development footprint and on the edges of the ridgeline associated with the wind farm infrastructure and internal roads, there are a number of steep sections with exposed rock outcroppings (Photo 4). These areas provide habitat resources, including shelter and roosting opportunities, for native fauna. In particular two areas have been identified as potential diurnal roost sites for threatened cave-dwelling bat species recorded on the site during field surveys. These areas were identified and have been avoided by the development footprint during the project concept design and are not located within the development footprint.

Photo 3 Grassy open eucalypt forest in the development footprint, showing Mountain Gum and stringybark eucalypts over a grassy ground layer

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Photo 4 Example of rocky outcrops, with rounded boulders in the foreground and steep, incised cliffs in the background

5.1.5 Waterways

The waterways which intersect with the development footprint are dominated by first order streams due to the steep topography of the location and location on a ridgeline at the top of catchments. On top of the ridgeline and upper slopes, waterways are highly ephemeral and are likely to experience flows only immediately following rainfall. These waterways are unlikely to provide habitat for any threatened frogs or fish.

Further down the catchment in areas of the development footprint covered by the transmission line and haul route, there several 3rd and 4th order waterways. These waterways are characterised by shallow banks, with rocky substrates. A very thin zone of riparian vegetation is usually present, with substantial evidence of impacts from cattle grazing and incursion of exotic pasture grasses (Photo 5).

Photo 5 4th order waterway located along Head of Peel road transport haul route

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5.2 Identifying habitat suitability for threatened species

A preliminary assessment was undertaken using the BAM Calculator to identify threatened flora and fauna species with potential to occur within the assessment area. Ground-truthed PCTs were entered into the BAM calculator including maximum values for native vegetation cover, patch size and vegetation integrity. Ecosystem credit species and species credit species predicted for the assessment area are provided in Appendix C.

A search of relevant government databases, including the Bionet database and the EPBC Act Protection Matters Search Tool (PMST) was also carried out for a 10km radius to the development footprint to identify any additional threatened species not identified by the BAM calculator. Desktop sources for the review are detailed in Section 1.8.

A wider desktop assessment area was developed for reviewing potential bat roost sites, including possible maternity roosts to understand more detail on cave systems where known threatened bats may have important roosts. This resulted in an additional three sites in known cave networks, in the landscape surrounding the development footprint, being assessed for microbat activity.

The suitability of habitat in the assessment area was assessed according to the steps outlined in BAM Section 6.4- *Steps for identifying habitat suitability for threatened species* (Appendix C). The results of the assessment are presented in the following sections and form the basis for the removal of species from the assessment where relevant.

5.2.1 Ecosystem credit species

Under the BAM, threatened species with a likelihood of occurrence that can be predicted by vegetation surrogates and landscape features or for which targeted survey has a low probability of detection are identified as ecosystem credits species. These species are not required to be subject to targeted surveys, and their habitat within the development footprint is linked directly to the PCTs present. Habitat for these ecosystem credit species is assumed to be present and their impacts are addressed as part of impacts and loss of habitat. Despite no requirement under the BAM to carry out targeted surveys for these species, the survey design employed for species credit species was sufficient to detect these.

Table 30 identifies ecosystem credit species predicted for the development footprint and an assessment of habitat suitability. The assessment indicates one identified ecosystem species that is unlikely to occur within the development footprint and can be removed from the assessment.

One predicted ecosystem species can be discounted from the assessment due to a lack for both foraging and breeding habitat is the white-bellied sea eagle. The development footprint does not occur within 1km of coastal rivers, lakes, large dams or creeks, wetlands and coastlines, with the exception of the minor road upgrade works in the Hunter Bioregion. These small impacts do not contain suitable breeding habitat for white-bellied sea-eagle. Where Peel River occurs within 1km of the development footprint it is considered a minor watercourse for the purpose of white-bellied sea-eagle habitat.

Table 30 Ecosystem credit species relevant to the assessment

Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
Anthochaera phrygia	Regent Honeyeater (Foraging)	CE	CE	No	Potential forage habitat present	Yes
Artamus	Dusky Woodswallow	-	V	Yes - 2 records	Potential forage	Yes

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Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
cyanopterus					habitat present	
Callocephalon fimbriatum	Gang-gang Cockatoo	-	V	Yes – 1 record	Potential forage habitat present	Yes
Calyptorhynchus lathami	Glossy Black Cockatoo (Foraging)	-	V	No	Potential forage habitat present	Yes
Chthonicola sagittata	Speckled Warbler	-	V	No	Potential forage habitat present	Yes
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies	-	V	No	Potential forage habitat present	Yes
Daphoenositta chrysoptera	Varied Sittella	-	V	No	Potential forage habitat present	Yes
Glossopsitta pusilla	Little Lorikeet	-	V	Yes - 3 records	Potential forage and breeding habitat present	Yes
Grantiella picta	Painted Honeyeater	V	V	No	Potential forage habitat present	Yes
Haliaeetus leucogaster	White-bellied Sea-Eagle (Foraging)	-	V	No	No habitat present	No
Hieraaetus morphnoides	Little Eagle (Foraging)	-	V	No	Potential forage habitat present	Yes
Lathamus discolor	Swift Parrot (Foraging)	CE	E1	No	Potential forage habitat present, but vagrant species	Yes
Lophoictinia isura	Square-tailed Kite (Foraging)	-	V	No	Potential forage habitat present	Yes
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	-	V	No	Potential forage and breeding habitat present	Yes
Melithreptus gularis	Black-chinned Honeyeater	-	V	No	Potential forage habitat present	Yes
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	-	V	No	Potential forage habitat present	Yes
Neophema pulchella	Turquoise Parrot	-	V	No	Potential forage habitat present	Yes
Ninox connivens	Barking Owl	-	V	No	Potential forage and habitat	Yes

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Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
					present	
Ninox strenua	Powerful Owl (Foraging)	-	V	Yes - 4 records	Potential forage habitat present	Yes
Pachycephala olivacea	Olive Whistler	-	V	No	Potential forage habitat present	Yes
Petroica boodang	Scarlet Robin	-	V	Yes - 3 records	Potential forage and breeding habitat present	Yes
Pomatostomus temporalis	Grey-crowned Babbler (eastern species)	-	V	No	Potential forage habitat present	Yes
Petroica phoenicea	Flame Robin	-	V	Yes - 1 record	Potential forage and breeding habitat present	Yes
Stagonopleura guttata	Diamond Firetail	-		No	Potential forage and breeding habitat present	Yes
Tyto novaehollandiae	Masked Owl (Foraging)	-		No	Potential forage habitat present	Yes
Tyto tenebricosa	Sooty Owl (Foraging)	-		No	Potential forage habitat present	Yes
Dasyurus maculatus	Spotted-tailed Quoll	E	V	Yes - 2 records Also recorded by survey within assessment area	Potential forage and breeding habitat present	Yes
Falsistrellus tasmaniensis	Eastern False Pipistrelle	-	V	Yes - 11 records	Potential forage habitat present	Yes
Kerivoula papuensis	Golden-tipped Bat	-	V	No	Potential forage habitat present	Yes
Miniopterus australis	Little Bentwing-bat (Foraging and Breeding)	-	V	No Recorded by survey within assessment area	Potential forage habitat present	Yes
Miniopterus orianae oceanensis	Large Bentwing-bat (Foraging)	-	V	No Recorded by survey within	Potential forage habitat present	Yes

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Scientific name	Common name	EPBC Act status	BC Act status	Bionet records within 10km of site	Habitat suitability	Species relevant to the assessment
				assessment area		
Mormopterus norfolkensis	Eastern Freetail Bat	-	V	No Recorded by survey within assessment area	Potential forage habitat present	Yes
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	No	Potential forage habitat present	Yes
Petaurus australis	Yellow-bellied Glider	-	V	No	Potential forage and breeding habitat present	Yes
Phascolarctos cinereus	Koala (Foraging)	V	V	No Recorded by survey within assessment area (3 individuals)	Potential forage and breeding habitat present	Yes
Pteropus poliocephalus	Grey-headed Flying-fox (Foraging)	V	V	No Recorded by survey within assessment area	Potential forage habitat present	Yes
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	-	V	No Recorded by survey within assessment area	Potential forage habitat present	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	-	V	Yes - 2 records. Recorded by survey within assessment area	Potential forage habitat present	Yes
Thylogale stigmatica	Red-legged Pademelon	-	V	No	Potential forage habitat present	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	-	V	No Recorded by survey within assessment area	Potential forage habitat present	Yes

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Table codes: E- Endangered, V- Vulnerable, C– Critical, CE- Critically Endangered, M- Marine/ Migratory.

5.2.2 Species credit species

Under the BAM, threatened species with a likelihood of occurrence that cannot be confidently predicted by vegetation surrogates and landscape features but can be reliably detected by targeted survey are identified as species credit species.

Table 31 identifies species credit species predicted for the development footprint and an assessment of habitat suitability.

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Table 31 Potential species credit species assignment of candidate status

Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
Adelotus brevis	Tusked Frog	3.00	Marginal habitat supported by a number of minor waterbodies within the wind farm infrastructure and internal access roads sections of the subject land. Habitats degraded on transmission line sections of the subject land.	Yes
Litoria booroolongensis	Booroolong Frog	2.00	Marginal habitat supported by a number of minor waterbodies within the wind farm subject land. Low quality potential habitat present where transmission line and access tracks crosses Wombramurra Creek	Yes
Litoria daviesae	Davies' Tree Frog	2.00	Marginal habitat supported by a number of minor waterbodies within the wind farm infrastructure and internal access roads sections of the subject land. Habitats degraded on transmission line sections of the subject land.	Yes
Litoria subglandulosa	Glandular Frog	3.00	Marginal habitat supported by a number of minor waterbodies within the wind farm subject land. Habitats degraded on transmission line and access tracks sections of the subject land. Species records associated with large areas on intact vegetation to the east of the subject land, with no records within 100kms of the project site.	No (however species targeted during frog survey)
Mixophyes balbus	Stuttering Frog	3.00	Marginal habitat supported by a number of minor waterbodies within the wind farm sections of the subject land. Habitats degraded on transmission line corridor. Species records associated with large areas on intact vegetation to the east of the project site, with no records within 100kms of the subject land for the wind farm and transmission line.	No (however species targeted during frog survey)
Philoria sphagnicolus	Sphagnum Frog	2.00	Typically found in high rainfall areas at high elevation in Sphagnum Moss beds or seepages on steep slopes. This habitat is not present within the development footprint.	No
Anthochaera phrygia	Regent Honeyeater	3.00	Potential forage habitat supported across the subject land and addressed through ecosystem credits. Subject land does not occur within mapped Important Areas for the species.	No
Burhinus grallarius	Bush Stone-curlew	2.00	Species occurs at altitudes much lower than the subject land with the highest	No

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Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
			elevation record of the species within over 120kms of the wind farm site at an altitude of 500 metres (approx.). The lowest point of the wind farm and transmission line subject land occurs along the transmission line at an altitude of 750 metres (approx.) and as such the subject land does not support habitat for the species. Two records of the species occur at an elevation of approximately 1,000 metres, one hear Armidale over 120kms from the subject land, and the other in Washpool NP, over 270kms from the project site. When these records are compared to the remainder of the 1,350 species' records in BioNet, these occurrences are considered to be vagrants.	
Callocephalon fimbriatum	Gang-gang Cockatoo	2.00	Of the 16,000 records of the species in ebird (and >600 in BioNet), none occur north of Muswellbrook NSW, except occasional records along coast just south of Coffs Harbour. As such the subject land does not support habitat for the species.	No
Calyptorhynchus lathami	Glossy Black-Cockatoo	2.00	Marginal potential forage habitat supported across the subject land, very few *Casuarina* spp or *Allocasuarina* spp. have been recorded during floristic surveys and fauna habitat assessments, with the exception of some very small (less than 1ha) patches of River Oak riparian forest. Breeding habitat potentially present in the form of hollow-bearing trees.	Yes
Haliaeetus leucogaster	White-bellied Sea-Eagle	2.00	The subject land associated with the wind farm, transmission line, access tracks and internal roads does not occur within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines. Where Peel River occurs within 1km of the subject land it is a minor watercourse. Some areas of the transport haul route subject land are within 1km of the coastline, however, habitat suitability in these areas of minor impact are not considered to support foraging or breeding functions for White-bellied Sea-eagle.	No
Hamirostra melanosternon	Black-breasted Buzzard	1.50	Riparian habitats are degraded within the subject land.	No
Hieraaetus morphnoides	Little Eagle	1.50	Potential forage and breeding habitat supported across the subject land.	Yes

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Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
Lathamus discolor	Swift Parrot	3.00	Potential forage habitat supported across the subject land. Project site does not occur within mapped Important Areas for the species.	No
Lophoictinia isura	Square-tailed Kite	1.50	Potential forage and breeding habitat supported across the subject land.	Yes
Ninox connivens	Barking Owl	2.00	Potential forage and breeding habitat supported across the subject land.	Yes
Ninox strenua	Powerful Owl	2.00	Potential forage and breeding habitat supported across the subject land.	Yes
Tyto novaehollandiae	Masked Owl	3.00	Potential forage and breeding habitat supported across the subject land.	Yes
Tyto tenebricosa	Sooty Owl	3.00	Potential forage and breeding habitat supported across the subject land.	Yes
Aepyprymnus rufescens	Rufous Bettong	2.00	Marginal and degraded potential habitat occurs within areas of the subject land associated with the wind farm and transmission corridor.	Yes
Cercartetus nanus	Eastern Pygmy-possum	2.00	Potential habitat is present within the subject land.	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	3.00	Habitat occurs within and adjacent to the subject land.	Yes
Macropus parma	Parma Wallaby	2.00	Potential habitat occurs in higher condition areas connected to Ben Halls Gap Nature Reserve. Potential habitats within the transmission line corridor are degraded.	Yes
Miniopterus australis	Little Bent-winged Bat	3.00	Habitat occurs within and adjacent to the subject land.	Yes
Miniopterus orianae oceanensis	Large Bent-winged Bat	3.00	Habitat occurs within and adjacent to the subject land.	Yes
Myotis macropus	Southern Myotis	2.00	Habitat occurs within and adjacent to the subject land.	Yes
Petaurus norfolcensis	Squirrel Glider	2.00	Potential habitat is present within the subject land.	Yes
Petrogale penicillata	Brush-tailed Rock-wallaby	3.00	Potential habitat is present within the subject land.	Yes
Phascogale tapoatafa	Brush-tailed Phascogale	2.00	Potential habitat is present within the subject land. However, BioNet notes the species occurrences in the following IBRA subregions relevant to the project	No

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Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
			site. Walcha Plateau IBRA - Known to occur, but a geographic restriction exists stating "East of the Tia River". This river's headwaters occur >50kms north-east of the assessment area. Nearest record of the species is 56kms east. Tomala IBRA - species known, with no geographic restrictions listed. However, only records of the species comprise an inaccurate record (10kms) noted as Mount Royal SF (or NP) from 1991, one more low accuracy (10kms) in similar location (but in Barrington Tops IBRA), one further single record in the IBRA from 1974, and >66kms from the assessment area. Peel IBRA - Species predicted to occur (i.e. not known), no geographic restrictions listed. Species never recorded in IBRA.	
Phascolarctos cinereus	Koala	2.00	Breeding and foraging habitat occurs within and adjacent to the subject land.	Yes
Potorous tridactylus	Long-nosed Potoroo	2.00	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. This habitat is not present within the development footprint, furthermore the species was not recorded during terrestrial mammal camera trap surveys	No
Pteropus poliocephalus	Grey-headed Flying-fox	2.00	Potential forage habitat supported across the subject land.	Yes
Vespadelus troughtoni	Eastern Cave Bat	3.00	Habitat occurs within and adjacent to the subject land.	Yes
Hoplocephalus bitorquatus	Pale-headed Snake	2.00	Species known only to occur at altitudes much lower than the subject land, within highest elevation BioNet records including 550m elevation (approx.) north of Bindarri NP (>200kms from the project site), 390m elevation (approx.) west of Kwiambal NP (>150km from the project site) and 375m elevation (approx.) west of Gunnedah (>100kms from the project site). The lowest point of the project site occurs along the transmission line at an altitude of 750m (approx.) and as such the subject land does not support habitat for the species.	No

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Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
Hoplocephalus stephensii	Stephens' Banded Snake	2.00	Rainforest and eucalypt forests and rocky areas up to 950 m in altitude. The species uses very old primary forest with many large old hollow bearing trees. Habitat needs to be well connected and geographically large. Potential habitat combining old primary forest <950m elevation does not occur within the development footprint.	No
Uvidicolus sphyrurus	Border Thick-tailed Gecko	2.00	Species distribution is north of the subject land associated with the wind farm and transmission line corridor and has never been recorded (or predicted to occur in) Tomala or Walcha Plateau IBRA subregions. Peel IBRA has records 20-25kms north of the site across cleared land, which are at the southern extent of the species' occurrence. Peel IBRA abuts parts of the wind farm subject land and includes the western 60% of the transmission line section of the subject land.	Yes
Acacia atrox	Myall Creek Wattle	3.00	Known populations more than 200km north/ northwest of the assessment area. No records within proximity to the site. Potential habitat in PCT599 is marginal and unlikely to support the species.	No
Callistemon pungens	Callistemon pungens	2.00	Habitats range from riparian areas dominated by *Casuarina cunninghamiana* subsp. *cunninghamiana* to woodland and rocky shrubland. Often in rocky watercourses, usually with sandy granite (occasionally basalt) creek beds. Marginal habitat may occur along the transmission line corridor however the subject land occur outside the known area of occurrence of the species.	No
Chiloglottis anaticeps	Bird Orchid	3.00	Often grows near streams or on the edges of low, flat rock outcrops, in grows in eucalypt forest in areas with very little ground cover, in gravely loam soils. Very broad habitat descriptions do not fit well with the habitats or soils present within the development footprint. Furthermore the subject land occurs well outside the species known area of occurrence.	No
Chiloglottis platyptera	Barrington Tops Ant Orchid	2.00	Potential habitat within grassy woodland and open forests within the wind farm infrastructure section of the subject land.	Yes
Cryptostylis	Leafless Tongue	1.50	EPBC Act SPRAT profile sates habitat associated for the species in the NSW	No

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Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
hunteriana	Orchid		Northern Tables lands regions include New England Blackbutt (*Eucalyptus andrewsii*) Grassy Forest and New England Blackbutt Shrubby Forest and Large-fruited Blackbutt (*Eucalyptus pyrocarpa*) / Strawberry Gum (*Eucalyptus olida*) Woodland. These habitats do not occur within the subject land.	
Dichanthium setosum	Bluegrass	2.00	Potential habitat within dry sclerophyll forests, derived native grassland and forested wetlands within the subject land.	Yes
Digitaria porrecta	Finger Panic Grass	2.00	Habitat within box woodland marginal for the species. No other suitable habitat within the site.	No
Diuris pedunculata	Small Snake Orchid	2.00	Grows on grassy slopes or flats, often on peaty soils in moist areas, also on shale and trap soils, on fine granite, and among boulders. This habitat is not present within the development footprint.	No
Eucalyptus magnificata	Northern Blue Box	2.00	Occurs in grassy open forest or woodland on shallow, sandy or loamy soils, on moderately hilly sites and at the edge of gorges, usually at altitudes from 900 - 1050 m. Potential habitat combining grassy open forest or woodland on shallow, sandy or loamy soils at 900 - 1050 m elevation does not occur within the development footprint.	No
Eucalyptus nicholii	Narrow-leaved Black Peppermint	2.00	Potential habitat within grassy woodland and dry sclerophyll forests within the subject land.	Yes
Eucalyptus oresbia	Small-fruited Mountain Gum	3.00	Habitat suitability within subject land for *Eucalyptus oresbia* was assessed by Arup. It was concluded that the subject land is not suitable to support this species due to the lack of 'very steep valleys and deeply incised creek lines with primarily south to southwest exposure' (NSW BioNet, DPIE 2021). Due to this habitat limitation, the species was excluded from assessment under the BAM	No
Euphrasia ciliolata	Polblue Eyebright	2.00	Species Flowers December to May and occurs on the edge of montane and sub-alpine swamps and on open grassy slopes bordering swamps, Snow Grass meadows, Snow Gum woodland, open boggy meadows amidst Black Sallee woodland, and in seasonally inundated upland grassland. Potential habitat for the species within the development footprint, comprising PCT 586, is degraded	No

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Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
			by weed invasion. Furthermore the species was not recorded during targeted meander and plot surveys undertaken within degraded habitats in March 2021.	
Homoranthus prolixus	Granite Homoranthus	2.00	No suitable habitat within the subject land.	No
Monotaxis macrophylla	Large-leafed Monotaxis	2.00	No suitable habitat within the subject land.	No
Picris evae	Hawkweed	2.00	Open Eucalypt woodland within site does not support *Dichanthium* spp. dominated ground layer and is marginal for the species.	No
Polygala linariifolia	Native Milkwort	2.00	Potential habitat within PCT 1194 in the wind farm sections of the subject land.	Yes
Prasophyllum sp. Wybong	Prasophyllum sp. Wybong	3.00	BioNet notes that the species is known to occur in open eucalypt woodland and grassland, however species records to not occur in habitats that are remotely similar to the those present within the development footprint. Impacts associated with the transport haul routes are to highly degraded road edges, that do not support habitat for the species.	No
Pterostylis elegans	Elegant Greenhood	2.00	BioNet notes that the species restricted distribution from the Barrington Tops to the Walcha district, which is exists outside the occurrence of the subject land	No
Pterostylis riparia	Pterostylis riparia	3.00	BioNet notes the species grows on the edge of small streams under shrubs, and is restricted to the Barrington Tops. Riparian habitats within the development footprint are degraded and generally relate to ephemeral first order watercourses at the highest point of the catchment. These areas do not support habitat for the species.	No
Commersonia procumbens	Commersonia procumbens	2.00	No PCTs known to be associated with the species occur within the subject land.	No
Senna acclinis	Rainforest Cassia	2.00	Species grows on the margins of subtropical, littoral and dry rainforests. The subject land does not support habitat for the species	No
Tasmannia glaucifolia	Fragrant Pepperbush	3.00	Eucalypt forest within PCT 934, 931 and 927 offers marginal habitat for the	Yes

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Scientific name	Common name	Biodiversity risk weighting	Habitat suitability	Candidate species requiring targeted survey
			species.	
Tasmannia purpurascens	Broad-leaved Pepperbush	2.00	Suitable habitat within open woodland and forest within the site (PCT 934, 931, 927 and 1194).	Yes
Thesium australe	Austral Toadflax	1.50	Suitable habitat within the assessment area.	Yes
Tylophora linearis	Tylophora linearis	2.00	Associated PCTs within the development site occur at higher altitudes than recorded for the species.	No
***Asterolasia* sp. 'Dungowan Creek'**	Dungowan Starbush	3.00	Marginal habitat within PCT 934.	Yes
Homopholis belsonii	Belson's Panic	2.00	Site lacks suitable habitat.	No
Euphrasia arguta	Euphrasia arguta	3.00	Suitable habitat within the assessment area.	Yes

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5.3 Candidate threatened species and targeted survey methods

Candidate species credit species requiring targeted survey include 33 threatened fauna species and 10 threatened flora species. Table 32 presents a summary of field survey methods for candidate species credit species relative to BAM survey requirements, with additional detail on the survey methods in the following section.

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Table 32 Candidate species credit species and survey design employed

Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
Frogs					
Adelotus brevis	Tusked Frog	Oct – Feb	Field survey methods for amphibians (DECC 2009).	Spotlighting, call playback surveys and active searches.	Frog surveys were undertaken in spring 2019 and autumn 2020. 12 sites were surveyed between 18 and 21 November 2019. Six sites were surveyed between 24 and 27 March 2020.
Litoria booroolongensis	Booroolong Frog	Nov - Dec	Field survey methods for amphibians (DECC 2009).	Spotlighting, call playback surveys and active searches.	
Litoria daviesae	Davies Tree Frog	Sep – Jan	Field survey methods for amphibians (DECC 2009).	Spotlighting, call playback surveys and active searches.	
Litoria subglandulosa	Glandular Frog	Oct - Dec	Field survey methods for amphibians (DECC 2009).	Spotlighting, call playback surveys and active searches.	
Mixophyes balbus	Stuttering Frog	Sep - Mar	Field survey methods for amphibians (DECC 2009).	Spotlighting, call playback surveys and active searches.	
Birds					
Anthochaera phrygia	Regent Honeyeater	Sep – Dec	Commonwealth Survey Guidelines for threatened birds (DEWHA 2010).	Diurnal bird surveys during the migration period/survey timing and habitat mapping.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
Calyptorhynchus lathami	Glossy Black Cockatoo	Mar - Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Habitat mapping, hollow-bearing tree mapping and diurnal bird surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
Hamirostra melanosternon	Black-breasted Buzzard	Sep - Nov	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Stick-nest surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
Hieraaetus morphnoides	Little Eagle	Aug - Oct	Draft Threatened Species Survey and Assessment	Stick-nest surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in

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Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
			Guidelines (DECC 2004).		November 2019 and 21 sites in February 2020.
Lathamus discolour	Swift Parrot	May - Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Winter diurnal bird survey targeting flower eucalypts.	Bird surveys undertaken at 17 sites in August 2019.
Lophoictinia isura	Square-tailed Kite	Sep - Jan	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Stick-nest surveys.	Bird surveys undertaken at 17 sites in August 2019, 21 sites in November 2019 and 21 sites in February 2020.
Ninox connivens	Barking Owl	May - Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Call Playback and spotlighting.	Nocturnal bird surveys undertaken between 26 and 30 August 2019.
Ninox strenua	Powerful Owl	May - Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Call Playback and spotlighting.	
Tyto novaehollandiae	Masked Owl	May – Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Call Playback and spotlighting.	
Tyto tenebricosa	Sooty Owl	May – Aug	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Call Playback and spotlighting.	
Mammals					
Aepyprymnus rufescens	Rufous Bettong	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
Cercartetus nanus	Eastern Pygmy Possum	Oct - Mar	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Deployment of baited arboreal camera traps and spotlighting.	Total of 1014 trap nights using arboreal deployed infrared motion sensing cameras.

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Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
Chalinolobus dwyeri	Large-eared Pied Bat	Sep - Mar	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
Dasyurus maculatus	Spotted-tailed Quoll	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
Macropus parma	Parma Wallaby	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
Miniopterus australis	Little Bentwing-bat	Dec - Feb	"Species credit' threatened bats and their habitats (EES 2018).	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
Miniopterus orianae oceanensis	Large Bentwing-bat	Nov - Feb	'Species credit' threatened bats and their habitats (EES 2018).	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
Myotis macropus	Southern Myotis	Nov - Mar	'Species credit' threatened bats and their habitats (EES 2018).	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
Petauroides volans	Greater Glider	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Spotlighting.	Total of 1014 trap nights using arboreal deployed infrared motion sensing cameras.
Petaurus norfolcensis	Squirrel Glider	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Deployment of baited arboreal camera traps and spotlighting.	Total of 1014 trap nights using arboreal deployed infrared motion sensing cameras.
Petrogale penicillata	Brush-tailed Rock-wallaby	Year round	Draft Threatened Species Survey and Assessment Guidelines (DECC 2004).	Deployment of baited terrestrial camera traps and spotlighting.	Total of 1362 trap nights using ground deployed infrared motion sensing cameras.
Phascolarctos cinereus	Koala	Year round	EPBC Act referral	SAT surveys in high quality	Total of 1014 trap nights using

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Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
			guidelines for the vulnerable koala (DoE 2014).	habitat (high abundance of feed trees), and spotlighting.	arboreal deployed infrared motion sensing cameras.
Pteropus poliocephalus	Grey-headed Flying-fox	Year round	Survey-guidelines-bats (DEWHA 2010).	Habitat mapping and active searches for camps.	No suitable camp habitat within the assessment area.
Vespadelus troughtoni	Eastern Cave Bat	Nov - Jan	'Species credit' threatened bats and their habitats (EES 2018).	Ultrasonic detection and habitat mapping.	24 Ultrasonic bat detectors were deployed for a total of 1042 trap nights.
Reptiles					
Uvidicolus sphyrurus	Border Thick-tailed Gecko	Nov - Mar	Survey guidelines for Australia's threatened reptiles (DSeWPaC 2011)	Targeted searches and habitat mapping.	A total of 3 nights spotlighting and active searches in marginal habitat present on site.
Plants					
Asterolasia sp. 'Dungowan Creek'	Dungowan Star Bush	Year round	NSW Guide to Surveying Threatened Plants (OEH, 2016) as far as practicable	Seasonal surveys involving transects and targeted random meanders, depending on the density of vegetation. All surveys were carried out within the suitable seasonal window for candidate flora except: • Barrington Tops Ant Orchid: surveys were completed from 18-22 November. Conditions were exceptionally dry for much of spring 2019 due to drought. Review of BOM (2020) indicates there was little change in local	A reasonable survey effort was employed including: • A spring survey over 5 days from 18-22 November 2019- limited to suitable habitat within the subject land. • Summer survey over 5 days in February 2020- including suitable habitat within the subject land and transmission line corridor (where accessible). • Autumn 2021 surveys over 5 days in March by two Biosis senior botanist during supplementary BAM plot surveys.
Chiloglottis platyptera	Barrington Tops Ant Orchid	Sep - Oct			
Dichanthium setosum	Bluegrass	Dec - May			
Digitaria porrecta	Finger Panic Grass	Dec - Jan			
Eucalyptus nicholii	Narrow-leaved Peppermint	Year round			
Polygala linariifolia	Native Milkwort	Year round			
Pterostylis elegans	Elegant Greenhood	Dec - May			
Tasmannia glaucifolia	Fragrant Pepperbush	Year round			
Tasmannia purpurascens	Broad-leaved Pepperbush	Year round			

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Scientific name	Common name	BAM survey period	Survey guidelines	Survey design employed	Survey effort
Thesium australe	Austral Toadflax	Sep - Feb		conditions from September to October. • Finger Panic Grass: Surveys were completed in February.	

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5.3.1 Terrestrial flora survey methods

Surveys for candidate threatened flora were carried out over two seasons by Arup and Biosis botanists and under the direction of accredited assessor Matt Davies, as follows:

- Survey of the wind farm development footprint over 5 days from 18-22 November 2019.
- Survey of the wind farm development footprint and accessible parts of the transmission line corridor over 5 days in February 2020.
- Supplementary vegetation community survey to verify PCTs, with incidental searches for threatened species conducted of the internal access roads, Ben Halls Gap Nature Reserve buffer and transport haul route portions of the development footprint over 5 days in August 2020.

Targeted surveys involved searches for target species and random meanders, depending on the density of vegetation. A summary of survey requirements and deployed field methods is provided for all candidate threatened flora in Table 32 above. The extent of targeted surveys for threatened flora is shown in Figure 10.

Following identification of the candidate threatened flora species list, a field survey plan was devised by Arup ecologists in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016). This plan included identification of potential habitat for each of the candidate threatened flora species based on known vegetation associations, review of threatened species profiles, PlantNet profiles, Recovery Plans Conservation Advices and other available literature to determine the presence of suitable areas of potential habitat for species within the assessment area, as well as BioNet records available for each species.

Optimum timeframes for surveys, and which species would be targeted when, were also determined based on the recommended survey times for the candidate species provided by the BAM calculator, literature review, as well as prevailing weather conditions on site. Estimation of the survey effort required to adequately assess the species was undertaken in accordance with Table 3 of the *NSW Guide to Surveying Threatened Plants* (OEH 2016) and was based on the distance required between the minimum separation of parallel traverses (20 metres), and the hectares of potential habitat calculated for each of the candidate species. A field guide of identification information was prepared, taken into the field and used as required.

Additional searches for threatened flora were undertaken during PCT verification and habitat assessments completed in Ben Halls Gap Nature Reserve and additional infrastructure elements in August 2020.

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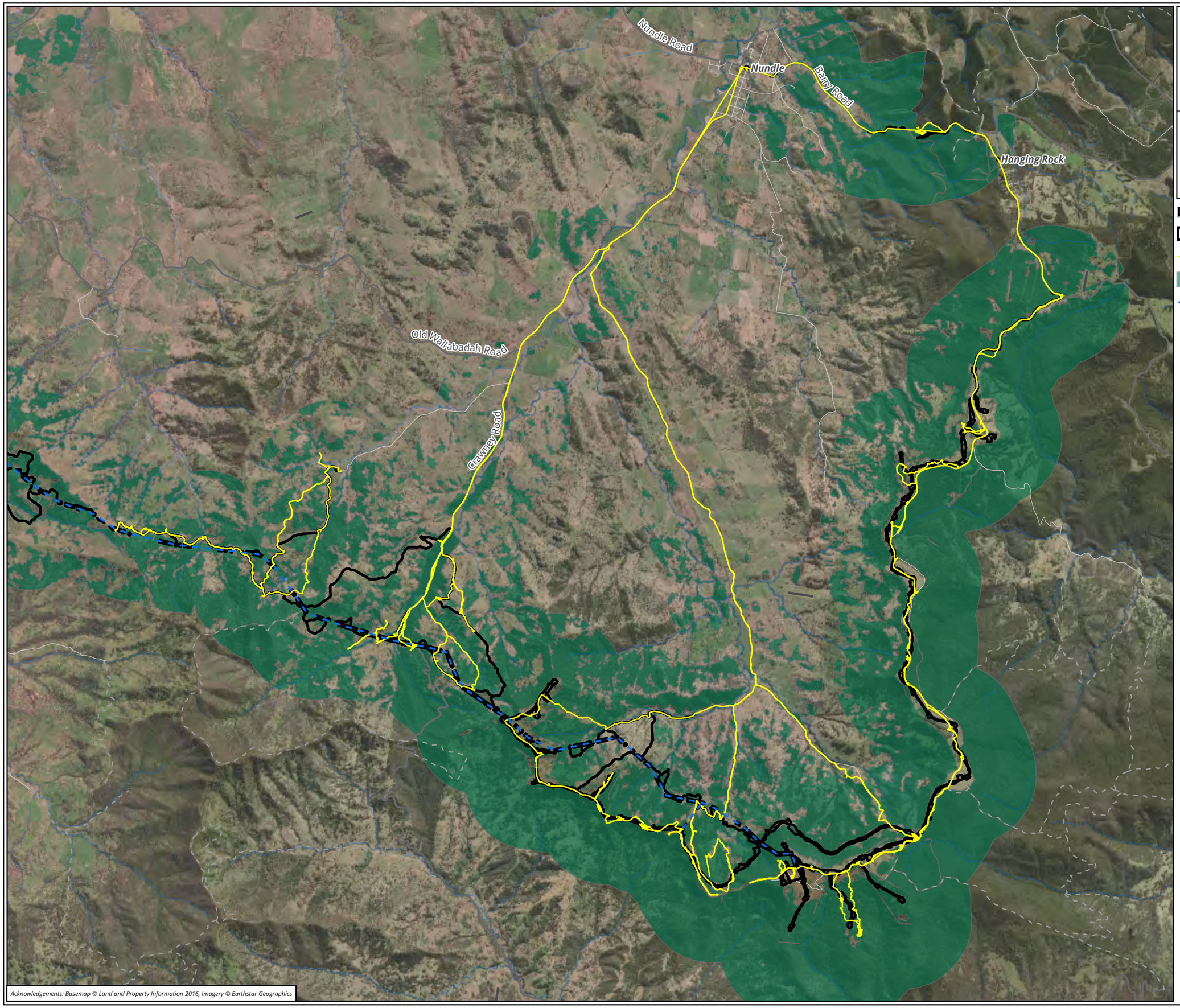

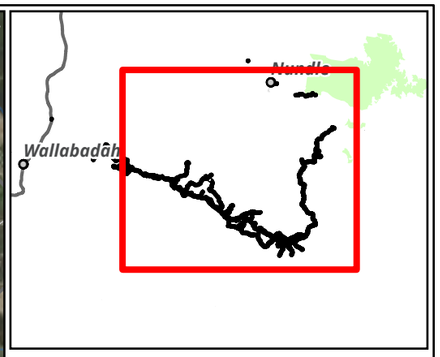

Legend

- Infrastructure footprint
- Targeted survey tracklog
- Native vegetation
- Transmission line

Figure 10 Threatened flora survey tracks

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:80,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F10_ThrFloraSurvey
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

5.3.2 Terrestrial fauna survey methods

A range of targeted terrestrial fauna survey methods were planned and implemented by Biosis ecologists over all four seasons between November 2018 and May 2020 to detect the candidate threatened species assessed as likely to occur on the site. Field surveys were carried out during optimal seasonal conditions and weather conditions, with rainfall and temperature (BOM, 2020) during all survey events provided in Table 33.

Weather and observations for the deployment of camera traps and passive acoustic detectors which remained in the field for several months have been presented as monthly averages for temperature and total monthly rainfall (Table 34). Note, temperature measurements on the wind farm development footprint are likely to be several degrees lower due to higher elevation; however, the BOM station presented below is the closest station with temperature data. The monthly observations during the fauna survey period show the drought conditions from November and December 2019, with substantially lower than average total monthly rainfall recorded in these months. These conditions were alleviated from January 2020, with an opposite trend of substantially higher falls than monthly means experience from January 2020 – May 2020, covering a large portion of the field survey campaign.

Also linked to the weather conditions during the field survey was the severe bushfire conditions that were experienced across south-eastern Australia in the 2019/20 summer (refer Section 3.2). During the field survey campaign, the area experienced bushfires within the transmission line and access track footprints. Habitat mapping has taken into consideration these fire events, with the vegetation and condition assessments assuming pre-fire condition for the purpose of PCT mapping, condition assessment and likelihood of occurrence for threatened fauna.

The following sections describe the fauna field methods in detail, with locations of all targeted fauna surveys shown on Figure 12,.

Table 33 Weather conditions during targeted fauna surveys[1]

Survey date	Temperature (°C)		Rainfall to 0900 hrs (mm)
	Minimum	Maximum	
12 November 2018	10.1	30.6	0.0
13 November 2018	12.8	32.2	0.0
14 November 2018	12.8	26.1	0.0
15 November 2018	9.3	32.2	0.0
26 August 2019	1.4	24.5	0.0
27 August 2019	3.4	23.5	0.0
28 August 2019	1.2	22.5	0.0
29 August 2019	0.6	20.9	0.0
30 August 2019	0.5	18.4	0.0
31 August 2019	5.0	19.8	0.0
18 November 2019	11.2	30.4	0.0
19 November 2019	10.8	36.4	0.0
20 November 2019	14.6	35.4	0.0
21 November 2019	13.6	37.0	0.0

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Survey date	Temperature (°C)		Rainfall to 0900 hrs (mm)
	Minimum	Maximum	
22 November 2019	20.8	31.0	0.0
24 February 2020	22.4	25.8	3.4
25 February 2020	16.2	30.3	11.4
26 February 2020	19.0	31.0	1.2
27 February 2020	16.6	30.5	15.2
28 February 2020	13.6	30.4	0.2
29 February 2020	15.2	No recorded	0.0
23 March 2020	15.4	27.5	0.0
24 March 2020	15.9	29.1	0.0
25 March 2020	16.6	23.6	0.0
26 March 2020	14.4	22.9	24.4
11 May 2020	-0.4	Not recorded	0.0
12 May 2020	0.3	20.5	0.0
13 May 2020	4.4	19.5	0.0
14 May 2020	2.4	19.5	0.0
15 May 2020	5.1	19.4	0.0
17 August 2020	4.2	16.0	1.0
18 August 2020	4.4	19.0	0.0
19 August 2020	3.8	20.0	0.0
20 August 2020	7.8	15.8	0.0
21 August 2020	3.0	15.6	0.0

[1] Recorded at Murrurundi Gap AWS, BOM station 061392

Table 34 Monthly weather observations during camera and acoustic detector deployment

Month deployed	Temperature (°C)[1]		Total rainfall[2,3]
	Mean daily minimum[3]	Maximum	
November 2019	13.1 (12.1)	31.5 (28.7)	42.4 (89.6)
December 2019	16.8 (14.8)	36.0 (31.3)	19.8 (131.8)
January 2020	20.8 (16.6)	36.8 (32.4)	137.6 (81.4)
February 2020	18.4 (16.2)	29.8 (31.5)	203.0 (66.7)
March 2020	13.9 (13.6)	27.2 (29.3)	71.8 (56.5)
April 2020	9.9 (9.0)	24.8 (25.0)	95.2 (40.6)

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Month deployed	Temperature (°C)[1]		Total rainfall[2,3]
	Mean daily minimum[3]	Maximum	
May 2020	4.7 (5.1)	19.0 (20.5)	112.0 (57.5)

[1] Recorded at Quirindi Post Office, BOM station 055049.

[2] Recorded at Head of Peel station, BOM station 55336.

[3] Numbers in brackets represent summary mean for all years recorded.

Bird strike collision risk survey and diurnal bird survey

This method provides a standardised measure of bird activity. It is important that a sufficient quantum of utilisation data for a fully representative annual cycle is obtained, for collision risk modelling. A representative sample of point counts were taken across the assessment area.

Surveys were conducted over three seasons:

- 17 survey points between 27-30 August 2019.
- 21 survey points between 18-22 November 2019.
- 21 number survey points between 25-29 February 2020.

All survey locations were near proposed turbines as this provided the best access and visual for surveys. The majority of the utilisation survey points were located in open areas between stands of native vegetation.

Method for the bird utilisation surveys is as follows:

- Observers walk to each transect and to move between fixed points on transects. When reaching an observation point on the transect observers stop and allow time for birds to habituate to their presence (approximately 10 minutes). The area is then scanned for 5 minutes, during which all birds present are recorded. Scanning involves observing at a steady rate in a circle while remaining on the spot (over 360 degrees).
- Observers record all birds as far as the eye can see over 20 minutes at each observation point (which does bias large birds over smaller ones, as the former are more conspicuous, however this can be accounted for in the analyses). Observations are to be made using the naked eye only. Binoculars can only be used to assist with the identification of a bird.
- As it is the number of movements of birds that is the important variable for modelling, all movements were noted even if it is the same individual. Only birds that were seen are to be recorded, although bird calls can be used to alert the observer to the presence of a bird and its location.
- The order in which transects were sampled was randomised to ensure that transects are equally sampled over the various times of day.

The information collected included:

- Time of the observation
- Point and transect number
- Species
- Number
- Direction of flight
- Height above ground

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- Distance from observer
- Behaviour

The location of all bird surveys is shown on Figure 12.

Nocturnal bird surveys and spotlighting

Spotlighting was aimed to detect small macropods, owls and arboreal mammals.

General and targeted spotlighting and call-broadcast surveys for candidate (and potential candidate) threatened mammal, reptile and bird fauna species over nine nights total between:

- 26-30 August 2019 (2 nights)
- 18-21 November 2019 (2 nights)
- 24-26 March 2020 (3 nights)
- 11-12 May 2020 (2 nights)

During the August 2019 winter survey event, call playback was conducted at six locations, near areas identified as supporting some potential suitable owl roosting/breeding habitat, to detect the presence of owls in the area. Species targeted which included Barking Owl *Ninox connivens*, Powerful Owl *Ninox strenua*, Masked Owl *Tyto novaehollandiae* and Sooty Owl *Tyto tenebricosa*.

Further nocturnal bird surveys undertaken to assess areas of identified better quality habitat for threatened owls, and additional to the two nights at six locations within the windfarm corridor between 26-30 August 2019, were two additional nights between 11-12 May 2020. These call-broadcast surveys included 1 location near area of highest potential habitat.

During the Stage 2 spring survey, spotlighting survey was conducted in the subject land along the edge of Ben Halls Gap Nature Reserve to gain additional information on the presence of potential nocturnal birds. The intent of this survey was to provide additional data about the specie present within the interface between the development footprint and the Nature Reserve.

The location of nocturnal bird surveys and spotlighting transects shown on Figure 12.

Surveys for hollow-dependant birds and raptors in breeding season

A total of 41 days targeted fauna surveys and habitat assessment between August 2019 and August 2020 by teams of between 1 and 4 ecologists/zoologists where the presence of stick nests, tree hollows and evidence of nesting / breeding was captured.

The aim of this survey was to determine whether the assessment area supports breeding habitat for the target species of birds, and whether that habitat is being used for breeding, tree hollows and stick nests were assessed for their suitability in providing breeding habitat, and evidence of use was recorded.

Camera trapping

A total of 19 Reconyx Hyperfire camera trap units were deployed within the subject land. Of these, 12 were targeted to terrestrial fauna and 7 were targeted for arboreal fauna. Three cameras were also deployed along the transmission line corridor; however, two arboreal cameras and one terrestrial camera were destroyed during the bushfires in the summer 2019 fire season.

Deployment methods included:

- Units with strong-odour meat bait for Spotted-tailed Quoll and Brush-tailed Phascogale.

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- Units passively deployed (without bait) for Parma Wallaby and Brush-tailed Rock Wallaby, Eastern Pygmy-possum, Greater Glider, Koala and Rufous Bettong.

Total of 12 baited ground deployed infrared motion sensing cameras set 20-21 November 2019 and collected on 9 April 2020 (1 camera) and 11-15 May 2020 (8 cameras), with 3 cameras destroyed in January 2020 bushfires affecting the assessment area. Camera batters and memory cards were checked in February 2020, allowing for up to 1,539 trap nights (burnt camera traps excluded).

Total of 7 baited arboreal deployed infrared motion sensing cameras set 20-22 November 2019 and collected on 9 April 2020 (1 camera) and 11-15 May 2020 (5 cameras), with 1 camera destroyed in January 2020 bushfires affecting the assessment area. Camera batters and memory cards were checked in February 2020, allowing for up to 1,009 trap nights (burnt camera traps excluded). An example of the arboreal camera trap set up is provided in Photo 6.

Camera trap deployment locations are shown on Figure 12.

Photo 6 Arboreal camera trap set up

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Nocturnal frog surveys

During the 2019 spring survey event, a total of 26 creeks were characterised for habitat considered potentially to support threatened frogs. Of these, eight were suitable for targeted frog survey. This is largely due to the prevalence of first order streams within the development footprint, providing a lack of permanent water even during optimal rainfall conditions.

Spotlighting and call playback surveys were conducted at sites identified as frog habitat and were damp or containing water at the time of survey.

Frog surveys were undertaken in spring 2019 and autumn 2020 and included:

- 18-21 November 2019 - Areas of potential habitat in the within the windfarm corridor were surveyed as follows:
  - 6 nights watercourse spotlight / call-playback / active search transect, including 300m, 250m, 500m transects.
  - 4 nights spotlight / call-playback / active search dam surveys.
  - 6 nights spotlight / call-playback / active search pool surveys.
- 23-25 March 2020 - Wombramura Creek (transmission line corridor) was surveyed over 3 x 2 nights watercourse spotlight / call-playback / active search transect over approx. 200m of creekline.

All frog survey and habitat assessment locations are shown on Figure 12.

Koala Spot Assessment Technique (SAT) surveys

SAT surveys are the Commonwealth recommended survey method used to determine the presence/absence of Koalas across the assessment area, the activity levels to determine resident aggregation and/or transient sites, the population density and size, and habitat availability. Searches are undertaken to identify direct/indirect evidence of activity of Koala including evidence of scats or characteristic, scratches on the trunks of trees. Preferred Koala feed trees will be recorded during flora surveys (i.e. Ribbon Gum Eucalyptus viminalis) and during the habitat feature surveys.

All SAT surveys were undertaken between the 24-28 February 2020 within the subject land and 11-15 May 2020 within the transmission line corridor. SAT surveys are recommended by the Commonwealth DAWE to assess Koala activity levels within the project area. Additional targeted surveys for Koala were also carried out through the deployment of terrestrial and arboreal camera traps, with confirmed photos of the species obtained in March 2020 (Photo 18).

The location of Koala SAT surveys is provided on Figure 12.

Microbat surveys and monitoring

Ultrasonic bat detectors were deployed at a total of 24 locations across the windfarm corridor for a total of up to 1,268 trap nights. Detectors were deployed between 26-29 February 2020 and collected between late March and early May 2020. Five units were relocated within the site in April 2020, when batteries and memory cards were also checked and replaced. An example of a ground-deployed detector used on the site is shown in Photo 7 to Photo 9 and all microbat detectors are shown on Figure 12.

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Photo 7 Ground-deployed acoustic detectors

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Photo 8 Met mast deployed acoustic detector at head height

Photo 9 Met mast deployed acoustic detector at aerial height

During the 2019 spring survey, an acoustic/ultrasonic transect assessment for threatened microbats was conducted between 19 – 21 November 2019 (three nights), targeting a variety of habitats such as open-space areas, open waterbodies, riparian corridors, vegetated edges, hollow-bearing trees and areas with rocky outcrops and overhangs that are suitable for foraging and roosting. These habitat types were characterised throughout the day and then subsequently surveyed during the evening.

The transects were approx. 1 hour each and on average 1 kilometre long with a range of 100 metres either side. This rapid assessment method was a preliminary survey to provide a perception of species richness and abundance throughout the assessment area and refine areas to primarily target during the summer survey event, where acoustic detectors were deployed.

The handheld acoustic equipment (Echo Meter 2 with a directional microphone – Wildlife Acoustics) using live mode and Real Time Expansion (RTE) function, allowed the observer to simultaneously view the spectrogram and identify bat species in audible (transformed data) and ultrasonic frequencies. Species were identified using the app compatible with the recording device (Echo meter) and in most cases; the species was identified via spotlight. The acoustic data was reviewed and cross-referenced using Kaleidoscope analysis software, the observers personal call library and Bat Calls of New South Wales (Pennay et al. 2004).

Further microbat survey was undertaken to assess for impacts relating to the likelihood of bat species being impacted by turbine strike and possibly barotrauma, the rate of impact per turbine per year, and the impacts to the bioregional populations. This relates not only to bats resident within (or adjacent to) the assessment area, but those that may fly through the site from surrounding habitats, such as local cave/karst systems.

Additional surveys consisted of deployment of acoustic devices on three meteorological masts within the assessment area to determine the activity level of bats at different elevations. Consultation was undertaken with BCD in order to confirm the suitability of the location of the masts, height and number of data points suggested.

Three acoustic detectors were deployed per meteorological mast at heights of 10 metres, 30 metres and 60 metres (Figure 11). These detectors were fitted with an omni-directional microphone capable of detecting and

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recording calls within a 100m radius in all directions. This capability allowed the detection of calls from ground level to a total height of 160m, capturing a large area within the potential rotor swept path of the wind turbines.

Additional acoustic devices were deployed within three separate karst cave systems identified within or nearby the assessment area. All acoustic devices on the met masts and within the karst systems in wider landscape were deployed between the 8-9 April 2020 and were collected on the 11-15 of May 2020.

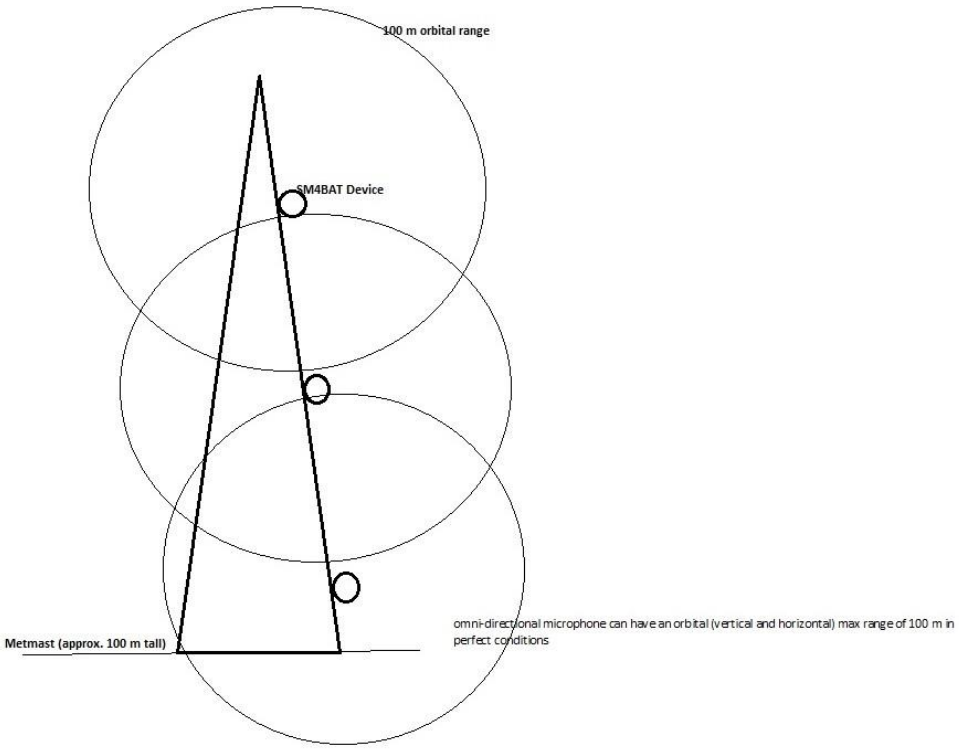

Figure 11 Schematic diagram of installation of acoustic bat detectors on meteorological masts

Additional on ground assessment of areas identified as potential microbat roost habitat was then undertaken between 29 March and 1 April 2021, by two zoologist staff over 80 person hours. High priority areas were able to be visually inspected from the nearest accessible point. Due to the large size of the subject land, not all areas previously mapped as potential habitat were able to be ground-truthed, and a sampling approach was undertaken. However, suitable conclusions were able to be reached for all areas not visited on ground based on the results of the desktop assessment and extrapolation of ground observations across other areas of the development footprint. Further detail is provided in Section 5.4.2.

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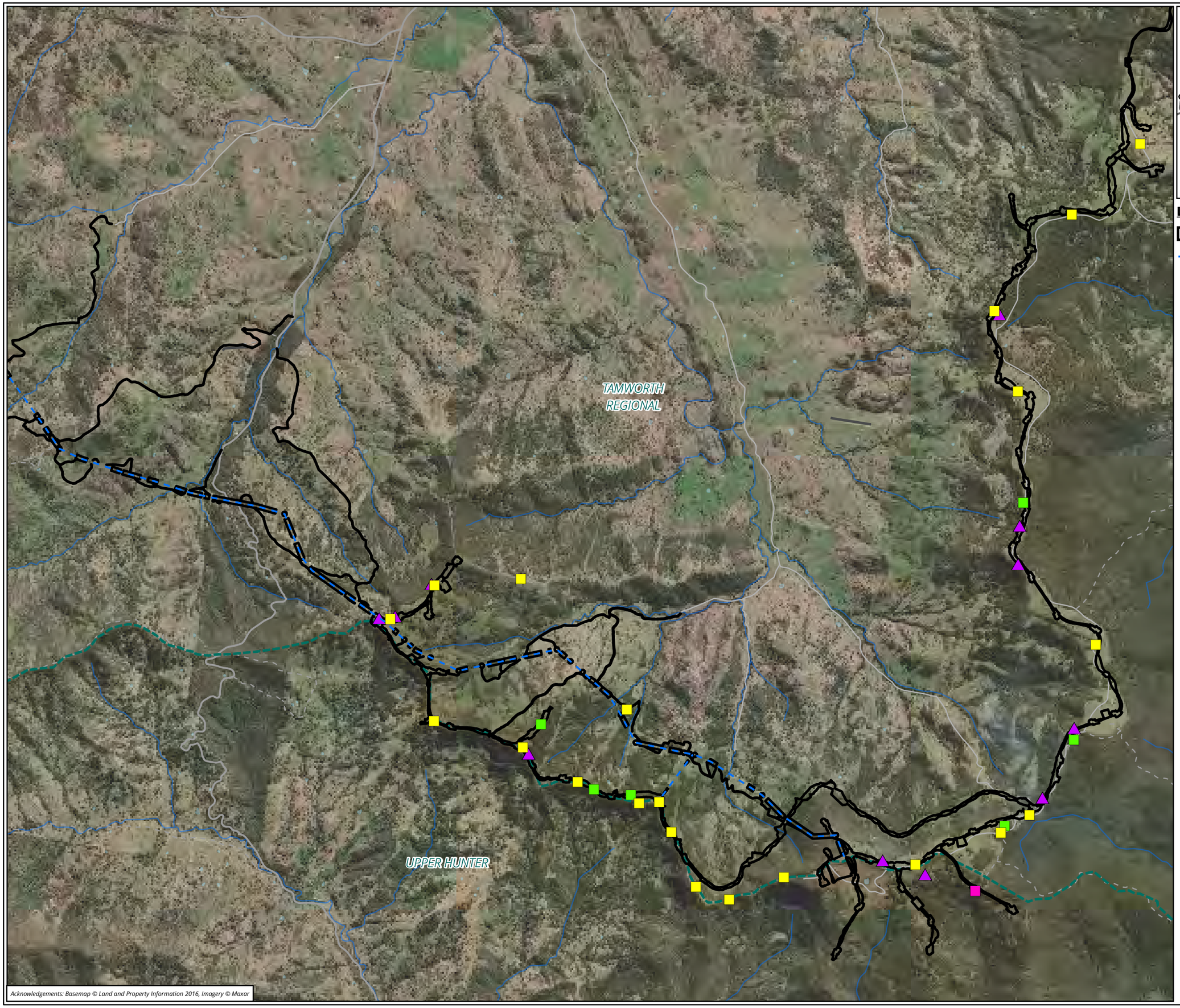

Legend

- Infrastructure footprint
- Transmission line
- Bird utilisation survey
- Owl call playback - Aug 2019
- Owl call playback - May 2020
- Koala SAT

Figure 12 Threatened fauna survey locations, Page 1

0 450 900 1,350 1,800

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F12_ThrFaunaSurvey
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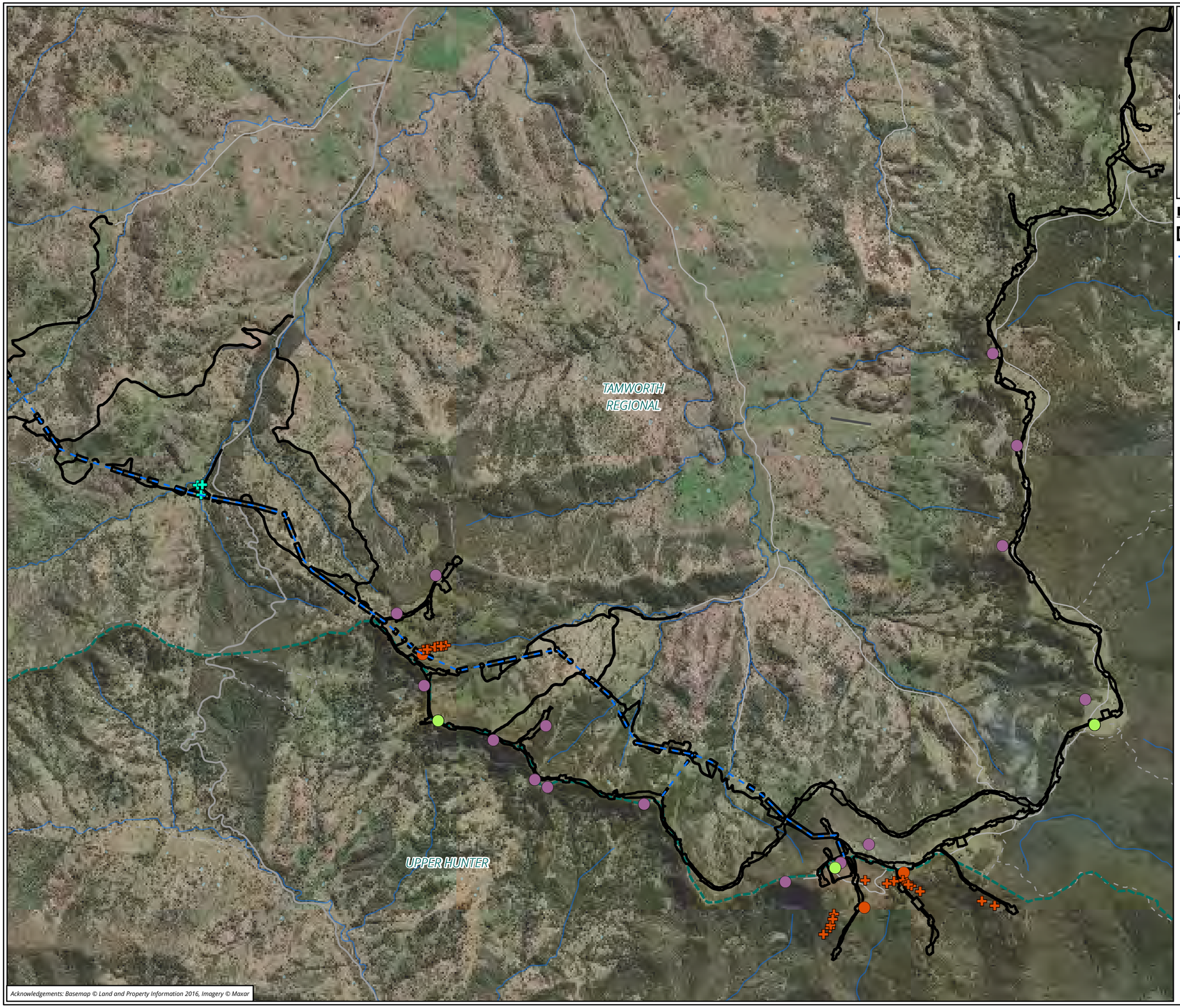

Legend

- Infrastructure footprint
- Transmission line
- Frog survey points - Mar 2020
- Frog survey point - Nov 2019

Microbat passive detector

- Met mast
- Ground level
- Microbat active transects

Figure 12 Threatened fauna survey locations, Page 2

0 450 900 1,350 1,800

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
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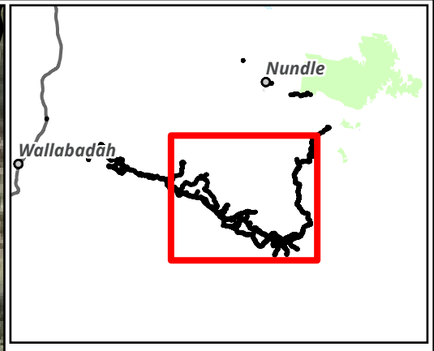

TAMWORTH REGIONAL

UPPER HUNTER

Legend

- Infrastructure footprint
- Transmission line
- Spotlighting - Nov 2019
- Habitat assessment
- Photopoint
- Spotlighting transect - Mar 2020
- Border Thick-tailed Gecko search - Mar 2020

Remote camera

- Arboreal
- Terrestrial
- Burnt (arboreal)
- Burnt (terrestrial)

Figure 12 Threatened fauna survey locations, Page 3

0 450 900 1,350 1,800

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
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5.4 Threatened species results

5.4.1 Threatened flora

One threatened flora species, Broad-leaved Pepperbush *Tasmannia purpurascens*, was identified within the project area, as detailed in Table 35. The species was recorded in two locations adjacent to the north-eastern section of the wind farm infrastructure section of the development footprint, as shown in Figure 13. They were not recorded within the development footprint.

The northern-most record of this species was located in an area of PCT 934, with Messmate *Eucalyptus obliqua* as the dominant canopy tree and an open shrub cover with Broad-leaved Pepperbush being locally abundant in areas. The second, more southerly record for Broad-leaved Pepperbush was within an area of good quality PCT 1194 dominated by Snow Gum *Eucalyptus pauciflora* with a grassy understory and an open shrub layer. The development footprint avoids direct impacts to both of these recorded locations of Broad-leaved Pepperbush.

Table 35 Threatened flora identified in the assessment area

Scientific name	Common name	EPBC Act Status	BC Act Status	Count
Tasmannia purpurascens	Broad-leaved Pepperbush	-	V	10

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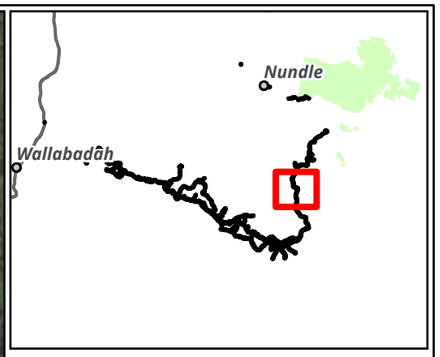

Legend

- Infrastructure footprint
- Broad-leaved pepperbush

Figure 13 Threatened flora recorded during field surveys

0 150 300 450 600

Meters

Scale: 1:14,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F13_ThrFloraRecords
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

5.4.2 Threatened fauna

Survey results - bird utilisation survey and diurnal bird survey

The raw data from all bird utilisation surveys, including survey location, species names, abundance, vertical and horizontal distances and flying directions are provided in the Collision Risk Model Report in Appendix D.

During the bird utilisation surveys, 51 bird species were recorded with 18 of these species recorded flying at the maximum rotor swept height of 230m (Table 36). During the bird utilisation surveys, 224 bird movements (flights) were recorded comprising 33 different bird species. Of the 224 flights recorded, 190 (or 85%) were recorded at between 5 and 20 metres vertical distance (height), indicating that the majority of bird activity within the development footprint will not be at risk of blade strike.

Table 36 Bird species recorded flying at rotor swept height

Common name	Species name
Brown Goshawk	*Accipiter fasciatus*
Galah	*Cacatua roseicapilla*
Nankeen Kestrel	*Falco cenchroides*
White-browed Treecreeper	*Climacteris affinis*
Australian Magpie	*Gymnorhina tibicen*
Yellow-tailed Black- Cockatoo	*Calyptorhynchus funereus*
Laughing Kookaburra	*Dacelo novaeguineae*
Red Wattlebird	*Anthochaera carunculata*
Spotted Pardalote	*Pardalotus punctatus*
Common Starling	*Sturnus vulgaris*
Rainbow Lorikeet	*Trichoglossus haematodus*
Crimson Rosella	*Platycercus elegans*
Little Wattlebird	*Anthochaera chrysoptera*
Pied Currawong	*Strepera graculina*
White-breasted Woodswallow	*Artamus leucorynchus*
Australian Raven	*Corvus coronoides*
Sulphur-crested Cockatoo	*Cacatua galerita*
Wedge-tailed Eagle	*Aquila audax*

In the interests of ensuring a conservative assessment, the impact assessment for bird collision risk assumes that all bird species that were recorded flying within the rotor swept height, even if only a single flight was recorded at this height. When the average flight heights are assessed, the majority of these 18 species were flying below the rotor swept height in most recorded flights (Figure 14).

The average flight heights shows that only four species have an average recorded flight height that is within the rotor swept height, including Australian Raven, Brown Goshawk, Wedge-tailed Eagle and White-breasted

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Woodswallow. This indicates that for most flights, there are only a small number of native birds that are considered at risk of collision with turbines.

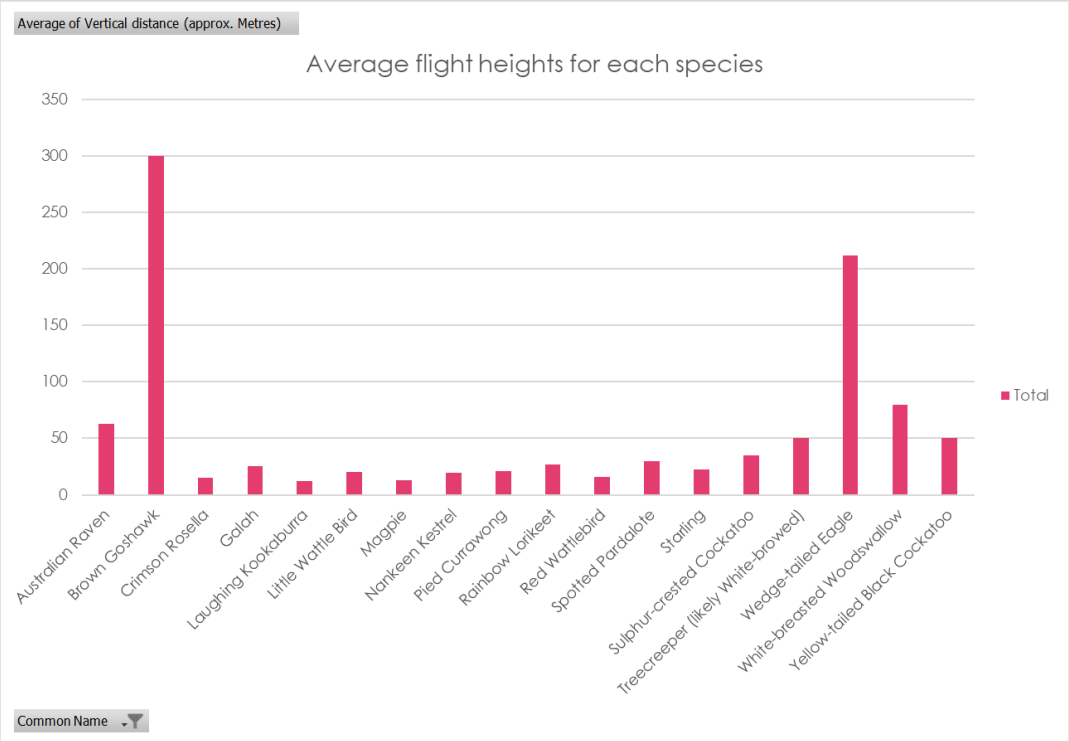

Figure 14 Average flight height for bird species recorded flying within rotor swept height

This list of at risk species is based on flight height and number of observed movements. All of the birds considered most at risk of collision with turbines are listed as least concern under the NSW BC Act and are not listed as listed threatened species or migratory species under the EPBC Act.

Regarding other diurnal, winter-specific threatened bird species that were assessed as having the potential to occur in the subject land with Glossy Black Cockatoo *Calyptorhynchus lathami*, listed as vulnerable under the BC Act, were considered unlikely to utilise the site for breeding, but suitable locations for breeding and foraging were observed down slope of the western section of the wind farm transmission line development footprint. Despite survey during suitable seasons and climatic condition, no Glossy Black Cockatoos were observed.

There were no records of Little Eagle *Hieraaetus morphnoides* during the diurnal bird surveys and no stick nests were recorded, suggesting areas of suitable habitat were not currently being utilised for breeding. There were also no records of Swift Parrot *Lathamus discolour* during the diurnal surveys and there is also a lack of preferred foraging trees within the subject land. Swift Parrot breed in Tasmania from September to January, meaning breeding habitat for this species is not a consideration for this project and field surveys are sufficient to rule out presence as a foraging species.

Nocturnal bird surveys and spotlighting

During all targeted surveys for threatened owls no response was detected for the species targeted, despite targeted call playback searches in areas considered to be good habitat. Habitat for these threatened owls was focused on areas within and adjacent to the development footprint.

The subject land is only considered likely to support potential large forest owl breeding habitat in the wetter forested gullies/drainage lines on the three "fingers" and with only low-moderate potential. The majority of

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the site is not suitable for owl breeding due to a lack of sheltered gullies, existing disturbances associated with clearing and agricultural land use and highly edge-effected patches of vegetation.

It is noted that in undertaking a total of four nights of targeted call-playback surveys for forest owls, the assessment was unable to meet the 90% probability requirement outlined in the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft November 2004 (DEC 2004) to exclude the species presence. As such determination of suitable areas of owl breeding habitat within and immediately surrounding the development site has been undertaken and the presence of Barking Owl, Powerful Owl, Masked Owl and Sooty Owl has been assumed in these areas (where applicable). Details on the parameters used to model potential owl breeding habitat impacted by the project (in accordance with the BAM) are provided in Section 5.5.

Notwithstanding the lack of owls detected during the nocturnal surveys, Table 37 below shows the threatened fauna that were detected during spotlighting surveys. A total of three threatened mammals were detected over all survey periods.

Table 37 Threatened fauna detected during spotlighting

Scientific name	Common name	EPBC Act status	BC Act status	Survey period identified
Phascolarctos cinereus	Koala	V	V	Stage 2 winter survey
Petauroides volans	Greater Glider	V	V	Stage 2 winter survey, Stage 2 spring survey
Dasyurus maculatus	Spotted-tailed Quoll	V	V	Stage 2 winter survey (road kill individual)

Hollow-dependent birds and raptors

Areas of high densities of hollows, fallen timber large trees and an intact understorey were mapped as part of the PCT condition classification, with areas in high condition providing fauna habitat to be targeted for threatened birds.

These areas are not large in the context of the whole site, although these areas are high priority for avoidance of impacts. These areas are also most intact in terms of vegetation structure, and as such likely represent the highest condition vegetation present.

These areas were targeted in the spring and summer survey events, due to the potential importance of these areas. During the field surveys no stick nests or threatened diurnal birds were observed within the development footprint.

Nocturnal frog surveys

During the field surveys no threatened frogs were recorded (Table 38).

Table 38 Frogs identified during nocturnal frog surveys

Creek/Dam	Survey Methods	Results
HoGCP06	One 200m transect within windfarm development area, surveyed on two separate nights by two ecologists, call play back conducted along transect	No frogs found

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Creek/Dam	Survey Methods	Results
	for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*.	
HoGCP07	One 200m transect within windfarm development area, surveyed on two separate nights by two ecologists, call play back conducted along transect for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*.	Night 1: 1x *Litoria verreauxii* (observed) Night 2: 1x *Litoria verreauxii* (observed)
HoGCP07g	Survey conducted around the perimeter of the dam on two separate nights by two ecologists, call play back conducted during survey for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*.	Night 1: 2x *Litoria peronii* (heard) Night 2: 1x *Litoria peronii* (heard & observed)
HoGCP07h	Survey conducted around the perimeter of the dam on two separate nights by two ecologists, call play back conducted during survey for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*. Tadpoles captured with non-abrasive net and photos taken for identification.	Night 1: 1x *Litoria verreauxii* (heard), several L. *verreauxii* tadpoles identified Night 2: 1x *Litoria verreauxii* (heard), several *L. verreauxii* tadpoles identified
HoGCP22 (Woodleys Ck)	One 200m transect within and immediately downstream of windfarm development area, surveyed on two separate nights by two ecologists, call play back conducted along transect for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*. --------- Survey conducted around the perimeter of large dam located upstream of transect on two separate nights by two ecologists, call play back conducted during survey for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*.	Night 1: 1x *Litoria peronii* (heard & observed) Night 2: 1x *Litoria peronii* (heard), 1x *Crinia signifera* (observed) -------- Night 1: 3x *Litoria peronii* (heard & observed) Night 2: Multiple Litoria peronii (heard), 4x *Litoria peronii* (observed), Multiple *Crinia signifera* (heard), 3x *Crinia signifera* (observed)
HoGCP24	Survey conducted around the perimeter of the pool on two separate	No frogs found

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Creek/Dam	Survey Methods	Results
	nights by two ecologists, call play back conducted during survey for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*. Tadpoles captured with non-abrasive net and photos taken for identification.	
HoGCP26	Survey conducted around the perimeter of the pool on one night two ecologists, call play back conducted during survey for all targeted frog species, boulders and rocks turned over targeting Tusked Frog *Adelotus brevis*. Tadpoles captured with non-abrasive net and photos taken for identification.	No frogs found

Microbats

Bat call analysis was completed from the data collected on the 25 separate detector units over a total of 257 'trap nights', ranging from between 2 nights to 38 nights per detector, with nearly 25,000 calls identified containing over 32,000 passes. Data analysis was undertaken across the temporal range of the survey period, with total 'trap nights' analysed per month including:

- November 2019 – 2 nights
- February 2020 – 49 nights
- March 2020 – 94 nights
- April 2020 – 87 nights
- May 2020 – 25 nights

Bat calls recorded were analysed using a combination of two separate call identification software programs, AnaScheme and Anabat Insight, due to the software requirements of the different detector units used in the survey.

Bat calls were identified to genus or species level using automated call identification software, AnaScheme (Adams et al. 2010) and a key developed for North-western NSW (unpublished data – K. Asplet and M. Gibson). Calls with fewer than three valid pulses (i.e. minimum of six data points and model quality of >0.8) are not analysed by AnaScheme due to a paucity in data and are assigned as 'unknown'. Because multiple bat species may call simultaneously, calls were assigned to a single species only if > 50% of pulses within a sequence are assigned to that species, and only passes with a minimum of three pulses classified to the same species were identified. Lower frequency calls, such as those produced by Southern Myotis and Freetail bats, cannot be distinguished using AnaScheme, and lower frequency calls were manually identified. Long-eared bat calls are only able to be identified to genus, due to the linear nature of the calls produced.

Additional call analysis was undertaken using Anabat Insight software and relevant published reference call guides (Pennay, Law, & Reinhold 2004). Analysis was run through a custom decision tree created for the project, to remove noise (frequencies below 7kHz) and files/passes with less than three pulses (as above). The decision tree was then run using characteristic frequency and duration to identify calls to genus, or species

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level where possible. Calls identified by the system as significant or uncommon species were checked manually against visual comparison of sonograms with published reference calls by an experienced bat expert (Pennay, Law, & Reinhold (2004)), to ensure accurate results. In addition, a subset calls were chosen for manual vetting from each species/genus grouping for quality assurance of data.

Microbat acoustic survey results

Bat call activity was found to occur throughout the project area, with 28 species identified to species level from data recorded across 25 acoustic detectors deployed during field surveys (Table 39). The majority of the species recorded were not threatened species listed under the BC Act or the EPBC Act, with 20 least concern species detected.

A total of 28 species is considered to represent a high level of species diversity within the local microbat population. The species with the highest mean calls per night recorded across the site as a whole is the White-striped Freetail Bat *Austronomus australis*, a common bat found throughout most of Australia, with an average of 46.3 calls recorded per night of data analysed. Next most common species include Inland Free-tailed Bat *Ozimops petersi* at 14.3 calls per night and then the BC Act listed threatened species Large Bent-wing Bat *Miniopterus orianae oceanensis* with 10.3 calls detected per night of data analysed. These are considered to be relatively high levels of call activity for each species.

Generally, microbat species known to be dependent (or at least partially dependent) on caves for roosting were less commonly recorded than non-cave dwelling species with just three cave dependent/utilising species, Large Bent-wing Bat, Eastern False Pipistrelle *Falsistrellus tasmaniensis* and Little Pied Bat *Chalinolobus picatus* among the 14 most commonly recorded species. With the remaining five cave dependent/utilising species recorded, occurring at levels among the 14 least commonly recorded bats.

Table 40 provides details of the mean number of calls recorded per night, per species, per detector deployed across the project area. Mean calls per night provides an indication of microbat activity within project area and provides insight into the nature and make-up of the local bat population. Call data can be used to infer how microbats are utilising a site based on analysis of variables such as the time a call has been recorded, the presence of calls on detectors deployed at various elevations, and the presence and relative abundance of species' calls across a temporal scale. Analysis of call data does not allow for the size of a bat population to be determined as a single recorded call does not equate to an individual bat, as a single individual can be responsible for multiple calls recorded on a detector (or multiple detectors). This is a known limitation of acoustic surveys for microbats.

Additional analysis of a number of previous un-analysed nights of data has been able to be undertaken following agency responses. This has been done to provide further detail on the extent and nature of the microbat populations within project area. Furthermore, it should be noted that in re-analysing the microbat call data a small number of mathematical errors were realised and have been corrected. These relate largely to the calculation of mean number of calls per night / detector for the most commonly recorded bat species (White-striped Freetail Bat) during call data analysis, and the total number of nights' data analysed for the November 2019 Echometer transect survey.

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Table 39 **Detailed summary of bat detector data listing mean number of calls per night per detector. Detectors were placed in a range of habitats around the Project Area to maximise diversity of bat species recordings in the area**

Species	Detector Number																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	MM1 – 2m	MM1-30m	MM1 - 60m	MM2 – 2m	MM2-30m	MM2-60m	MM3 – 2m	MM3-30m	MM3 – 60m	Nov 2019 Echometer transects
White-striped free-tailed bat *Austronomus australis*	25.73	173.00	48.43	116.00	1.00	14.33	27.00	25.10	13.50	20.50	5.67	3.00	31.50	56.50	141.25	88.25	38.50	20.72	42.71	111.61	62.19	60.00	37.75	33.97	5.00
Large-eared Pied Bat *Chalinolobus dwyeri #**	0.36	0.00	0.04	0.50	0.00	0.67	1.33	0.40	0.00	0.10	0.17	2.00	0.75	5.33	0.00	7.25	1.50	0.06	0.71	0.26	0.14	1.75	0.50	0.03	0.00
Gould's Wattled Bat *Chalinolobus gouldii*	14.36	14.75	9.14	6.50	0.75	6.33	9.67	13.80	17.20	3.80	15.17	7.00	9.00	27.00	5.50	15.50	4.00	2.25	1.14	6.76	2.05	4.50	3.50	2.97	1.00
Chocolate Wattled Bat *Chalinolobus morio*	0.09	10.00	0.32	8.00	0.00	3.50	6.50	0.10	0.40	0.60	0.33	2.00	6.25	24.00	5.75	7.00	0.17	0.00	0.14	0.32	0.10	2.00	5.25	0.30	0.50
Little Pied Bat *Chalinolobus picatus +**	1.00	4.00	0.11	12.50	0.25	5.67	14.50	1.10	0.00	0.00	0.00	8.00	3.75	5.17	5.00	15.50	5.00	0.16	1.00	0.00	0.33	2.50	2.50	0.18	0.00
Eastern False Pipistrelle *Falsistrellus tasmaniensis +**	9.64	0.50	1.07	0.00	0.00	0.50	0.00	9.00	7.70	4.20	0.50	0.00	0.00	2.17	1.25	0.00	0.17	1.06	0.57	5.03	0.38	0.00	0.00	1.85	1.00
Eastern Coastal Free-tailed Bat *Micronomus norfolkensis +*	30.91	0.00	0.00	0.00	0.00	0.00	0.00	32.10	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.39	1.29	0.00	0.00	0.15	0.00
Little Bent-winged Bat *Miniopterus australis #**	3.45	0.00	0.25	0.00	0.00	0.00	0.17	3.60	5.50	2.60	0.17	0.00	0.00	1.83	0.00	0.00	0.00	0.25	0.29	0.74	3.29	0.00	0.00	1.06	4.00
Large Bent-winged Bat *Miniopterus orianae oceanensis #**	17.18	19.75	14.32	49.00	0.00	11.83	20.83	15.90	3.50	6.00	1.33	0.00	4.50	14.33	27.50	18.00	3.83	1.63	3.14	13.89	0.24	1.25	2.25	1.39	7.00
Southern	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Species	Detector Number																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	MM1 – 2m	MM1-30m	MM1 - 60m	MM2 – 2m	MM2-30m	MM2-60m	MM3 – 2m	MM3-30m	MM3 – 60m	Nov 2019 Echometer transects
Myotis *Myotis macropus #**																									
Lesser Long-eared Bat *Nyctophilus geoffroyi*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
***Nyctophilus* sp.**	5.45	2.00	1.75	3.00	0.00	0.67	0.50	5.00	2.60	2.30	0.33	0.00	2.50	4.17	0.75	0.25	0.33	0.19	0.29	8.24	0.38	0.00	0.00	0.27	0.50
Northern Free-Tailed Bat *Ozimops lumsdenae*	0.00	0.75	0.46	0.00	0.00	0.00	0.00	0.00	2.80	0.10	0.00	0.00	0.00	0.00	0.25	0.50	0.00	0.25	0.29	1.66	0.00	0.25	0.75	1.79	0.00
Inland Free-tailed Bat *Ozimops petersi*	0.00	50.50	0.00	15.50	0.00	7.00	51.67	0.00	0.00	0.00	1.50	0.00	64.50	22.00	67.50	26.50	14.00	0.00	2.43	0.00	0.00	18.50	30.00	0.00	0.00
South-eastern Free-tailed Bat *Ozimops planiceps*	0.00	8.00	0.00	2.00	1.75	10.50	4.33	0.00	0.00	0.00	1.33	0.00	11.50	16.00	1.25	3.75	1.67	0.00	0.29	0.00	0.00	0.25	0.75	0.00	0.00
Ride's Free-Tailed Bat *Ozimops ridei*	0.09	0.00	3.82	0.00	0.00	0.00	0.00	0.10	0.80	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.59	0.00	1.71	0.10	0.00	0.00	5.48	0.50
Golden-tipped Bat *Phoniscus papuensis*	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Smaller Horseshoe Bat *Rhinolophus megaphyllus* *	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.30	0.00	0.00	0.00	0.00	0.17	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*	0.00	0.00	0.82	12.00	0.00	1.67	4.33	0.00	0.50	0.10	2.83	0.00	0.00	3.33	0.00	1.75	7.00	0.13	2.71	0.55	0.33	0.25	0.00	0.76	1.50
Greater Broad-nosed	19.91	0.00	0.86	0.50	0.00	0.00	0.00	18.20	9.00	1.00	1.33	0.00	0.00	0.50	0.00	0.00	0.00	1.91	0.43	6.53	1.71	0.00	0.00	1.85	1.50

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Species	Detector Number																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	MM1 – 2m	MM1-30m	MM1 - 60m	MM2 – 2m	MM2-30m	MM2-60m	MM3 – 2m	MM3-30m	MM3 – 60m	Nov 2019 Echometer transects
Bat *Scoteanax rueppellii*																									
Scotorepens balstoni	0.00	0.25	0.00	0.00	0.25	0.00	0.17	0.00	0.00	0.00	0.83	0.00	0.00	0.83	0.00	0.00	0.17	0.00	0.43	0.00	0.00	0.25	0.00	0.00	0.00
Scotorepens greyii	3.09	13.00	5.25	6.00	0.00	2.83	15.67	3.20	0.20	0.30	0.17	0.00	4.00	9.67	5.25	3.50	0.67	6.00	1.57	26.92	0.38	1.25	0.50	1.91	5.00
Scotorepens orion	0.00	0.00	5.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vespadelus darlingtoni	5.18	9.25	8.00	0.00	0.00	0.83	10.67	5.20	7.80	4.10	0.67	0.00	9.50	8.50	7.50	0.00	0.50	0.03	0.14	0.37	0.14	0.50	0.00	0.61	1.00
Vespadelus regulus	0.00	4.75	0.04	32.00	0.00	7.17	12.67	0.00	0.00	0.00	1.17	0.00	0.25	1.83	0.50	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00
***Vespadelus* sp.**	0.00	0.00	0.00	0.50	0.00	0.00	2.50	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	4.50	0.17	0.00	0.00	0.00	2.14	1.25	0.25	0.00	0.00
Eastern Cave Bat *Vespadelus troughtoni #**	0.00	0.25	0.00	0.00	0.00	0.83	7.83	0.00	0.00	0.00	0.00	0.00	0.50	2.17	0.25	1.00	0.33	0.00	0.00	0.00	0.00	1.75	0.00	0.00	0.00
Vespadelus vulturnus	0.55	0.00	0.93	40.00	0.00	11.17	20.83	0.50	0.70	0.10	0.83	0.00	2.00	7.33	9.25	4.00	7.33	0.00	2.71	0.00	0.00	2.25	3.50	0.42	0.00

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Assessment of microbat activity at different elevations

Acoustic detectors were deployed at varying elevations on meteorological masts (met masts) across the project area to allow for the relative abundance of microbat species flying at different heights to be determined. This analysis is critical to determine the potential impacts of the project with regards to blade strike and possibly barotrauma.

Acoustic detectors deployed at ground level were most common and comprise 19 of the 25 detectors deployed. Ground level detectors were found to have recorded similar results to the project area as whole, with the top three species recorded (based on mean calls per night) including White-striped Freetail Bat, Inland Free-tailed and Large Bent-winged Bat, with non-cave dependent species again more frequently recorded. For detectors mounted on met masts at canopy height (three detectors at approximately 30 metres above the ground) White-striped Freetail Bat and Inland Free-tailed Bat were again the most common, with *Scotorepens greyii* the third most commonly recorded, and Large Bent-winged Bat fourth ranked. Most commonly recorded species flying above canopy (three detectors deployed approximately 60 metres above the ground) again include White-striped Freetail Bat and *Scotorepens greyii*, with Ride's Free-Tailed Bat *Ozimops ridei*, Gould's Wattled Bat *Chalinolobus gouldii* and the BC Act listed Greater Broad-nosed Bat *Scoteanax rueppellii* among the top five most commonly recorded species. It should be noted that the mean number of calls for White-striped Freetail Bat at 60 meters elevation is far greater than the next most common species with a mean of 39 calls recorded per night of data analysed, compared to the next most common species with a mean of 2.8 calls per night.

Other BC Act and or EPBC Act listed threatened species recorded by the detectors deployed at above canopy height (60 metres), and thus within the expected rotor swept area include:

- Little Bent-winged Bat *Miniopterus australis* – Mean of 1.5 calls recorded per night.
- Eastern False Pipistrelle– Mean of 1.1 calls recorded per night.
- Large Bent-winged– Mean of 1.1 calls recorded per night.
- Eastern Coastal Free-tailed Bat *Micronomus norfolkensis* – Mean of 0.6 calls recorded per night.
- Yellow-bellied Sheathtail-bat Saccolaimus flaviventris – Mean of 0.4 calls recorded per night.
- Little Pied Bat – Mean of 0.2 calls recorded per night.
- Large-eared Pied Bat *Chalinolobus dwyeri* – Mean of 0.1 calls recorded per night.

Of the 28 species recorded across the site, 23 were recorded by detectors mounted on meteorological masts at canopy height (30 metres), and 19 recorded at the above canopy level (60 metres). A total of eight species recorded at the above canopy level were recorded with a mean of more than one call per night of analysed data, seven species were recorded with a mean of between 0.7 calls per night and 0.2 calls per night, and the remaining four species were recorded as having a mean of 0.1 calls per night.

There is a general trend for reduced activity levels with increased elevation with ground detectors averaging a total of 130.3 mean calls per night, detectors deployed at 30 metres averaging a total of 107.5 mean calls per night, and detectors deployed at 60 metres averaging a total of 56.0 mean calls per night. Table 40 and Table 41 provide a comparison of total mean activity across the paired detectors deployed at each of the three met masts and illustrates the decrease in activity at higher elevations.

Table 40 Mean calls per night on met mast deployed detectors

Met mast location	2m height	30m height	60m height
MM1	193.8	85.7	37.6

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Met mast location	2m height	30m height	60m height
MM2	61.0	185.0	75.2
MM3	98.5	87.5	55.2
Averages	117.8	119.4	56.0

Table 41 Mean calls per night on met mast deployed detectors White-striped Freetail Bat removed

Met mast location	2m height	30m height	60m height
MM1	109.5	47.2	16.9
MM2	18.3	73.4	13.0
MM3	38.5	49.8	21.2
Averages	55.4	56.8	17.0

The above tables also illustrate that with White-striped Freetail Bat included in the analysis, the activity at 60 metres elevation is approximately half that recorded below canopy and at canopy height, whereas with the species removed the relative activity level at 60 metres falls to approximately one third of that closer to the ground. This illustrates that not only is White-striped Freetail Bat the most commonly recorded species across the project area, it is also contributing to a higher proportional representation of the species abundance higher in the air column. Furthermore, it should be noted that White-striped Freetail Bat has a loud, low frequency call that is likely to be recorded from further away, so the detectors are likely to be recording this species from a larger volume of air than for other species.

When the results of the bat detectors installed on met masts are reviewed for the threatened microbats, there is also a similar trend for the majority of species having decreased activity at rotor swept height (Table 42). Generally, activity of the threatened bats at the 60m height was found to be low, with the highest number of mean calls per night recorded being 3.3 for Little Bent-winged Bat. The majority of threatened bats detected recorded less than 1 mean calls per night at each detector installed at 60 metres, with Southern Myotis and Eastern Cave Bat absent from the data at this elevation. The highest activity at met mast sites, based on mean calls of 17.3 (Large Bent-winged Bat) and 15.3 (Little Pied Bat) per night, were recorded at the ground level (2 metre height).

The BC Act and EPBC Act listed Large-eared Pied Bat showed a marked reduction in the mean number of calls per night with increasing height. The species mean nightly activity across all ground deployed detectors was found to be 0.7 calls per night, 0.6 calls per night across detectors deployed at canopy height and less than 0.1 calls per night at 60 metres elevation. A very similar trend was observed for the Little Pied Bat. This suggests that bats of this genus (*Chalinolobus* spp.) prefer to forage below canopy height.

The two bent-wing bat species belonging to the genus *Miniopterus*, Greater Broad-nosed Bat and Eastern False Pipistrelle recorded the highest nightly mean calls at the 60 metres height. These species are known to forage above the canopy and for most of the met mast sites there was a greater number of mean calls per night detected at the 30 metres detector height.

Large Bent-winged Bat was the most commonly recorded threatened species with a mean of 10.3 call per night across all detectors. The highest mean nightly calls were recorded at Site 4 with 49 calls per night, this is however only based on data captured for two nights, in late February / early March, with the majority of other detectors recording between 6 and 27.5 calls per night. The species was recorded at all but two sites, with sites representing highest activity spread throughout the development footprint. The species was recorded

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with highest levels of activity on detectors deployed at ground level, with a mean of 12.39 calls per night, activity was seen to decrease at canopy level by approximately half with a mean of 6.66 calls per night recorded, and activity fell further again at the above canopy (60 meter) elevation where the species was recorded on average at 1.09 calls per night.

Table 42 provides details of all threatened species of microbats and the relative activity at different elevations based on data from paired detectors deployed on met masts. As is the case with Large-eared Pied Bat and Large Bent-winged Bat, activity can be seen to generally decrease with increasing elevation for the majority of species.

Notable exceptions to this, based solely on met mast data are Little Bent-winged Bat, Greater Broad-nosed Bat and Eastern Coastal Free-tailed Bat.

When data collected across the site as a whole is considered Little Bent-winged Bat, it is found to be more active at ground level with 1.15 mean nightly calls, and at above canopy height with 1.53 mean nightly calls recorded, and least active at the canopy level with only 0.25 mean nightly calls recorded. Greater Broad-nosed Bat and Eastern Coastal Free-tailed Bat show the more common trend of decreasing levels of activity with increasing elevation, with calls most commonly recorded at ground level and to a lesser degree at canopy and above canopy levels.

Table 42 Mean calls per night for threatened microbats detected at paired met mast locations

Threatened species	MM1			MM2			MM3		
	2m	30m	60m	2m	30m	60m	2m	30m	60m
Chalinolobus dwyeri* #	7.25	1.50	0.06	0.71	0.26	0.14	1.75	0.50	0.03
Chalinolobus picatus* +	15.50	5.00	0.16	1.00	0.00	0.33	2.50	2.50	0.18
Falsistrellus tasmaniensis* +	0.00	0.17	1.06	0.57	5.03	0.38	0.00	0.00	1.85
***Micronomus norfolkensis* +**	0.00	0.00	0.38	0.00	0.39	1.29	0.00	0.00	0.15
Miniopterus australis* #	0.00	0.00	0.25	0.29	0.74	3.29	0.00	0.00	1.06
Miniopterus orianae oceanensis* #	18.00	3.83	1.63	3.14	13.89	0.24	1.25	2.25	1.39
Myotis macropus* #	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
***Saccolaimus flaviventris*+**	1.75	7.00	0.13	2.71	0.55	0.33	0.25	0.00	0.76
***Scoteanax rueppellii*+**	0.00	0.00	1.91	0.43	6.53	1.71	0.00	0.00	1.85

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Threatened species	MM1			MM2			MM3		
	2m	30m	60m	2m	30m	60m	2m	30m	60m
Vespadelus troughtoni* #	1.00	0.33	0.00	0.00	0.00	0.00	1.75	0.00	0.00

This above data suggests that whilst the majority of species present within the subject land will occur most frequently below canopy or at canopy height, there is also a high number of species, both threatened and non-threatened, that will on occasion fly higher and may be at risk of collision with turbine blades during the operational phase of the wind farm.

Assessment of potential roosting or foraging activity

To further determine the nature of the microbat population recorded within the development footprint, analysis of the times calls were recorded has been undertaken. The aim of this analysis is to provide insight into the likelihood of the development footprint and the immediately surrounding landscape to support bat roosts, or whether the microbats recorded on site are travelling form roosts located away from the development to forage. It could be expected that if bats were roosting in close proximity to the development footprint, calls would be consistently clustered towards sunset and sunrise times, when bats are entering/exiting the roost for nocturnal forage activity. Furthermore, if the microbats present within the project area are roosting further from the site, and traveling some distance through the landscape to forage, calls would generally be clustered later into the night.

Table 43 provides times for sunset, end of twilight and sunrise as provided by https://www.timeanddate.com/ for Nundle in 2020.

Table 43 Sunset, twilight and sunrise times for February to May 2020

Month	Sunset	End of twilight	Sunrise
February	7:55pm – 7:30pm	8:23pm – 7:55pm	6:20am – 6:44am
March	7:29pm – 6:52pm	7:54pm – 7:17pm	6:45am – 7:06am
April	6:51pm – 5:19pm	7:15pm – 5:44pm	7:06am – 6:25am
May	5:18pm – 5:00pm	5:43pm – 5:26pm	6:26am – 6:45am

The following graphs have been prepared using the time-stamped call data collected between February and May 2020 and are provided to illustrate the time of night various species of microbats were found to be active within the project area. The first set of graphs relates to cave dependent/utilising species.

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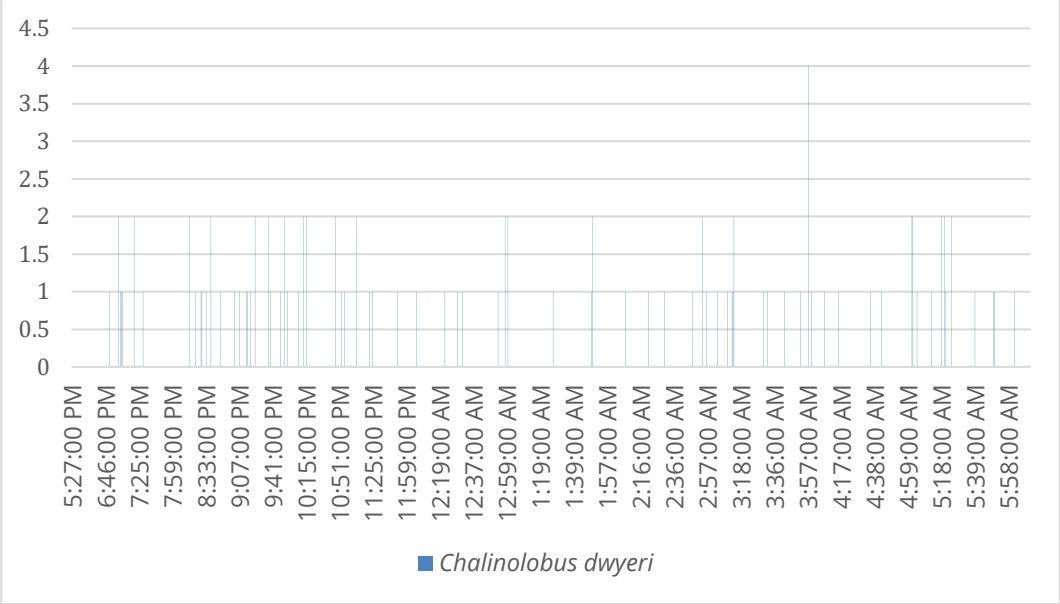
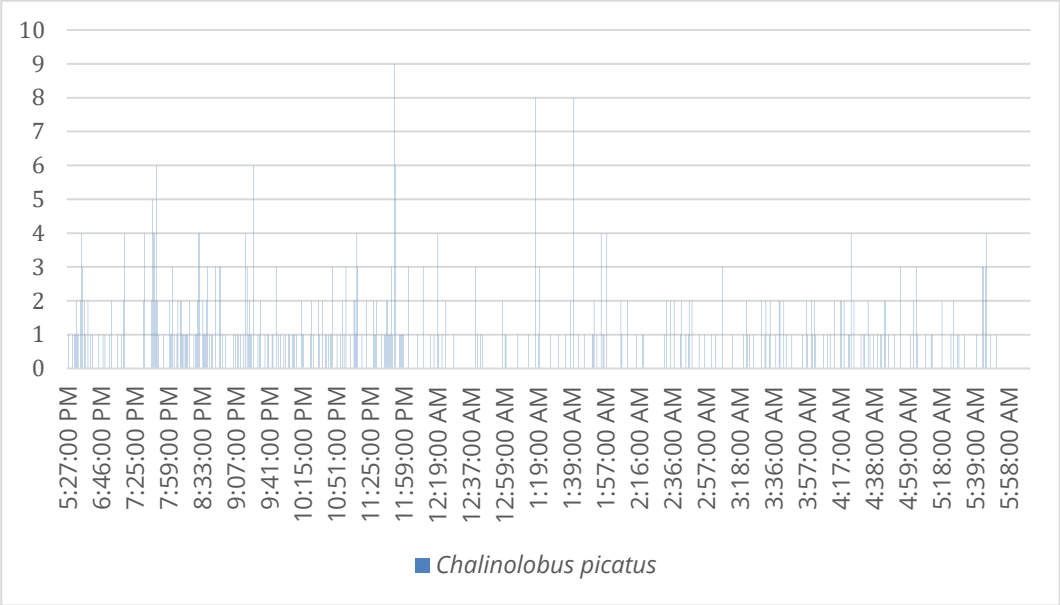


Graph 1 Time range and total number of calls recorded for Large-eared Pied Bat



Graph 2 Time range and total number of calls recorded for Little Pied Bat

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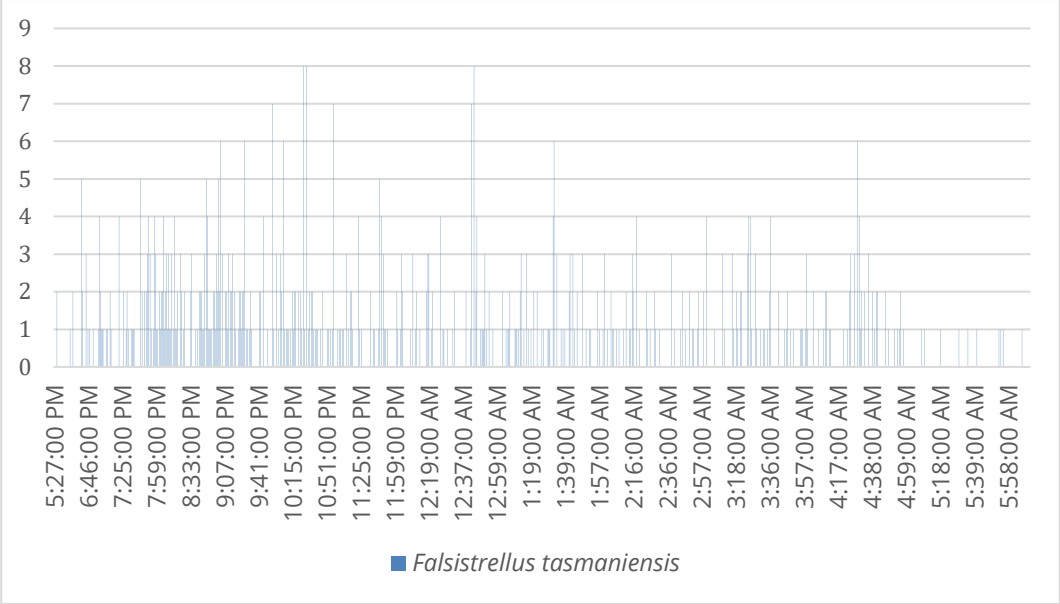
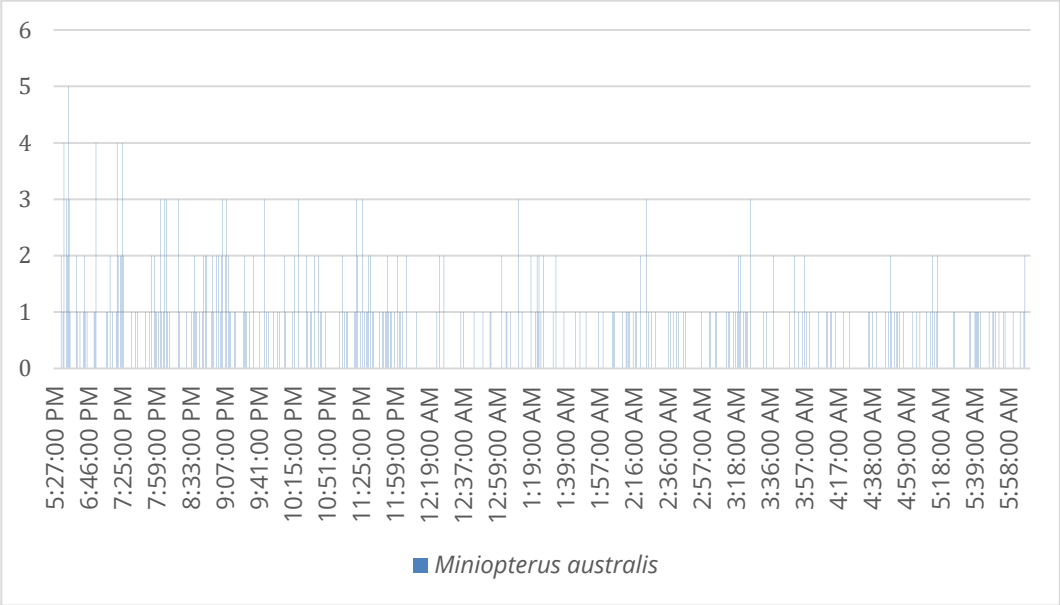


Graph 3 Time range and total number of calls recorded for Eastern False Pipistrelle



Graph 4 Time range and total number of calls recorded for Little Bent-winged Bat

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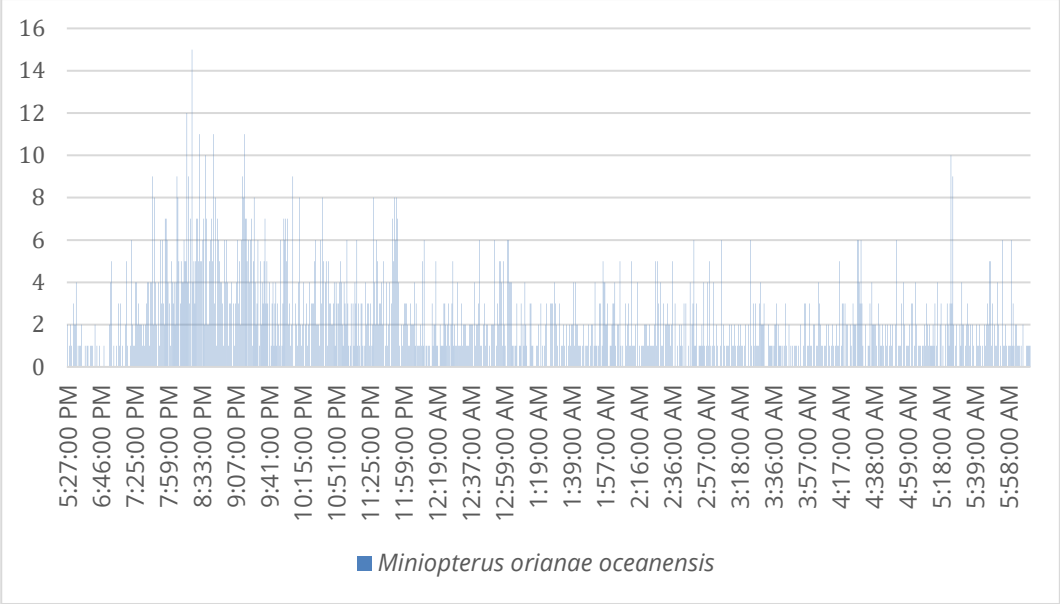
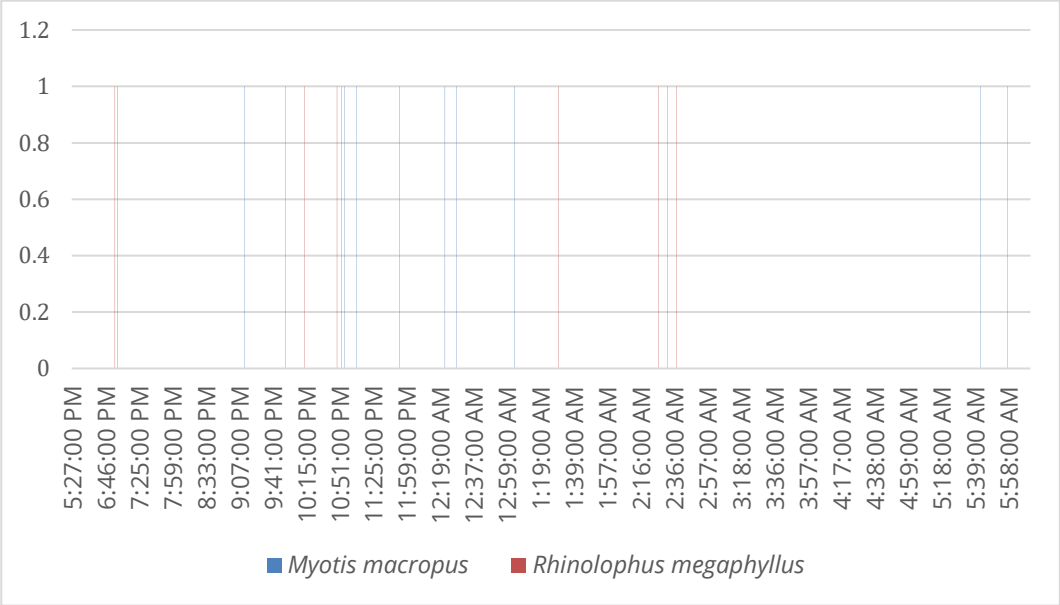


Graph 5 Time range and total number of calls recorded for Large Bent-winged Bat



Graph 6 Time range and total number of calls recorded for Southern Myotis and Smaller Horseshoe Bat

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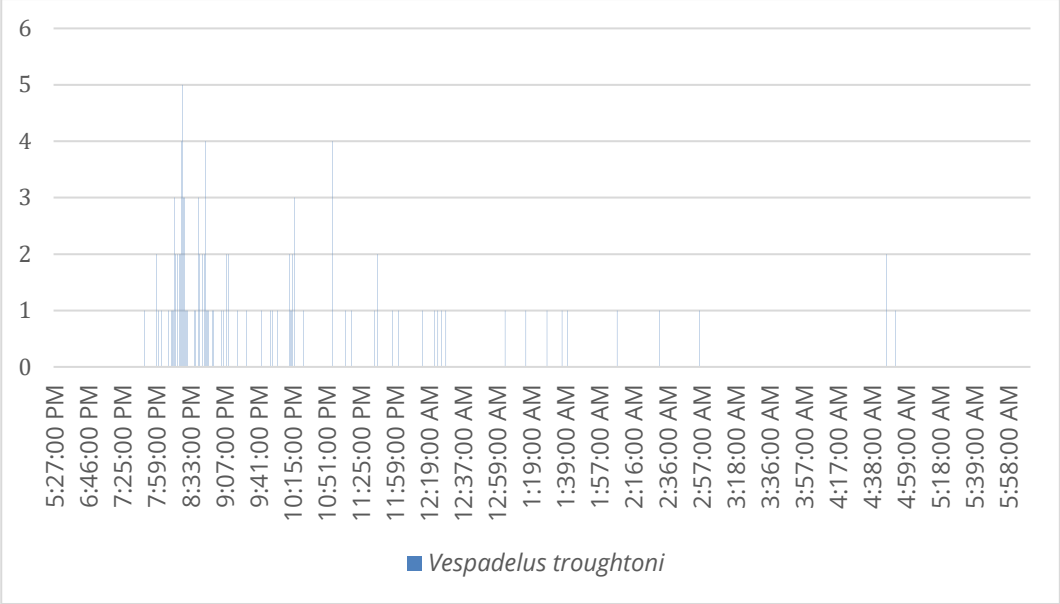

Graph 7 Time range and total number of calls recorded for Eastern Cave Bat

Based on the above graphs of time and number of calls recorded within the project area for cave dependent species, there appears to be a correlation for both Little Bent-winged Bat and Large Bent-winged Bat being commonly recorded on site between 5:30pm and 7:15pm for Little Bent-winged Bat, and 7:15pm and 9:25pm for Large Bent-winged Bat. Whilst this data suggests bats are arriving on site around sunset and end of twilight, the highest number of calls for Large Bent-winged Bat can be seen to be after 8:00pm, well after the end of twilight for the majority of the survey period. Furthermore, other than a total of five additional calls occurring before 7:30pm, call activity for Little Bent-winged Bat is relatively consistent through until 12:00am. Both species' high proportion of calls earlier in the night suggest they may be roosting close by, and only traveling a short distance to the site. This is supported by the presence of the known non-maternity roost for the species at Timor Caves, approximately 5 kilometres to the south of the project area. Both species are commonly recorded throughout the rest of the night, with Large Bent-winged Bat calls showing another minor increase closer to sunrise. Little Pied Bat, Eastern False Pipistrelle and Eastern Cave Bat calls also show some correlation towards the sunset / end of twilight time range however the trends are less apparent.

The following graphs provide comparable data for the three most common non-cave dependent microbat species and the remaining three threatened species (non-cave dependents) recorded within the project area.

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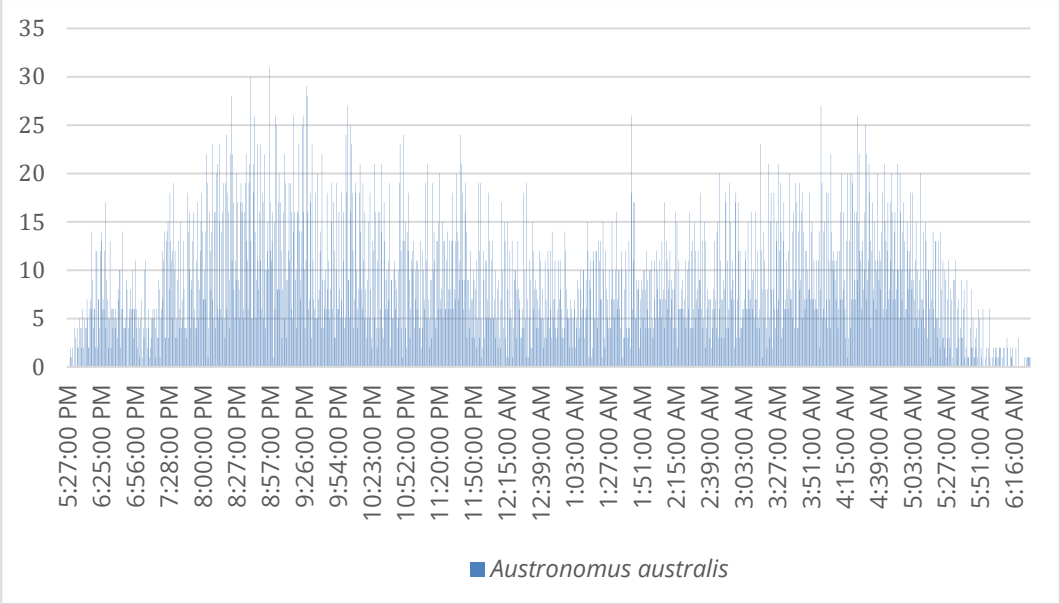
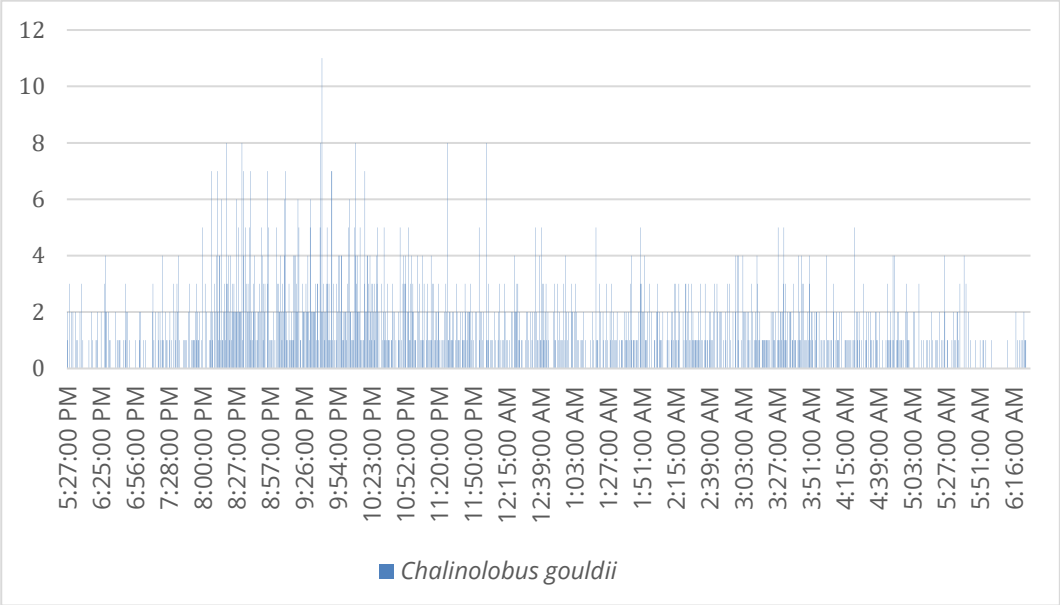


Graph 8 Time range and total number of calls recorded for White-striped free-tailed bat



Graph 9 Time range and total number of calls recorded for Gould's Wattled Bat

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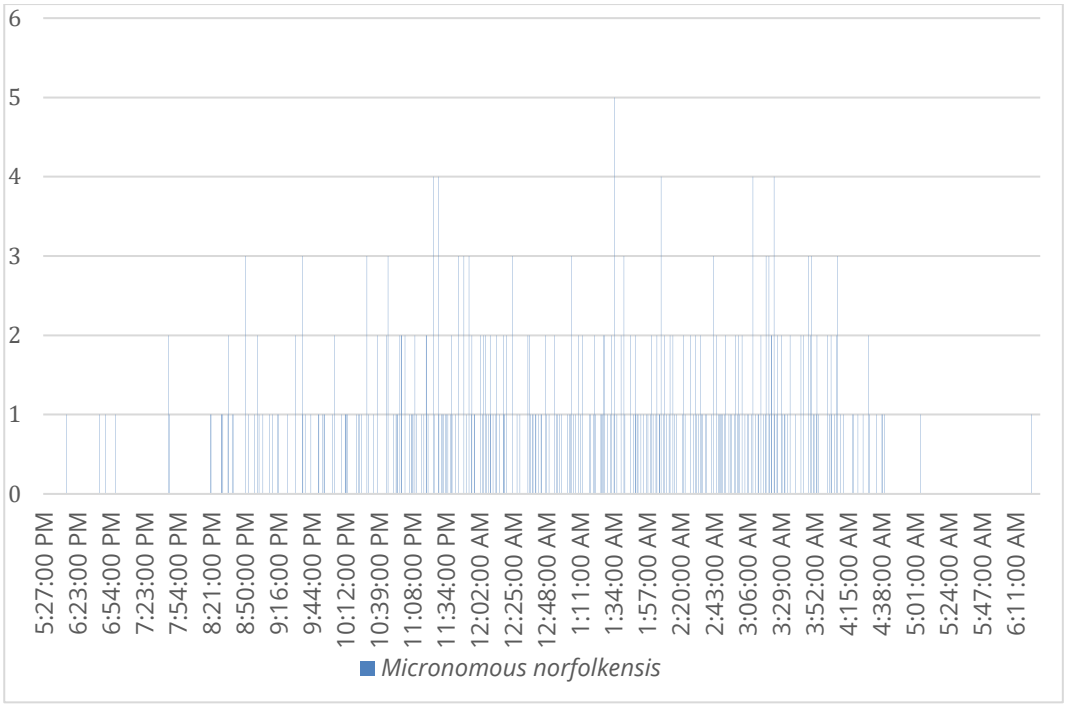
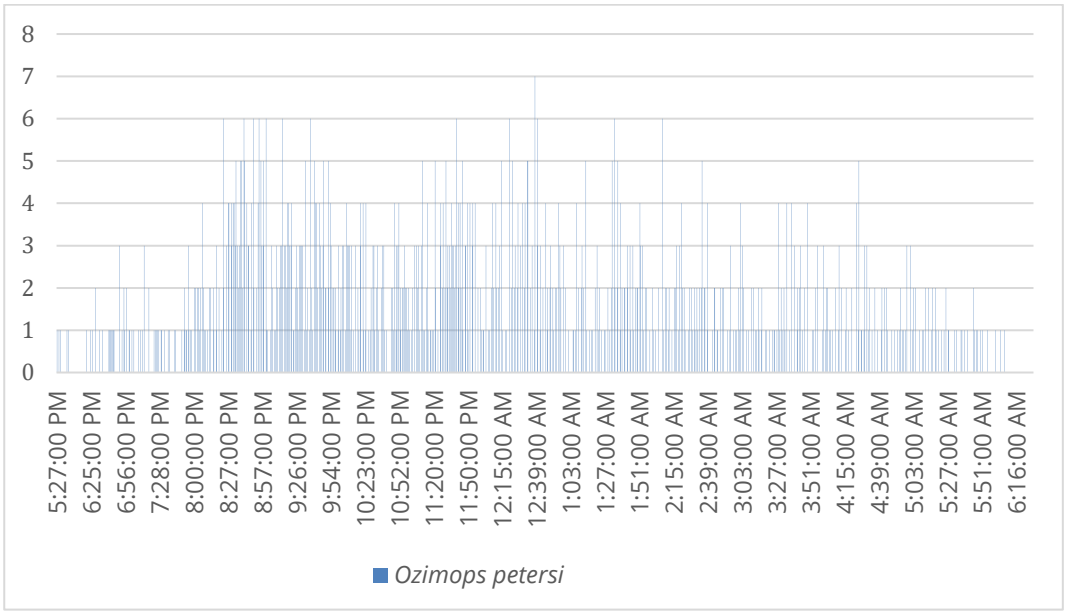


Graph 10 Time range and total number of calls recorded for Eastern Coastal Free-tailed Bat



Graph 11 Time range and total number of calls recorded for Inland Free-tailed Bat

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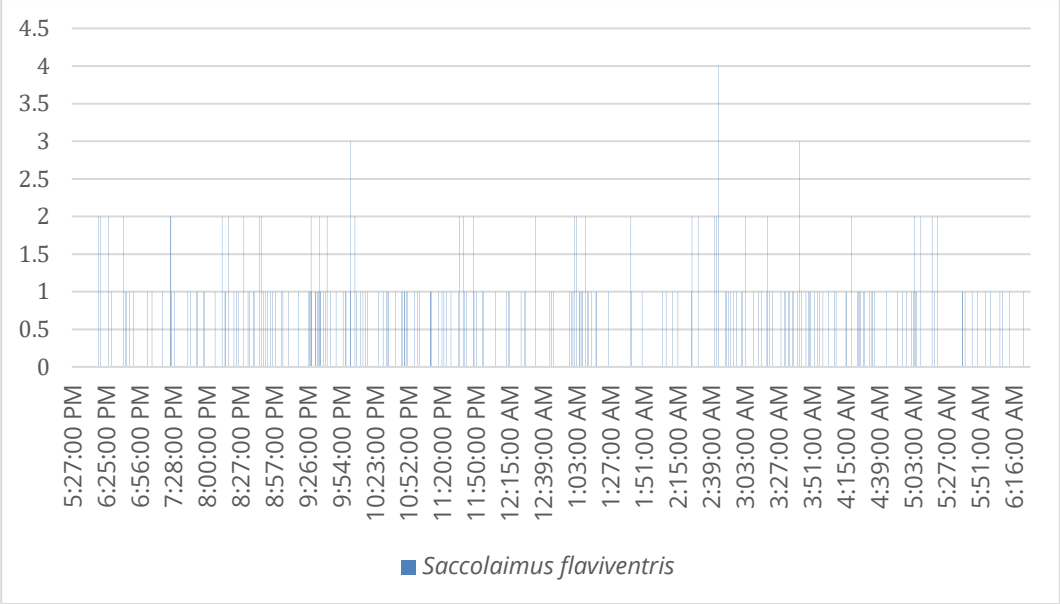
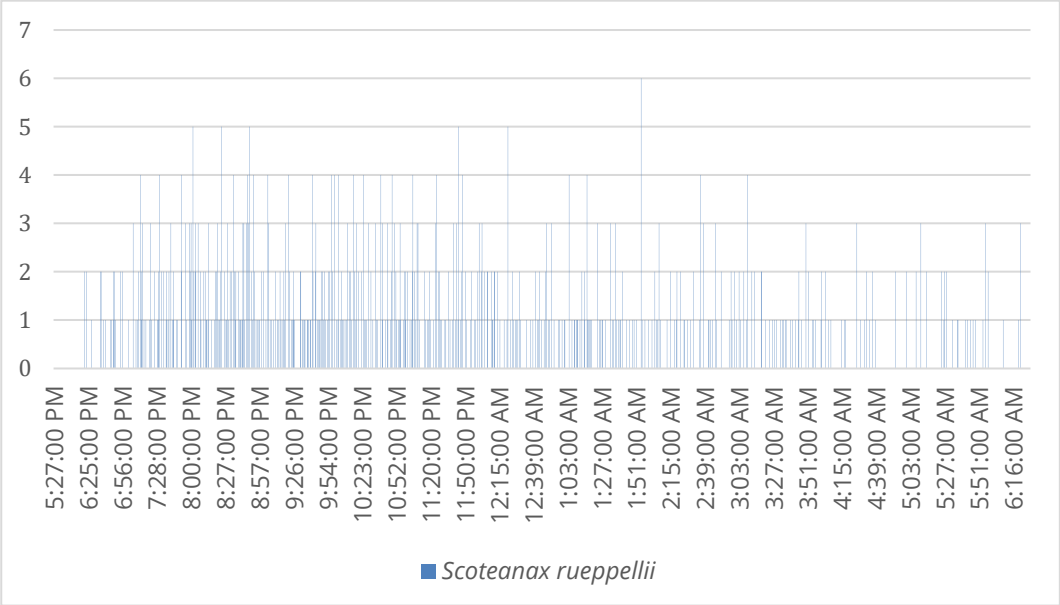


Graph 12 Time range and total number of calls recorded for Yellow-bellied Sheath-tailed Bat



Graph 13 Time range and total number of calls recorded for Greater Broad-nosed Bat

Two of the non-cave dependent bats, the threatened Eastern Coastal Free-tailed Bat and non-threatened Inland Free-tailed Bat, are clearly more active within the project area during the later stages of the night suggesting roosting is occurring elsewhere. Timing of calls recorded for Gould's Wattled Bat and the threatened Great Broad-nosed Bat are somewhat clustered towards the start of the night with most activity found to be occurring between 8:00pm and 9:00pm, however there are also calls reasonably consistently recorded across the remainder of the night. Yellow-bellied Sheath-tailed Bat show no real trend in time of call, with numbers of calls recorded remaining consistent across the night.

The most common bat species recorded during the survey, White-striped Free-tailed Bat, shows a correlation for being recorded on site most commonly between 7:00pm and 10:30pm and again between 3:00am and 5:30am, which suggests roosting may be occurring in the vicinity of the site. However, calls are skewed somewhat away from both sunset / end of twilight and sunrise suggesting roosting may not be within the

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immediate surrounds. The species is known to roost in tree hollows and an abundance of this habitat type is present within the development footprint and the landscape immediately surrounding, and further afield from, the project area.

Based on the analysis of the time ranges that species' calls were recorded, it is concluded that whilst some species, including Large Bent-winged Bat, Little Bent-winged Bat and White-striped Free-tailed Bat, are arriving on site during the early parts of the night, there is no clear evidence to suggest that regularly utilised roosts are present within the development footprint or immediate surrounds. The presence of potential cave roosts is discussed further below, and as outlined above the potential for tree roosts supporting White-striped Free-tailed Bat exists, however there is an abundance of potential tree roosting habitat throughout the broader landscape.

Assessment of potential breeding activity

Another limitation of acoustic surveys for microbats is the lack of ability to confirm the presence of breeding status of the bats present within the project area. To confirm the presence of breeding activity bats must be trapped and checked for signs of breeding such as attached juvenile bats or lactation. Largely due to the size and inaccessible nature of the development footprint, as well as the wide-spread potential for possible roost habitat, trapping surveys were not able to be undertaken as part of the current assessment.

To provide insight into the likelihood of habitats potentially present within and immediately surrounding the development footprint being used as maternity roosts, call data has been analysed based on mean nightly activity across the survey period on a temporal scale. Many bats are known to migrate to colonial maternity roots and as such, activity levels can be expected to change over time based largely on the presence of breeding females. Survey data was collected in November 2019 and March to May 2020, allowing for temporal comparison of activity around the known breeding periods of a number of bats.

Due to the high species diversity in microbat activity within the project area, the focus of this analysis has been on those bats considered at highest risk of substantial or significant impacts if breeding was found to occur and was impacted upon. Those species being the BAM species credit listed bats; Large-eared Pied Bat, Eastern Cave Bat, Large Bent-winged Bat and Little Bent-winged Bat.

Movement patterns relating to the reproductive strategies of these bats are outlined below, with information based on that provided in Churchill (2008), Parnabt et al. (2008), Hoye & Hall (2008), and Hoye & Schulz (2008).

Large-eared Pied Bat

- Births occur at maternity roosts in late November to early December, with juveniles suckled until late January.
- Young leave the roost in February, followed by females in late March.

Eastern Cave Bat

- Females congregate at maternity roosts in November, with births occurring in mid to late November.

Large Bent-winged Bat

- Females congregate at maternity roosts in spring (from October), with births in December to January.
- Females leave maternity roost in February, with juveniles leaving around a month later. The colonies are deserted by April.

Little Bent-winged Bat

- Females congregate at maternity roosts in spring (recorded as early as August), males are also present but disperse from December.

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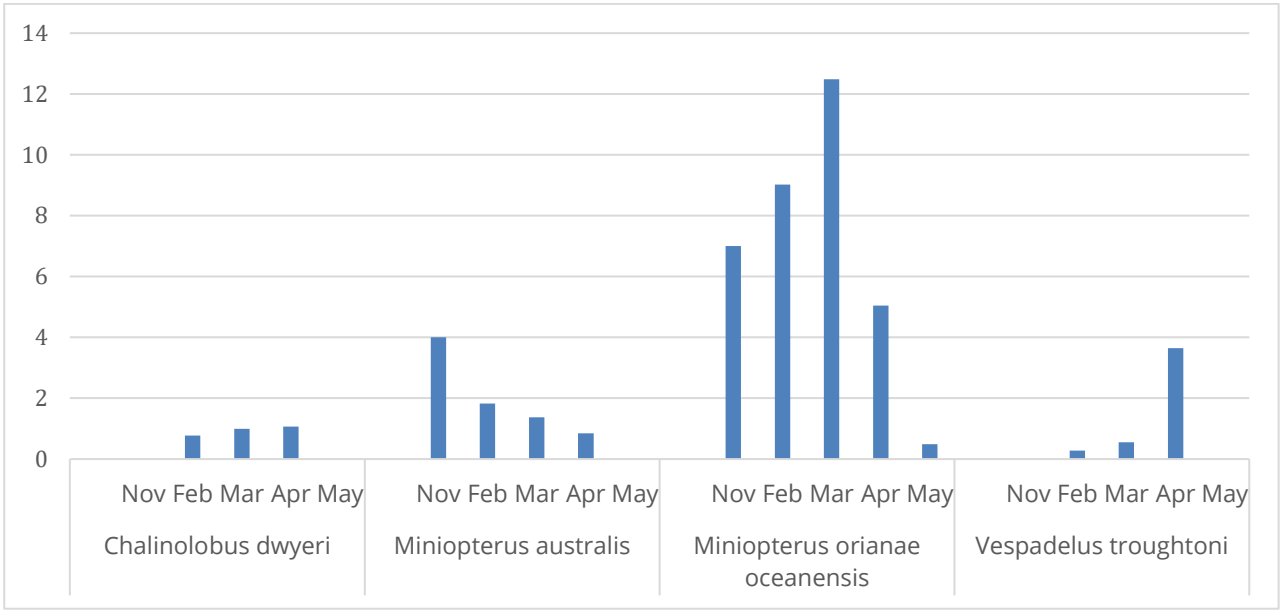
- Young are born in December.

The graph below illustrates the mean nightly activity recorded for the four BAM species credit microbat species across the survey period to provide an indication of relative abundance within the project area over a temporal scale.



Graph 14 Mean nightly activity for Large-eared Pied Bat, Eastern Cave Bat, Large Bent-winged Bat and Little Bent-winged Bat during the microbat acoustic survey period

Relative abundance of Large-eared Pied Bat can be seen to be stable across late summer and into early autumn, with no activity recorded in either November or May. This indicates that breeding roosts are unlikely to be present within or immediately surrounding the development footprint as higher levels of activity would be expected in November, with activity levels dropping in late March.

Eastern Cave Bat can be seen to be most active within the project area in April, with low levels of activity recorded in February and March. Little is known about the breeding biology of this species; however, it could be expected that some activity would have been recorded in November if maternity roosts were present.

Large Bent-winged Bat activity peaks in March with higher activity levels also recorded in November and February. This suggests that individuals occurring within the project area are unlikely to be breeding females, who are known to leave maternity roosts in February, which would lead to a reduction in activity through March. Furthermore, as noted above, the species' maternity roosts are generally deserted by April and activity was recorded within the development footprint in both April and May, though at lower levels to those recorded in the warmer months. This could be expected for a species known to decrease activity during colder weather.

Little Bent-winged Bat activity was highest within the project area in November and reduces from February through to April although the reduction relates to a mean of less than one call per night fewer being recorded between these months. Higher levels of activity in November are based on only two nights' data and as such higher activity may be more related to outlier nights than truly higher activity. There is little evidence from activity levels to suggest breeding behaviour in the immediately vicinity of the development footprint, and that overall activity for the species is comparatively low. Furthermore, Little Bent-winged Bat is known to co-occur in maternity roosts with Large Bent-winged Bat, especially in colder environment, and based on activity data for Large Bent-winged Bat, there is again little evidence to suggest either species is breeding in the area.

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Whilst it is acknowledged that without trapping microbat breeding activity cannot be conclusively ruled out from occurring within and surrounding the project area, temporal activity patterns do not suggest that this is occurring.

Review of microbat forage space and flight behaviour

To inform the assessment of indirect impacts to microbat species recorded within the project area a review of flight behaviour, forage space, relationship to tree canopies and additional descriptive information has been undertaken. This information has been utilised and referenced in the impact assessments undertaken in Section 8.3 and is presented in Table 44 below. This information has been taken from Blakely et al (2017), Bullen and McKenzie (2001), Bullen and McKenzie (2008) and Churchill (2008).

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Table 44 Review of microbat behaviour

Species	Foraging space	Flight characteristics	Canopy	Overview
White-striped free-tailed bat	Open	Fast, not designed for manoeuvrability	Above canopy	Fast-flying species intercepting their prey 50 m or more above the ground. (Churchill 2008).
Large-eared Pied Bat	Edge	Slow, direct, moderately manoeuvrable	Below	Insectivorous bat that flies relatively slowly with rapid but shallow wing beats (Churchill 2008). The relatively short, broad wing indicates manoeuvrability suggesting the species forages below the forest canopy (DPIE profile 2018).
Gould's Wattled Bat	Edge	Fast, agile	Just below, within the lower level of the tree canopy and along forest edges, creeklines and isolated paddock trees.	Feeds on a wide variety of prey, regularly foraging 5 - 10 km from their roost site. They fly just below or within the lower level of the tree canopy and along the forest edges, creeklines and around isolated paddock tree with fast, agile flight (Churchill 2008).
Chocolate Wattled Bat	Edge	Fast, agile, direct	Below canopy	In inland areas their distribution is associated with water courses that provide large trees for roosts. They prefer forests to small forest patches (Churchill 2008). They forage up to 5 km from their roost site, their flight is usually fast and direct with considerable agility (Churchill 2008). They mostly forage in the zone between the top of the understorey and the canopy, although sometimes fly low along forest trails.
Little Pied Bat	Edge	Fast, highly manoeuvrable	Below canopy	Greatest relative abundance in the mallee and mixed species woodlands of the Willandra Lakes area of NSW. They fly close to the vegetation, about 2-4 metres above the ground, and have been observed to glean prey from various substrates. Capable of commuting up to 17 km from roost sites (Churchill 2008).
Eastern False Pipistrelle	Open/ Edge	Swift, direct	Below canopy	Flight is swift, direct, within or just below the tree canopy. Can travel large distances between roost and foraging area (12 km). Absent from small forest patches preferring continuous forest to forage along tracks, creeks and rivers. Capable of moving through cleared landscapes and foraging over open areas.
Eastern Coastal Free-tailed Bat	Open/ Edge	Probably fast, direct	Above canopy	Preference for open spaces in woodland or forest, foraging in openings and gaps in the forest usually within a few kilometres of their roost (Churchill 2008). Fly quickly over the tops of trees in forests or along vegetation edges to hunt their prey.
Little Bent-winged Bat	Edge	Fast, manoeuvrable	Below	Fly rapidly with considerable manoeuvrability between shrub and canopy layers of densely wooded areas. Capable of flying large distances to congregate in maternity colonies.

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Species	Foraging space	Flight characteristics	Canopy	Overview
Large Bent-winged Bat	Open/ Edge	Very fast, direct	Above canopy	Flies high, from just above the canopy to many times canopy height or above grasslands, flight may be just above the ground. Flight is very fast, and they can forage long distances from the roost site.
Southern Myotis	Closed / Edge	Probably slower, manoeuvrability	Water	Live in most habitat types as long as it is close to water where they forage for insects and small fish by flying back and forth low across the water.
Lesser Long-eared Bat	Closed	Slow, manoeuvrable	Below canopy	Species tend to fly close to vegetation and into the understorey as they feed on moths, crickets and grasshoppers
Northern Free-Tailed Bat	Open/ Edge	Fast to very fast, direct.	Above canopy	Forage in the unobstructed air-spaces from just above to well above the canopy as well as above the ground in grasslands and large clearings. Fast to very fast.
Inland Free-tailed Bat	Open/ Edge	Fast, direct	Above canopy	Forage in open unobstructed areas. They fly fast above the canopy. They are not very manoeuvrable in flight.
South-eastern Free-tailed Bat	Open/ Edge	Fast, direct	Above canopy	Forage at or above canopy height in the spaces between trees, and the outer edge of remnant vegetation and above the forest canopy.
Ride's Free-Tailed Bat	Open/ Edge	Fast, direct	Above canopy	Fly predominantly in the spaces between trees.
Golden-tipped Bat	closed	Slow, manoeuvrable	Below canopy	Typically forage within a 2 km radius inside rainforest gullies or cluttered habitat where orb-weaving spiders are present.
Smaller Horseshoe Bat	Closed	Slow, highly manoeuvrable	Below canopy	Short, broad wings and low wing loading. Adapted to cluttered habitats. Slow, but highly manoeuvrable flight. They often hover and manoeuvre successfully among the branches and foliage of dense shrubs. (Churchill 2008).
Yellow-bellied Sheath-tailed Bat	Open	Fast, direct, not manoeuvrable	Above canopy	Almost all habitats, migratory, probably fly high. Long, narrow wings.
Greater Broad-nosed Bat	Edge	Limited manoeuvrability and moderate speed	Below canopy	Forage about 5 m from the edge of isolated trees, forest remnants or along forest crowns with a slow, direct flight pattern.
Scotorepens balstoni	Edge	Moderately fast, agile	Below canopy	Flight is continuous with sudden rapid diversions. Forage mostly between trees but also at the edges of forests, and out in open areas. (Churchill 2008). They stay within 15 m of the ground and do not forage above the canopy.
Scotorepens greyii	Edge	Moderately fast, agile	Below canopy	Flight is continuous, moderately fast, agile. Search for insects close to the tree tops but not above them, flying in the open spaces along the contour of the vegetation within 2 m of the foliage. Forage over water, grasslands and other open habitat. (Churchill 2008).

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Species	Foraging space	Flight characteristics	Canopy	Overview
Scotorepens orion	Edge			
Vespadelus darlingtoni	Edge	Fast, less manoeuvrable.	Below canopy	Fast-flying bat that is less manoeuvrable than most *Vespadelus*. Avoid cluttered regrowth and rainforest by foraging mainly within the spaces among trees and between the canopy and the understorey.
Vespadelus regulus	Edge	Fast, agile, manoeuvrable	Below canopy	Highly manoeuvrable, moderately fast insectivores. Fly with great agility very close to vegetation and readily enter gaps in the understorey, usually foraging at less than half the canopy height. Small foraging range of less than 10 ha.
***Vespadelus* sp.**	N/A			
Eastern Cave Bat	Edge			
Vespadelus vulturnus	Edge			

In general:
Open space / aerial = typically free-tail and sheath-tail bats. Fly fast. Long, narrow wings, not manoeuvrable.
Edge space = most bats (vespertilionids and Myotis). Fly fast to moderately slow. Moderately long and broad wings.
Closed = gleaning bats (*Phoniscus, Nyctophilus, Rhinolophus*) = slow, but able to manoeuvre and hover in cluttered places. Broad, shorter wings, rounded tip, large tail membrane.

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Microbat cave roost assessments and results

To further define the nature and extent of the local mircobat population within the project area, investigation of potential microbat roost and possible breeding habitat within and surrounding the development footprint was undertaken during the course of the development of the BDAR. Initial desktop investigation using GIS were undertaken to locate areas of potential for field investigation, the results of which were fed back into the project design to allow for avoidance of direct and indirect impacts. Follow-up desktop assessment and additional detailed field validation was then undertaken to further refine these areas of potential habitat.

The locations of steep topography with the potential to represent cliff-lines (and therefore potential bat roosts) on the edge of the escarpments in the project area were mapped. The GIS desktop analysis was undertaken as follows:

- A 5 m Digital Elevation Model (DEM) was created from a LiDAR point cloud.
- Focal statistics were run on the DEM to create a surface representing the range of elevation in a 2x2m cell neighbourhood around each input cell (roughly a 10m buffer).
- Focal range surface was reclassified to remove areas with a range less than 3m between highest and lowest points in the neighbourhood. This was undertaken to remove small topographic features less likely to provide suitable root habitat.
- The resulting 'clifflines' layer was symbolised to show areas of potential clifflines based on where the range was 4, 5, 6, 7 or >7 metres within the 2x2 neighbourhood.

These areas of steepest topography were used to identify potential areas where cave-dwelling microbats could establish roosts, and potentially breeding habitat.

Initial ground-truthing of these areas of potential habitat was undertaken in late-February 2020; however, rain and fog over the duration of the field event meant accessing down or near these areas of potential habitat, which comprise the steepest areas of the upper slopes surrounding the development footprint, was unable to undertaken, and views from the top were highly restricted. As illustrated in Photo 10 below.

The result of the inclement weather meant areas of potential habitat were mapped in a highly conservative manner and encompassed all areas of steep terrain potentially supporting cliff-lines, overhangs and any other such potential bat roost habitat. Ultrasonic recording devices were installed at many of the locations assessed as potential bat roost habitat to record the level of microbat activity at each location (with results as discussed above).

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Photo 10 Wet and foggy weather conditions during February 2020 attempted ground-truthing survey

Follow-up assessment of the areas mapped as potential microbat roosting habitat was able to be undertaken in March 2021, and the two-staged process of desktop analysis followed by on-ground confirmation was repeated.

During the second round of desktop analysis of, the LiDAR data used to create the potential 'clifflines' layer was re-analysed using a slope analysis, with slope face classified into ranges, with the areas of steepest slope classified into between 65 to 75 degrees and 75 to 90 degrees. It was determined that whilst the potential clifflines layer provided information of the areas of greatest change in elevation, the approximately 10 metre buffer (created by the 2x2 pixel neighbourhood) meant that a change of 7 meters in elevation could occur over a 10 metre area, representing only a 35 degree slope. As the potential cliffline habitat being targeted by the desktop assessment is considered to comprise slopes of 75 degrees or greater, the aim of this second round of desktop analysis was to located areas supporting a combination of a large change in elevation (>3 metres) within a 10 metre neighbourhood, and a steep slope (>65 degrees).

In undertaking the desktop assessment in this manner, combined with a detailed review of high definition aerial imagery captured for the purposes of project design, a number of the areas previously assessed as potential microbat habitat could be discounted. It was found that in a number of locations the large change in elevation occurred either over a wide area, therefore representing steep slopes rather than cliffs or overhangs, or that where such changes occurred over more discrete areas they were often associated with breaks in canopy, rather than sharp changes in ground topography. All areas previously mapped as potential bat roost habitat were re-assessed and prioritised for follow-up ground confirmation.

On ground assessment of areas identified as potential microbat habitat was then undertaken between 29 March and 1 April 2021. All high priority areas that were identified as having a sudden decrease in elevation were able to be visually inspected from the nearest accessible point. The terrain within the project area was notably steep and rugged, and as a result some sections could only be accessed 50 to 100 metres away. This was not considered a significant limitation as the slopes or clifflines were visible from these distances when the location could not be directly accessed. Due to the large size of the site, not all areas previously mapped as potential habitat were able to be ground-truthed, and a sampling approach was undertaken. However, suitable conclusions were able to be reached for all areas not visited on ground based on the results of the

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desktop assessment and extrapolation of ground observations across other areas of the development footprint.

Photographs were taken at each location and information regarding the type of slope, presence of outcropping, presence of clifflines, overhangs and fissures etc. was recorded. A significant portion of the sites identified during the desktop assessment as having sharp decreases in elevation were confirmed as very steep slopes and comprised of loose soils and unconsolidated material (Photo 11 to Photo 17) and were not considered to provide suitable habitat for microbats. This was in some cases observed to be the result of relatively recent landslides, less than 50 years old, as evident by the immature vegetation structure (images included) and eroded slopes. Two sites were identified as containing microbat habitat suitable to provide roosting and possibly breeding opportunities (Table 45 and Figure 15), one a small cliff line and another forming a large pillar like rocky outcrop. The majority of the rock forming these two habitats was deeply fissured, however the rock forming them was highly friable.

Table 45 provides details of the results of the desktop and/or ground assessment of all areas previously mapped as potential microbat roosts surrounding the development footprint. Area numbers are illustrated on Figure 15, and photos of a number of locations assessed on ground are provided below.

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Table 45 Microbat habitat investigation results

Area No. (refer Figure 15)	Microbat habitat presence	Desktop assessment conclusions	Rationale and field observations
01	No	Steepness >65 degrees correlates to edges of canopy only. Larger areas of change associated with canopy breaks only	Moderate to steep slope with well vegetated grassy forest. No outcropping present.
02 & 03	No	Area of significant change, and linear steep slopes adjacent and continuing to the north	Steep slope, no cliff lines or notable outcropping.
04	No	Steepness >65 degrees correlates to edges of canopy only. No larger areas where change in elevation occur over a wider area (Ie lower potential cliffline values only)	Desktop assessment only.
05	No	Areas of significant change and steepness appear to relate to patchy canopy, however previous notes say rocky habitat abundant	Loose older landslip, no caves, crevices or fissures, unconsolidated and unstable.
06	No	Areas of significant change and steepness appear to relate to broken canopy edges, understory disturbed and cleared, lacks steep changes away from canopy	Desktop assessment only.
07	No	Areas of significant change and steepness appear to relate to patchy canopy, however previous notes say potential cave. Significant erosion in gully. Roost potential seems low	Loose older landslip, no depth to cavities, approx. 20 cm deep.
08	No	Areas of significant change and steepness mainly appear to relate to patchy canopy, however area of large change >7m should be targeted for ground-truthing	Very steep, almost vertical slope, well vegetated and boulders present, however no clifflines or fissures suitable for microbats were present.
09	No	Area appears steep from aerial, larger areas of change and steep slopes not well correlated (slope patchy not linear). will be able to extrapolate from other areas	Desktop assessment only.
10	No	Steepness >65 degrees correlates to edges of canopy only. No larger areas where change in elevation happens over a wider area (Ie lower potential cliffline values only)	Moderate to steep well vegetated slope. No clifflines or rock outcropping observed.
11	No	Large area of significant change, with more linear areas of steep slope	Moderate to steep well vegetated slope. No clifflines or rock outcropping observed.
12	No	Large area of significant change, with patchy areas of steep slope, sample approach	Moderate to steep well vegetated slope. Loose

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Area No. (refer Figure 15)	Microbat habitat presence	Desktop assessment conclusions	Rationale and field observations
			boulders present and no outcropping observed.
13	No	Area of large change and steep decent at western extent appears to be consistent slope	Desktop assessment only.
14	No	Area appears steep from aerial, larger areas of change and steep slopes generally appear to be canopy edges, western end could be targeted for ground-truthing	Desktop assessment only.
15	No	Areas of significant change and steepness appear to relate to patchy canopy	Desktop assessment only.
16	No	Areas of significant change and steepness appear to relate to patchy canopy	Desktop assessment only.
17	No	Areas of significant change and steepness appear to relate to patchy canopy, understory less disturbed may represent breaks in slope, targeted ground-truthing likely to provide good clarity	Steep grassy slope, with very loose soils and no outcropping.
18	Yes	Large change steep descent, high priority for ground-truth	Cliffline extending for 70 metres, with both ends buried by landslide.
19	No	Areas of significant change and steepness appear to relate to patchy canopy	Steep and highly unstable slope. Many small clifflines and outcropping observed, however these contained only shallow cavities and depressions. Exposed material considered a result of relatively recent landslide.
20	No	Areas of significant change and steepness appear to relate to patchy canopy	Desktop assessment only.
21-23	No	Areas of significant change and steepness appear to relate to patchy canopy, data can be extrapolated form other areas	Loose steep slope, no large boulders mostly unconsolidated material.
24	No	Areas of significant change and steepness appear to relate to patchy canopy, data can be extrapolated form other areas	Densely vegetated steep slope, with no rock outcrops observed.
25	No	Areas of significant change and steepness appear to relate to patchy canopy, data can be extrapolated form other areas	Desktop assessment only.
26 (south)	No	Potential gully in centre of polygon high priority for ground-truth, remaining area is	Steep and loose slope with some grassy

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Area No. (refer Figure 15)	Microbat habitat presence	Desktop assessment conclusions	Rationale and field observations
		similar to other areas and data can be extrapolated	groundcovers and unconsolidated rocks.
26 (north)	No	Potential gully in centre of polygon high priority for ground-truth, remaining area is similar to other areas and data can be extrapolated	Steep slope formed of unconsolidated cobble and boulders.
27	Yes	Potential gully in centre of polygon high priority for ground-truth, remaining area is similar to other areas and data can be extrapolated	Pillar like outcrop with many deep and vertical fissures. No guano or odours identified.
28	No	Areas of significant change and steepness appear to relate to patchy canopy, but breaks in slope also possible, data can be extrapolated to/from other areas	Desktop assessment only.
29	No	Areas of significant change and steepness appear to relate to patchy canopy, data can be extrapolated form other areas	Heavily incised drainage line. No fissures observed and rock highly friable.
30	No	Areas of significant change and steepness appear to relate to patchy canopy, but breaks in slope also possible, data can be extrapolated to/from other areas	Desktop assessment only.

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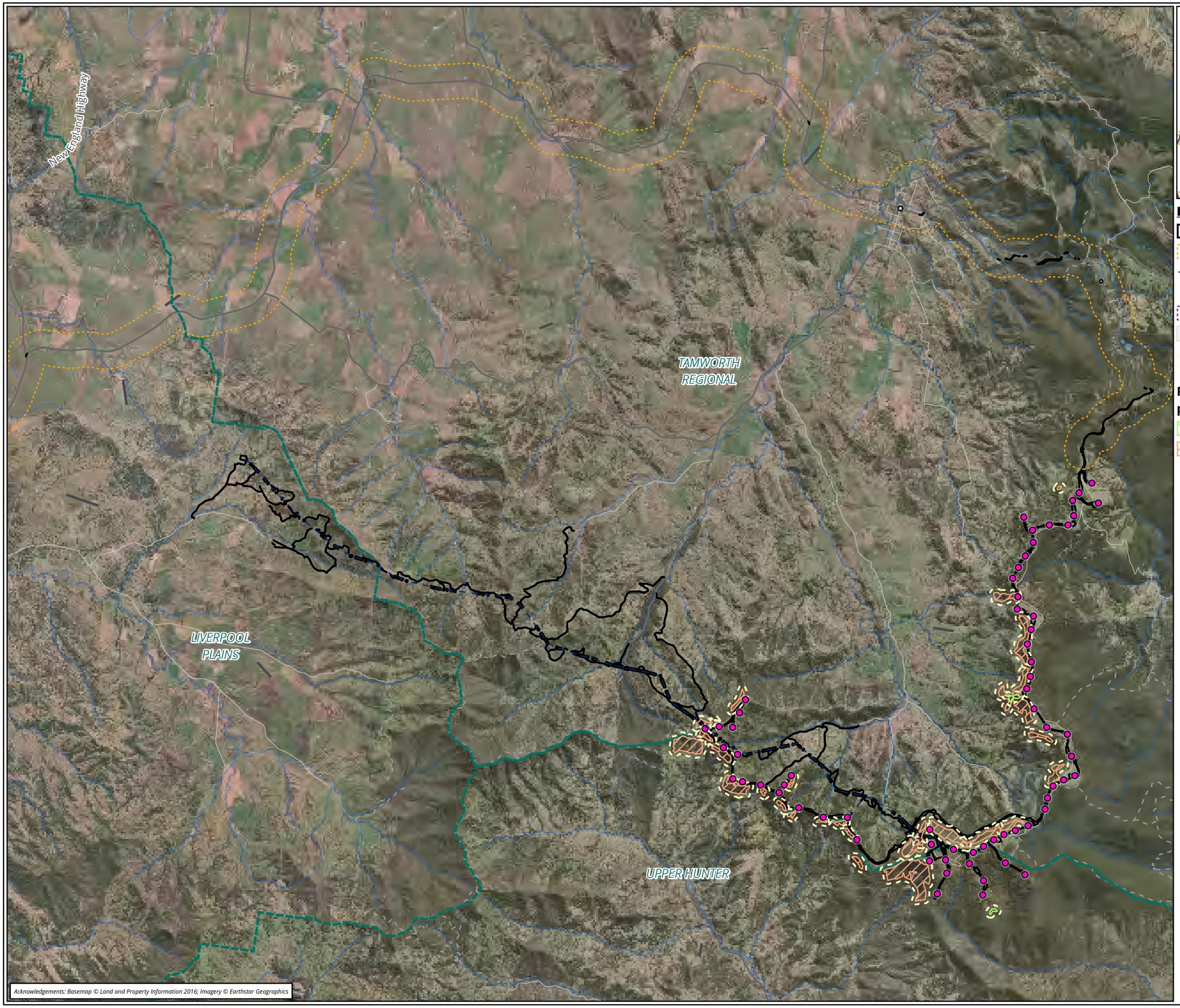
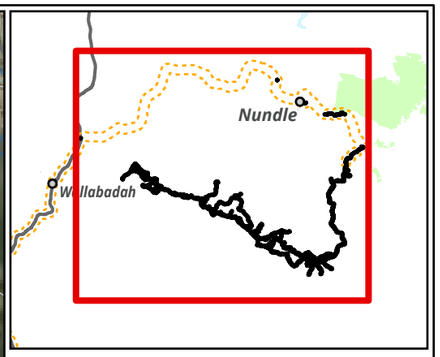




Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Wind turbine locations
- Rotor swept area
- Zone of disturbance
- Potential microbat habitat 100m buffer

Potential microbat breeding habitat polygons

- Habitat
- Not habitat

Figure 15 Potential cave dwelling bat habitats with design and 100m buffer,
Page 1

0 1,000 2,000 3,000 4,000

Meters

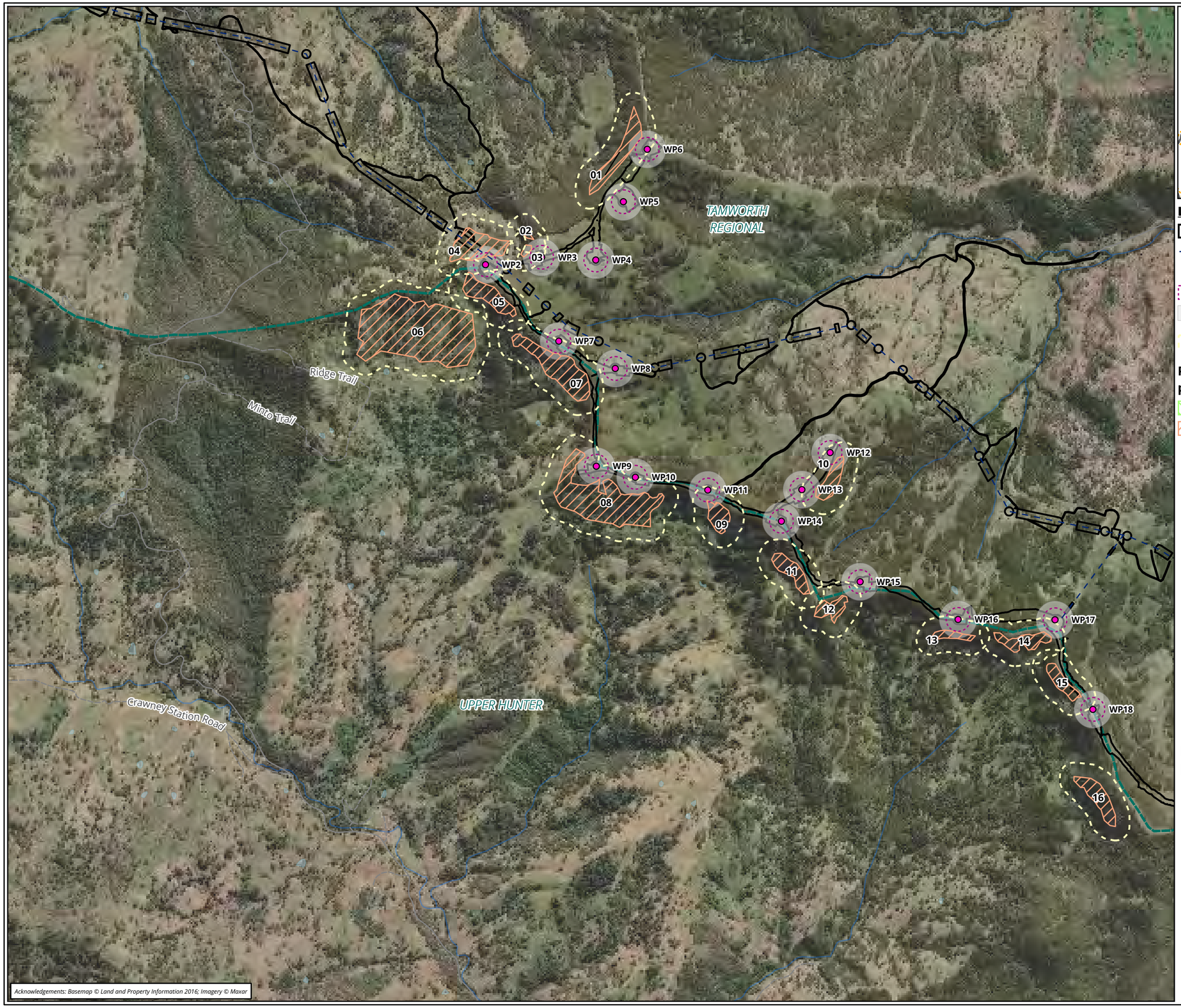
Scale: 1:100,000 @ A3

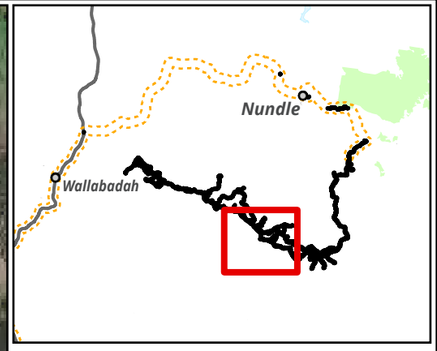
Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F15_PotentialBatHab
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx





Legend

- Infrastructure footprint
- Transmission line
- Wind turbine locations
- Rotor swept area
- Zone of disturbance
- Potential microbat habitat 100m buffer

Potential microbat breeding habitat polygons

- Habitat
- Not habitat

Figure 15 Potential cave dwelling bat habitats with design and 100m buffer,
Page 2

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F15_PotentialBatHab
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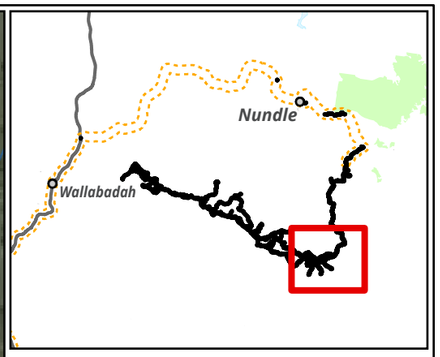

Legend

- Infrastructure footprint
- Transmission line
- Wind turbine locations
- Rotor swept area
- Zone of disturbance
- Potential microbat habitat 100m buffer

Potential microbat breeding habitat polygons

- Habitat
- Not habitat

Figure 15 Potential cave dwelling bat habitats with design and 100m buffer,
Page 3

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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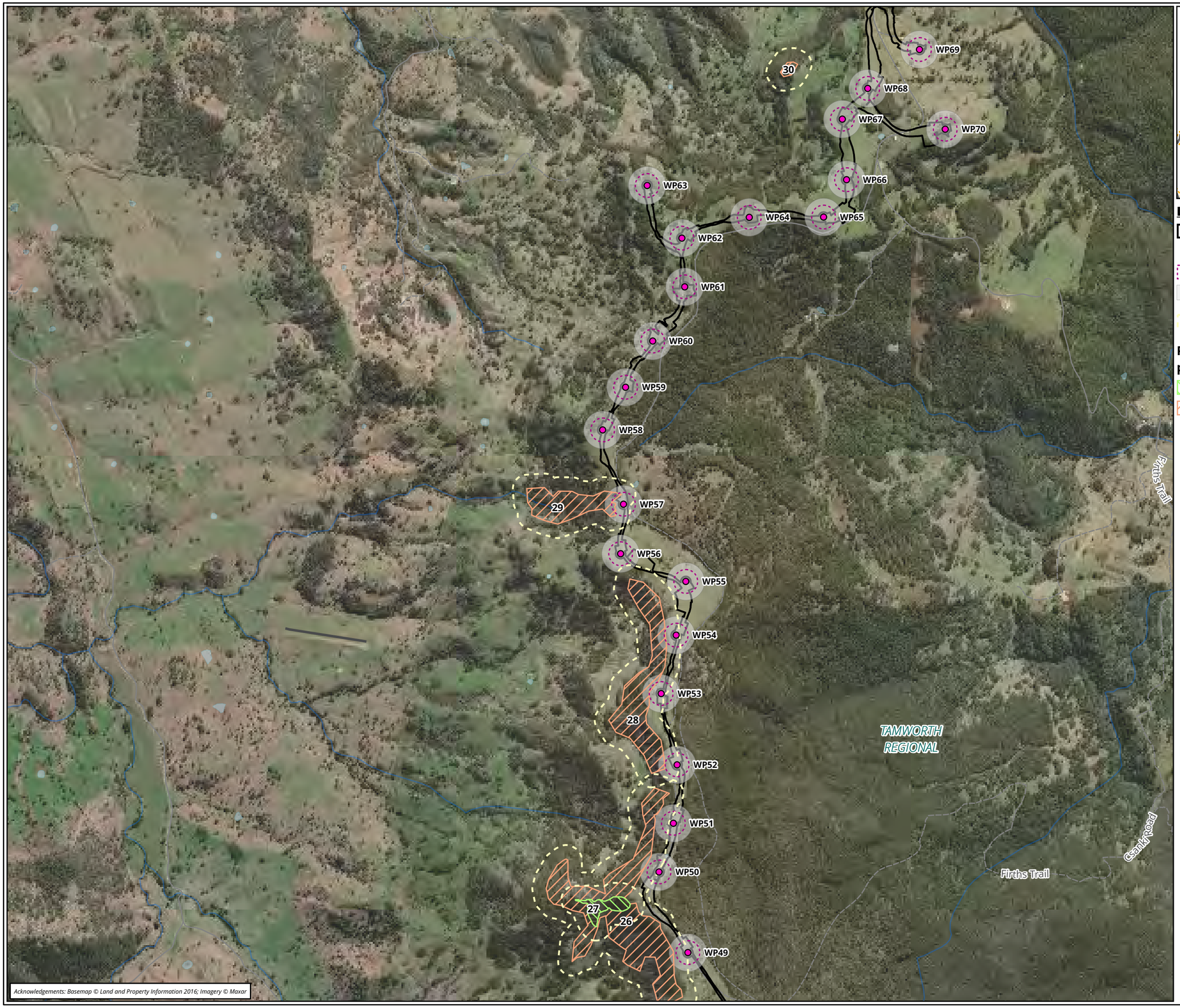
Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F15_PotentialBatHab
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx



Legend

- Infrastructure footprint
- Wind turbine locations
- Rotor swept area
- Zone of disturbance
- Potential microbat habitat 100m buffer

Potential microbat breeding habitat polygons

- Habitat
- Not habitat

Figure 15 Potential cave dwelling bat habitats with design and 100m buffer,
Page 4

0 250 500 750 1,000

Meters

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F15_PotentialBatHab
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

Photo 11 Area 27 potential microbat roost habitat

Photo 12 Area 18 potential microbat roost habitat (over crest of slope)

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Photo 13 Area 19 steep rocky slope not supporting microbat habitat

Photo 14 Area 01 steep slope not supporting microbat habitat

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Photo 15 Example of recent landslide east slope, not supporting microbat habitat

Photo 16 Example of recent landslide west slope, not supporting microbat habitat

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Photo 17 Area 26 (north) steep rocky slope not supporting microbat habitat

Geomorphology and Geology and Potential Microbat Roosting Habitat

To provide additional scientific advice on the likelihood of the project area and surrounding landscape to provide roosting and potential breeding habitat opportunities for microbats, a desktop geomorphological assessment was undertaken by Environmental Geosurveys Pty Ltd (Neville Rosengren, Geomorphologist and Honorary Associate La Trobe University). The full report (Environmental Geosurveys 2021) is attached as Appendix F of the BDAR.

The geomorphological assessment found the project area and surrounding landscape to comprise a diverse geological landscape formed in part by a range of volcanic activity resulting in the basalt lithology present at the development footprint. The occurrence of suitable microbat habitat was considered based on the potential presence and persistence of spaces in a coherent rock mass, or in accumulations of detached rock clasts. The extent to which either of these niches is present and suitable is a function initially of lithology and rock structure modified over time by geological and environmental processes that can increase or decrease the available space (Environmental Geosurveys 2021), with a diverse range of both inherent structures and secondary processes likely to occur in the broader landscape.

It was assessed that the likelihood for unreported caves within the vicinity of the development footprint, and specifically relating to previously mapped potential bat roost polygons, was low given the areas were not remote and there was generally good surface visibility, and that the potential roost sites in the wider area of basalt and other lithologies should be considered (Environmental Geosurveys 2021).

Within the surrounding basalt lithology, it was considered unlikely that large caverns such as those formed by dissolution of limestone at Timor and amygdaloidal basalt as at Coolah Tops have remained undetected. However, the extent of basalt exposure in valleys and at the margins of the several lava fields within flight range of microbats (conservative estimated as around 50-75 kilometres) means smaller cavities formed in this way may occur. Similarly, outcrops of fractured and weathered rock and downslope accumulations of blocky scree as potential habitat sites are also possibly widespread (Environmental Geosurveys 2021). This latter

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form of potential habitat is considered of lower likelihood to support microbat roots due to it being low to the ground and unlikely to provide bats with opportunities to fly into the habitat. Furthermore, the wide range of lithology within the estimated microbat flight range, including carbonate and close-bedded sandstone-mudstone units, have the inherent and secondary (weathering) properties to develop potential habitat opportunities (Environmental Geosurveys 2021).

It was found that the diverse terrain and lithology across the broader landscape, combined with dynamic geomorphology result in a high potential for microbat roosting sites to occur at all elevations within the expected flight range of mircobats potentially present within the project area. However, the undulating plateau and ridge terrain of the project area has no extended rock escarpments and limited outcropping of fractured basalt as vertical or inclined columnar structures. Detailed ground survey would be needed to define the extent of such outcropping, but the evidence from the available data lead to the conclusion that there is discontinuous and limited bat roost habitat in the immediate vicinity. Furthermore, no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in any way. (Environmental Geosurveys 2021).

The assessment found that in the immediate vicinity of the project area, outcrops of fractured basalt may provide localised habitat, However, the terrain and geology of this precinct provide limited opportunity for extensive habitat. While several large solution caverns in limestone and basalt occur in surrounding terrain, these are localised and there is a low probability that similar unreported large roost habitat sites occur. It is extremely unlikely there are basalt caverns of the dimension to accommodate a large bat colony. There is also a low possibility that unknown caves occur in the Devonian crystalline limestone, as these outcrops have been searched on several occasions (Allen et al. 1986, Environmental Geosurveys 2021).

The geomorphological assessment is considered to support the findings of the re-assessment of potential microbat roosting habitat within and immediately surrounding the development footprint. A diverse range of rocky outcropping was recorded during on-ground assessments, however few sites were of a size and structure suitable to support roosting bats. The broader landscape is considered highly likely to support a large range of bat roosting opportunities for the local bat populations, hence the high levels of microbat activity recorded as part of the current assessment. Due to this expected high availability of habitat in the landscape, there is no reason to suggest that bats are favouring the project area for roosting, and/or doing so in large numbers, and may well be present foraging over the higher ground, and intact vegetation on the slopes surrounding the project area.

This conclusion is supported by Biosis' senior microbat ecologist Mark Venosta (refer Section 1.9.2 for credentials). It is considered more likely that the bats utilising the habitats within and surrounding the development footprint are coming from a range of larger roosts elsewhere in the landscape, rather than a disproportionally large number of smaller roosts in the immediate vicinity of the project site. Based on this expectation, it is considered highly unlikely that the project would result in direct impacts to rocky roosting habitats, of a scale substantial enough to result in impacts to the local populations of microbat species. This is also supported by the detailed field assessment (referred to above) by Biosis ecologists undertaken in March-April 2021, which confirmed the presence of suitable rocky habitat features for roosting bats within just two of the thirty areas initially considered to provide potential roosting habitat. The total area assessed in the immediate vicinity of the development footprint comprised over 330 hectares of land considered of the highest likelihood for supporting potential cave roosting microbat habitat features (refer Figure 15).

Further supporting the assessment of high levels of available habitat in the broader landscape surrounding the project area, is in Table 46 provided by Environmental Geosurveys from local speleological groups (specifically academic and expert speleologist—Dr Susan White of La Trobe University), illustrating 14 known caves with microbats known to be present, in the Tamworth area.

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Table 46 Known bat caves in the Tamworth area

Cave Area	District	Cave Number	Cave Name	Significant number of bats	Occasional roosting
Kunderang Brook	East of Kempsey	2KB-1	Youdales Cave, Hut Cave	Yes	
-	-	2KB2	-		Yes
Timor (Incl. Isaacs Ck; Isis R; Allston)	Timor	2TR-2	Belfry Cave		Yes
-	-	2TR-4	Helictite Cave		Yes
Stockyard Creek	West of Kempsey	2SC-5	Carrai Bat Cave	Yes	
-	-	2SC-7		Yes	
-	-	2SC-9			Yes
Moparabah	West of Kempsey	2MP-1	Moparabah Cave; Main Cave	Yes	
Yessabah	WSW of Kempsey	2YE-1	Yessabah Bat Cave	Yes	
Willi Willi	West of Kempsey	2WW-1	Willi Willi Bat Cave	Yes	
-	-	2WW-4	Possum Cave	Yes	
Moore Creek	North of Tamworth	2MC-1	Moore Creek		Yes
Sulcor	North of Tamworth	2S-4	Bullock Hole		Yes

Note. Many of the locations of the above caves were not provided due to the regarded sensitivity of caves to the speleological groups who provided the information.

Whilst the presence of these caves in the broader Tamworth area illustrates the availability of habitat across the landscape, not all of the locations in the table above will be relevant to the subject land, and the local populations of microbat species. In the provided (Appendix F) advice Dr Susan White notes *pers. comm.* advice from Emmi van Harten regarding the need to assess the foraging range of microbats from major roosts to be 'at least' 75 kilometres, which has informed the list of caves provided. Whilst this may be true for some species, particularly the Southern Bent-wing Bat *Miniopterus orianae bassanii*, on which Emmi van Harten is a recognised expert, this is not the case for all cave roosting bats. Eastern Cave Bat, for example, is known to forage only over small areas over consecutive nights, and are noted as being capable of flying 500 m over cleared land (Churchill 2008).

Based on the above, the occurrence of high potential cave dependent microbat habitat within and/or immediately surrounding the development footprint, additional to that confirmed as present during the recent field investigation, is considered low, and that this habitat is likely to be present throughout the broader landscape. As such direct impacts to a significant or substantial portion of the local populations of microbat species as a result of the project is considered unlikely. Indirect impacts associated with potential turbine strike and barriers to movement and habitat accessibility are discussed further in Section 8.3 and Section 8.5.

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Greater Glider

The Greater Glider is listed as Vulnerable under the EPBC Act and is not a listed species under the BC Act. It is the largest gliding possum in Australia, with a head and body length of 35 – 46 centimetres, and a tail measuring 45 – 60 centimetres (Menkhorst & Knight 2011). The species is arboreal and nocturnal and is mostly restricted to eucalypt forests and woodlands. It is typically found in highest abundance in tall, montane and moist eucalypt forests with old trees and abundant hollows. The species favours forests with a diversity of eucalypt species, due to the seasonal variation in its preferred tree species. During the day Greater Glider shelters in tree hollows, particularly those that are in large, old trees (McKay 2008).

The Greater Glider occurs in eastern Australia, from the Windsor Tableland in north Queensland through to central Victoria. The broad extent of occurrence is unlikely to have changed substantially since European settlement, however the area of occupancy has decreased substantially, mostly due to land clearing (Threatened Species Scientific Committee 2016). This decline is most likely continuing due to further land clearing, fragmentation, fire and forestry activities. The species is considered to be particularly sensitive to forest clearance, logging and fire, and is slow to recover following major disturbance. The species is also considered to be sensitive to fragmentation due to a low dispersal ability, previously showing low persistence in small forest fragments (Threatened Species Scientific Committee 2016).

Twenty-five Greater Gliders were recorded within the development footprint during targeted surveys in the current assessment (Biosis 2019). Previous records of the species are also scattered throughout the adjacent Ben Halls Gap Nature Reserve (EES 2020). As Greater Glider tend to have relatively small home ranges (1 – 4 ha), for the purposes of this assessment, these records throughout the development footprint and adjacent reserve make up the 'local population'. Nationally, there are no officially recognised 'important populations' of Greater Glider. However, in NSW there are three specific populations listed as Endangered under the BC Act (EES 2020). These are the populations of the Eurobodalla LGA, Mount Gibraltar Reserve, and Seven Mile Beach National Park which are remote from the Project. It is not considered that the local population addressed in this assessment makes up an important population of the species. Further assessment of impacts to Greater Glider are provided in Section 8.8.5.

Approximately 35.48 hectares of Greater Glider habitat is proposed to be removed from the development footprint as a part of the current project. This encompasses eucalypt woodland, and the associated hollow-bearing trees throughout. The impacts to Greater Glider habitat are also predominantly to smaller patches of fragmented suitable habitat on the wind farm infrastructure sections of the development footprint, and no large contiguous patches of habitat will be impacted.

Koala

Koala is listed as Vulnerable under the Commonwealth EPBC Act and the NSW BC Act. It occurs from north-east Queensland to South Australia, including parts of NSW. A rapid decline in the number of individuals has been seen since European settlement, primarily due to a reduction in available good quality vegetation with appropriate canopy species suitable for supporting the species (DECC 2008).

The development footprint is located within the Northern Tablelands Koala Management Area (KMA), and the proposed works include the removal of a total of 132.4 hectares of native vegetation, composed of various forms of eucalypt forest. Of this, approximately 36.4 hectares is considered to be Koala habitat as defined using the BAM method for mapping species polygons, encompassing multiple PCTs.

Within 10 kilometres of the development footprint, the species has been recorded seven times (EES 2020), with an additional three individuals recorded within the development footprint during the current field assessment (consisting of a mother and joey during spotlighting surveys, and a mature individual on camera trap). The closest previous records of Koala occur within Ben Halls Gap Nature Reserve, which is east of, and contiguous with, the development footprint. Hanging Rock State Forest, Nundle State Forest, and Tomalla

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State Forest and Nature Reserve all lie within 20 kilometres of the development footprint and contain scattered Koala records throughout (EES 2020). For the purposes of this assessment the definition of "the population" encapsulates all contiguous areas of Koala habitat into a singular spatial unit.

Photo 18 Koala recorded on arboreal camera trap

The results of the Koala SAT survey indicate that there is a low level of Koala activity across the site. Eight of the eleven SAT surveys had no scats recorded around the 30 surveyed trees, two SATs recorded scats around two trees and one SAT recorded 6 scats. This level of koala activity is consistent with the known population dynamics of Koalas in central NSW, with lower levels in drier areas. The escarpment where the wind farm is located is likely to support higher koala numbers than the transmission line corridor due to the higher soil nutrients and preferred koala food trees.

Phillips and Callaghan (2011) note that low levels of Koala activity assessed using the SAT method can also indicate that Koala use of the site may be transitory or a result of a naturally low density population.

As Koala is listed under the EPBC Act and, as the proposed works include potential impacts to this species, an assessment against the Significant Impact Criteria detailed in the Matters of National Environmental Significance: Significant impact guidelines version 1.1 (Commonwealth of Australia 2013) has been undertaken in this BDAR.

Spotted-tailed Quoll

Spotted-tailed Quoll is listed as Endangered under the Commonwealth EPBC Act and Vulnerable under the NSW BC Act. It occurs across south-east Queensland, eastern NSW, Victoria, south-east South Australia and Tasmania (Jones 2001). The subspecies' mainland range is now considered to have reduced by 50–90% (Jones 2001). However, detailed distribution records and abundance estimates are generally lacking due to the scale and intensity of surveying that is required to detect the species across its entire range (DAWE 2016).

The Spotted-tailed Quoll has previously been recorded within and adjacent to the development footprint. In 2019 a roadkill individual was located within the Ben Halls Gap State Forest adjacent the development footprint, and another individual was recorded on a camera trap within the development footprint. Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve all lie within 20

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kilometres of the development footprint and contain scattered previous Spotted-tailed Quoll records throughout (EES 2020).

Potential Spotted-tailed Quoll habitat occurs throughout the development footprint in the form of eucalypt woodland, rocky outcrops, caves, logs and tree hollows. Spotted-tailed Quoll was recorded twice during targeted remote camera surveys as part of the current assessment. As such approximately 40.67 hectares of Spotted-tailed Quoll habitat has been identified within the development footprint which will be removed as part of the proposed works. This habitat is comprised of the PCTs identified in BioNet, assessed as having high and moderate condition levels.

As Spotted-tailed Quoll is listed as Endangered under the EPBC Act and, as the proposed works include potential impacts to this species, an assessment against the Significant Impact Criteria detailed in the Matters of National Environmental Significance: Significant impact guidelines version 1.1 (Commonwealth of Australia 2013) has been undertaken in this BDAR.

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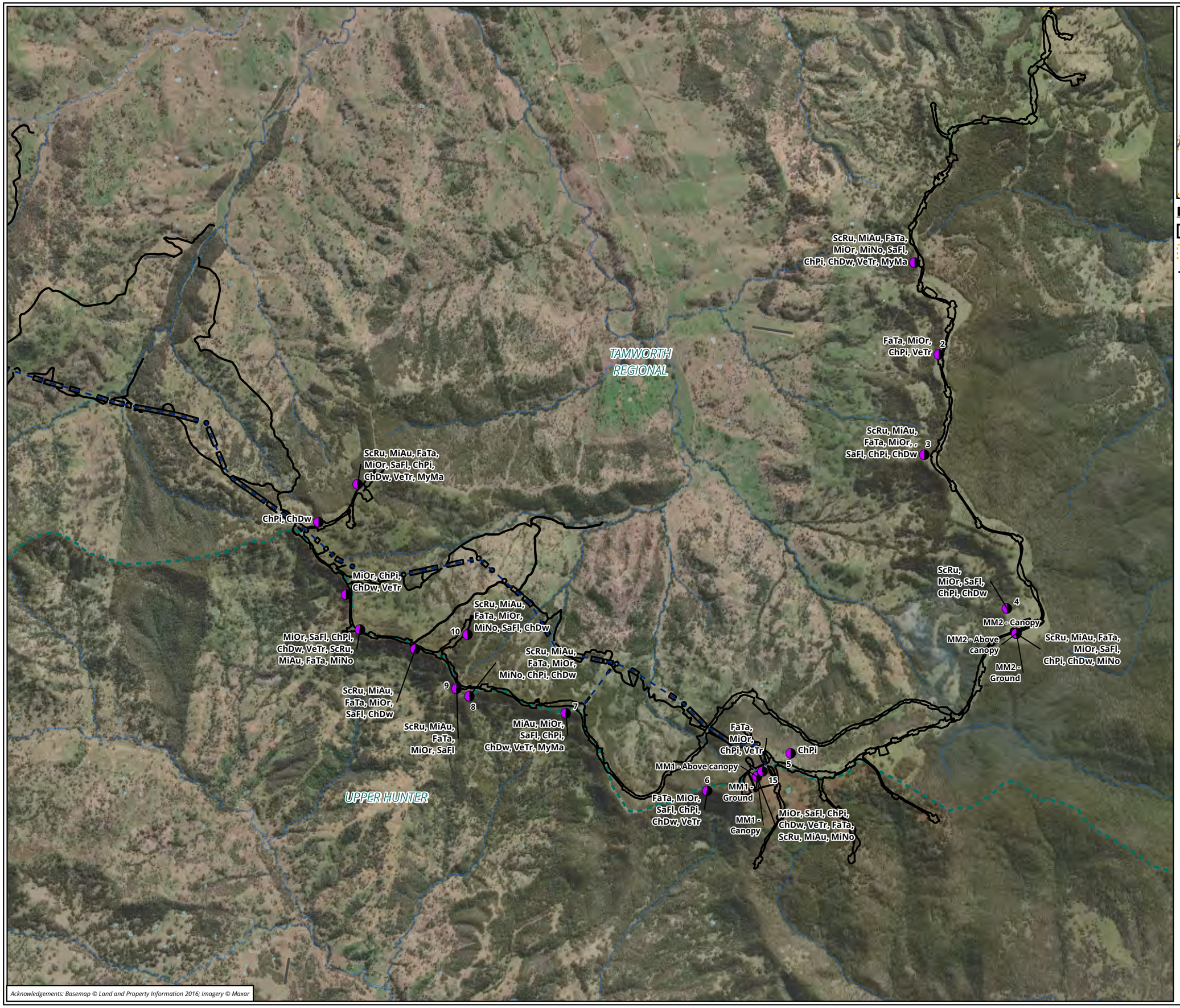
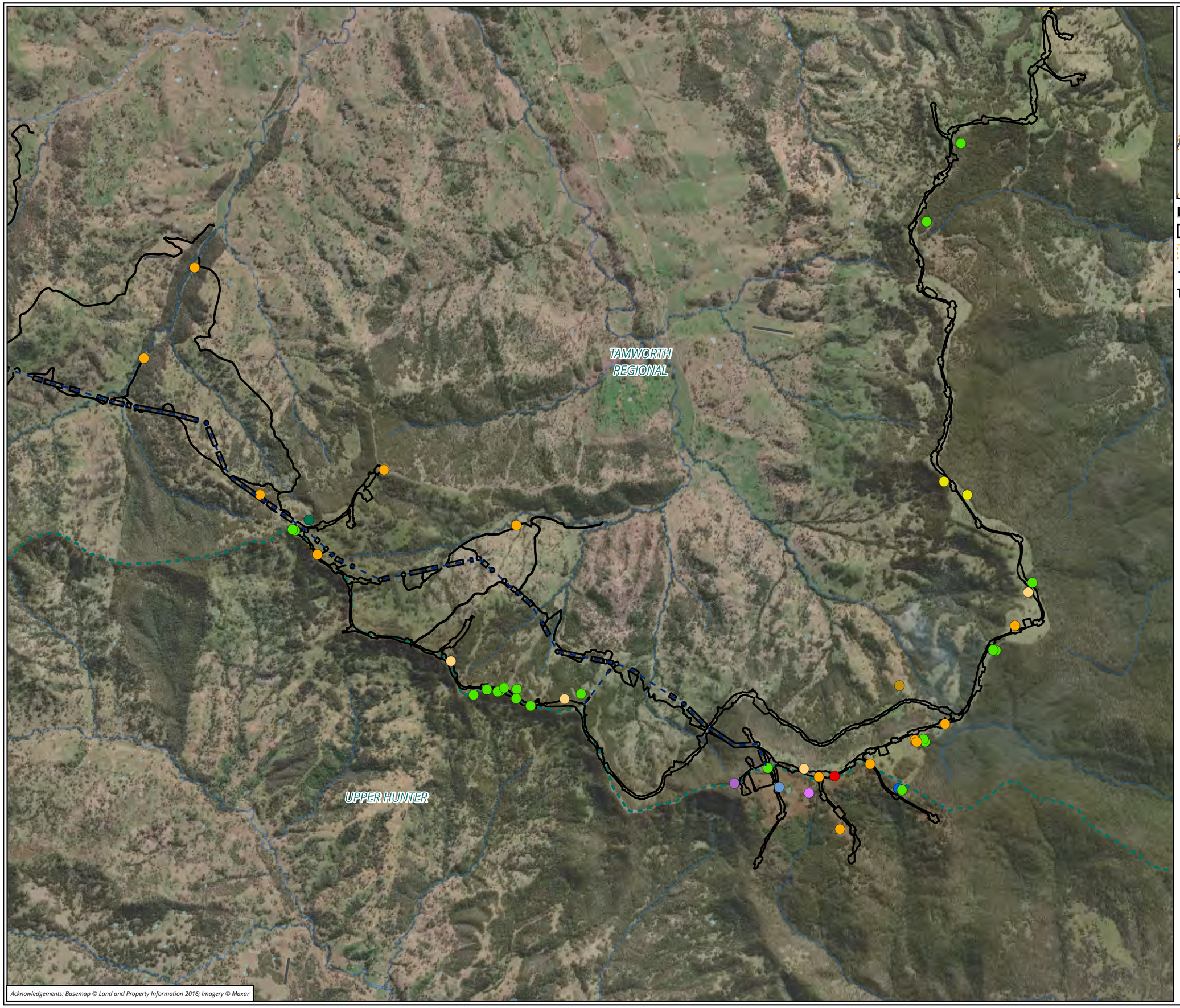


Figure 16 Threatened fauna and raptors recorded during field survey

Matter: 34963,
Date: 10 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F16_ThrFaunaRecorded
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx



Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line

Threatened fauna and raptors

- Australian Hobby
- Black Kite
- Flame Robin
- Greater Glider
- Grey-headed Flying-fox
- Koala
- Large-eared Pied Bat
- Southern Myotis
- Spotted-tailed Quoll
- Wedge-tailed Eagle
- Yellow-bellied Sheathtail-bat

Figure 16 Threatened fauna and raptors recorded during field survey

0 500 1,000 1,500 2,000

Meters

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 05 November 2021 ,
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5.5 Threatened fauna habitat polygons

According to the BAM, impacts to threatened fauna species must be calculated according to the area of suitable habitat identified by the species polygon. For dual credit species, only the breeding habitat for the species is to be mapped. For full credit species, both foraging and breeding habitats need to be included in any species polygons.

A detailed assessment of the mapped fauna habitat for threatened species listed under the BC Act is provided in Table 47 and mapped in Figure 17 to Figure 21.

Habitat polygons have been developed based on a combination of targeted field surveys, ground-validated habitat assessments, and species' habitat requirements based on published literature and the TBDC. Preparing species polygons in this manner was undertaken to ensure the use information available for each species; such as PCT associations, habitat parameters where they can be justified based on BioNet or published, peer-reviewed literature, habitat assessments, and targeted surveys; was adequately included to ensure species polygons that are as accurate and meaningful as possible. The approach was undertaken considering Section 6.1.1.2 of the BAM, which specifies that:

'An assessor may use additional information about a threatened species, in BioNet (e.g. the profile of a threatened species) or published, peer reviewed literature, when assessing the habitat suitability of a site'

Koala, Eastern Pygmy Possum, and Squirrel Glider species polygons, were developed based on a combination of on-ground fauna habitat assessments undertaken across the entire wind farm corridor, and the results of targeted surveys undertaken for all three of these species. Whilst Koala was confirmed as present within the project area, Eastern Pygmy-possum and Squirrel Glider were not recorded despite 11 nights of nocturnal surveys over five separate events and up to 1009 trap nights from arboreal camera traps.

Due to the large size and linear nature of the project area, areas of potential habitat for these species occur adjacent to the development footprint. As such the presence of Eastern Pygmy-possum and Squirrel Glider was not considered to be conclusively excluded, despite the high level of survey undertaken, and the species not being recorded. The species' presence was instead conservatively assumed, with this assumption of presence relating to the areas of optimal habitats only, justified by the lack of detection of the species during the targeted survey effort. In order to determine areas of optimal habitat for each species the data collected during on-ground habitat assessments was used to refine the species' habitat polygons, this data related to the presence (or lack thereof) of habitat features such as high condition vegetation, characteristic feed trees, abundant tree hollows, and levels of human disturbances.

Habitat polygons for Koala were also refined on the basis of these on-ground habitat assessments, with areas considered as less suitable habitat excluded. Such areas comprised substantially rocky areas less likely to be traversed by the species, and areas of significant human disturbance.

Owl species habitat polygons were refined on the basis of the Large Forest Owl Recovery Plan (DEC 2006) that states Powerful Owl and Sooty Owl optimal breeding habitat occurs in unlogged, unburnt gullies and lower slopes. BioNet also makes this point for Masked Owl, and notes that the species breeds in moist eucalypt forested gullies. Barking Owl has an affinity for roosting near watercourses, which in the context of the project area are again associated with forested gullies. It should be noted that survey to date has not detected any evidence of these species, and that a commitment has been made to undertake further surveys for relevant owls with a hollow bearing tree inventory prior to construction. If breeding owls are located on site during these surveys, or >20cm hollows determined to be impacted, then compensatory measures in accordance with the BAM would be determined and retired, as per the an unexpected finds procedure incorporated into the Biodiversity Management Plan. Further details are provided in Section 8.10.1.

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Table 47 Approach to estimating impacts for species credit species

Species credit species	Survey status	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
Large-eared Pied Bat	Recorded	The species is a full species credit because it cannot be reliably predicted to occur on a site based on vegetation and other landscape features (either foraging or breeding). Potential breeding habitat is PCTs associated with the species within 100m of rocky areas containing caves, or overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict concrete buildings. Surveys must be undertaken as per the Threatened Bat Survey Guide to confirm breeding habitat. Species mapping polygon for breeding habitat must use high resolution aerial imagery and topographic maps to identify features on the subject land (caves, scarps, cliffs etc.). Polygon must be at least 100m wide (or 50m radius for point locations such as caves) with the breeding habitat features (may be multiple) as the centroid (see Threatened Bat Survey Guide). All breeding habitat on or within 100m of the subject land and the area immediately surrounding the feature must be identified. All habitat on the subject land should also be mapped if present. Use high resolution aerial imagery and topographic maps to identify potential roost habitat features on the subject land within 2km caves, scarps, cliffs etc. Species polygon boundary should align with PCTs on the subject land to which the species is associated that are within 2km of identified potential roost habitat features.	Species polygons for 'Forage habitat' include PCTs associated with the species in the BioNet database, in moderate and high condition states, where they occur within 2km of confirmed potential microbat breeding habitat, and/or within 2km of Mount Royal Tops soil landscape (Mitchell 2002). All impacted native vegetation in the development footprint within the buffer areas is captured. Cave bat habitat polygons are mapped in Figure 17.
Eastern Cave Bat	Recorded	The species is a full species credit because it cannot be reliably predicted to occur on a site based on vegetation and other landscape features (breeding or foraging). Potential breeding habitat is PCTs associated with the species within 100m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within the potential habitat. Surveys must be undertaken as per	Species polygons for 'Forage habitat' include PCTs associated with the species in the BioNet database, in moderate and high condition states, where they occur within 2km of confirmed potential microbat breeding habitat, and/or within 2km of Mount Royal Tops soil landscape (Mitchell 2002). All impacted native vegetation in the development

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Species credit species	Survey status	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
		the Threatened Bat Survey Guide to confirm breeding habitat. All breeding habitat on or within 100m of the subject land and the area immediately surrounding the feature must be mapped. Artificial structures should be inspected and included on the map if the species is using these features for breeding. All habitat for this species should also be mapped if present. Species mapping polygon for breeding habitat must use high resolution aerial imagery and topographic maps to identify features on the subject land (caves, scarps, cliffs etc). Polygon boundaries must be at least 100m wide (or 50m radius for point locations such as caves) with the breeding habitat features (may be multiple) as the centroid (see Threatened Bat Survey Guide). When the species is present on the subject land and the proposed impact is not a potential SAII, standard species credits will be generated. All habitat on the subject land where the subject land is within 2km of caves, scarps, cliffs, rock overhangs and disused mines must be mapped. Use high resolution aerial imagery and topographic maps to identify potential roost habitat features on the subject land within 2km caves, scarps, cliffs etc. Species polygon boundary should align with PCTs on the subject land to which the species is associated that are within 2km of identified potential roost habitat features.	footprint within the buffer areas is captured. Cave bat habitat polygons are mapped in Figure 17.
Southern Myotis	Recorded	The species was allocated to species credit because it is dependent on waterways with pools of 3m wide or greater for foraging (which will be protected under legislation), habitat surrounding waterways is used for breeding and roosting. All habitat on the subject land where the subject land is within 200m of a waterbody with pools/ stretches 3m or wider including rivers, creeks, billabongs, lagoons, dams and other waterbodies on the subject land must be mapped. Use aerial imagery to map	Dams more than 3m wide were mapped and a 200m buffer applied. All PCTs within the development footprint forming habitat associations for the species, as listed in the BioNet database, were included within the habitat polygons where they were located with 200m of the dams. No waterways >3m wide were identified. Habitat polygons for Southern Myotis are mapped in Figure 18.

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Species credit species	Survey status	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
		waterbodies with pools/ stretches 3m or wider on or within 200m of the subject land. Species polygon boundaries should align with PCTs on the subject land to which the species is associated that are within 200m of waterbodies mapped.	
Koala	Recorded	No specific guidance is provided on how to derive habitat polygons for the species.	Habitat polygons include impacted areas of the species' associated PCTs within the development footprint, as listed in BioNet, and mapped in moderate and high condition states. Field captured habitat assessments were used to refine the polygons, with the following characteristics excluded: Areas supporting >50% rock outcropping Areas mapped as being subject to high severity clearing of the tree canopy Habitat polygons for Koala are mapped in Figure 19.
Eastern Pygmy-possum	Assumed present	Based on BioNet, there are no habitat constraints for these species other known PCT habitat associations.	Habitat polygons include impacted areas of the species' associated PCTs within the development footprint as listed in BioNet and mapped as in 'High" condition. Field captured habitat assessments were used to refine the polygons, with the following characteristics excluded: Areas supporting <5% characteristic understorey feed species Areas mapped as not supporting any tree hollows Areas mapped as being subject to high severity clearing of the tree canopy Areas mapped as being subject to highly or moderately severe agriculture impacts such as cropping, grazing, exotic pasture, soil disturbance. Habitat polygons for Eastern Pygmy Possum are mapped in Figure 19.

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Species credit species	Survey status	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
Squirrel Glider	Assumed present	No specific guidance is provided on how to derive habitat polygons for the species.	Habitat polygons include impacted areas of the species' associated PCTs, as listed in BioNet, and mapped in Moderate and High condition within the development footprint. Field captured habitat assessments were used to refine the polygons, with the following characteristics excluded: Areas supporting <5% characteristic understorey feed species Areas mapped as not supporting any tree hollows Areas mapped as being subject to high severity clearing of the tree canopy Areas mapped as being subject to high severity agriculture impacts such as cropping, grazing, exotic pasture, soil disturbance. Furthermore, areas where sufficient survey in the form of arboreal camera trapping has been undertaken for the species have been removed from the habitat polygons (as the species was not recorded). Areas retained are considered to have undergone less intensive survey and include the central-southern portion of the wind farm corridor, due to camera traps being burnt in bushfire in this area, and along the transmission line corridor, where nocturnal surveys did not occur. Habitat polygons for Squirrel Glider are mapped in Figure 19.
Border Thick-tailed Gecko	Assumed present	Based on BioNet, there are no habitat constraints for this species other known PCT habitat associations.	Habitat polygons include impacted areas of the species' associated PCTs as listed in BioNet, and mapped in Moderate and High condition states, where they are associated rocky areas mapped in the development footprint as potentially suitable to support the species,

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Species credit species	Survey status	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
			and within the species' known elevation range of 500 - 1000m altitude. Habitat polygons for Border Thick-tailed Gecko are mapped in Figure 20.
Booroolong Frog	Assumed present	No specific guidance is provided on how to derive habitat polygons for the species.	Habitat polygons include areas within the development footprint of native vegetation in High and Moderate condition where they occurred within a 40m riparian buffer from Wombramurra Creek (centreline/hydroline). PCTs not listed in the BioNet database as associated with the species were also included in the habitat polygons due to the presence of a high density of records in the area and the known SOS population along the creekline. A 40m buffer was selected as it represents the BAM riparian buffer for a 5th order watercourse, which Wombramurra exists as in this location. Habitat polygons for Booroolong Frog are mapped in Figure 20.
Barking Owl	Assumed present	Where any known nest trees occur on site (e.g. known from existing data, studies or other documented evidence), a species polygon providing a circular buffer with a 100 m radius should be drawn around the known nest trees. As nest trees have not been recorded, and the species is assumed as present, the following guidance has been used in determining the location and extent of species polygons. The species typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands (NPWS 2006). The species seems most abundant in the largest remnants but also occurs at low density in fragmented habitat, where it uses healthy riparian woodland or gallery forest amid extensive, diverse woodland supporting a diversity of native prey. (Debus 2001). Sometimes able to successfully breed along timbered	Timbered watercourses in deep gullies within and surrounding (within 100m) the development footprint was manually reviewed using high-definition aerial imagery, LiDAR data, and topographical contour lines, to selected potential locations for breeding habitat. Mapped hydroline features present within potential gully habitat were used to create a 100m buffer, within which all native vegetation was selected, and included within the species polygon. Habitat polygons for Barking Owl are mapped in Figure 21.

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Species credit species	Survey status	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
		watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey found on these fertile riparian soils. (BioNet 2021b). It was also noted that Barking Owl habitat has a strong spatial association with hydrological features such as rivers and wetlands (Taylor & Kirsten 1999).	
Powerful Owl	Assumed present	Where any known nest trees occur on site (e.g. known from existing data, studies or other documented evidence), a species polygon providing a circular buffer with a 100 m radius should be drawn around the known nest trees. Species known to breed in old hollow eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines (DEC 2006).	Timbered watercourses in deep gullies within and surrounding (within 100m) the development footprint was manually reviewed using high-definition aerial imagery, LiDAR data, and topographical contour lines, to selected potential locations for breeding habitat. Mapped hydroline features present within potential gully habitat were used to create a 100m buffer, within which all native vegetation was selected, and included within the species polygon. Habitat polygons for Powerful Owl are mapped in Figure 21.
Masked Owl	Assumed present	Where a breeding site has been identified in accordance with the BAM the species polygon should be established by providing a circular buffer with a 100m radius around the nest tree. Species known to breed in old hollow eucalypts, live or dead but commonly live, in a variety of topographic positions from gully to upper slope, with hollows greater than 40 cm wide and greater than 100 cm deep; there is no relationship with distance to streams. (DEC 2006). Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. Lives in dry eucalypt forests and woodlands from sea level to 1100 m. (BioNet 2021a).	Deep gullies within and surrounding (within 100m) the development footprint was manually reviewed using high-definition aerial imagery, LiDAR data, and topographical contour lines, to selected potential locations for breeding habitat. Mapped hydroline features present within potential gully habitat were used as the centreline of the gully to create a 100m buffer, within which all native vegetation was selected, and included within the species polygon. Sections of the habitat polygons above an elevation of 1100m were removed. Habitat polygons for Masked Owl are mapped in Figure 21.

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Species credit species	Survey status	BioNet and OEH (2018) guidance on species polygon extent	Approach to assessment of impacts
Sooty Owl	Assumed present	Where a hollow bearing tree has been identified as a breeding site in accordance with the BAM the species polygon should be established by providing a circular buffer with a 100m radius around the nest tree. Old hollow trees, eucalypt or rainforest species usually live but stags are occasionally used, in unlogged, unburnt gullies and lower slopes within 100 m of streams, with hollows greater than 40 cm wide and greater than 100 cm deep; surrounded by canopy trees. (DEC 2006) Also nests in caves.	Timbered watercourses in deep gullies within and surrounding (within 100m) the development footprint was manually reviewed using high-definition aerial imagery, LiDAR data, and topographical contour lines, to selected potential locations for breeding habitat. Mapped hydroline features present within potential gully habitat were used to create a 100m buffer, within which all native vegetation was selected, and included within the species polygon. Habitat polygons for Sooty Owl are mapped in Figure 21.

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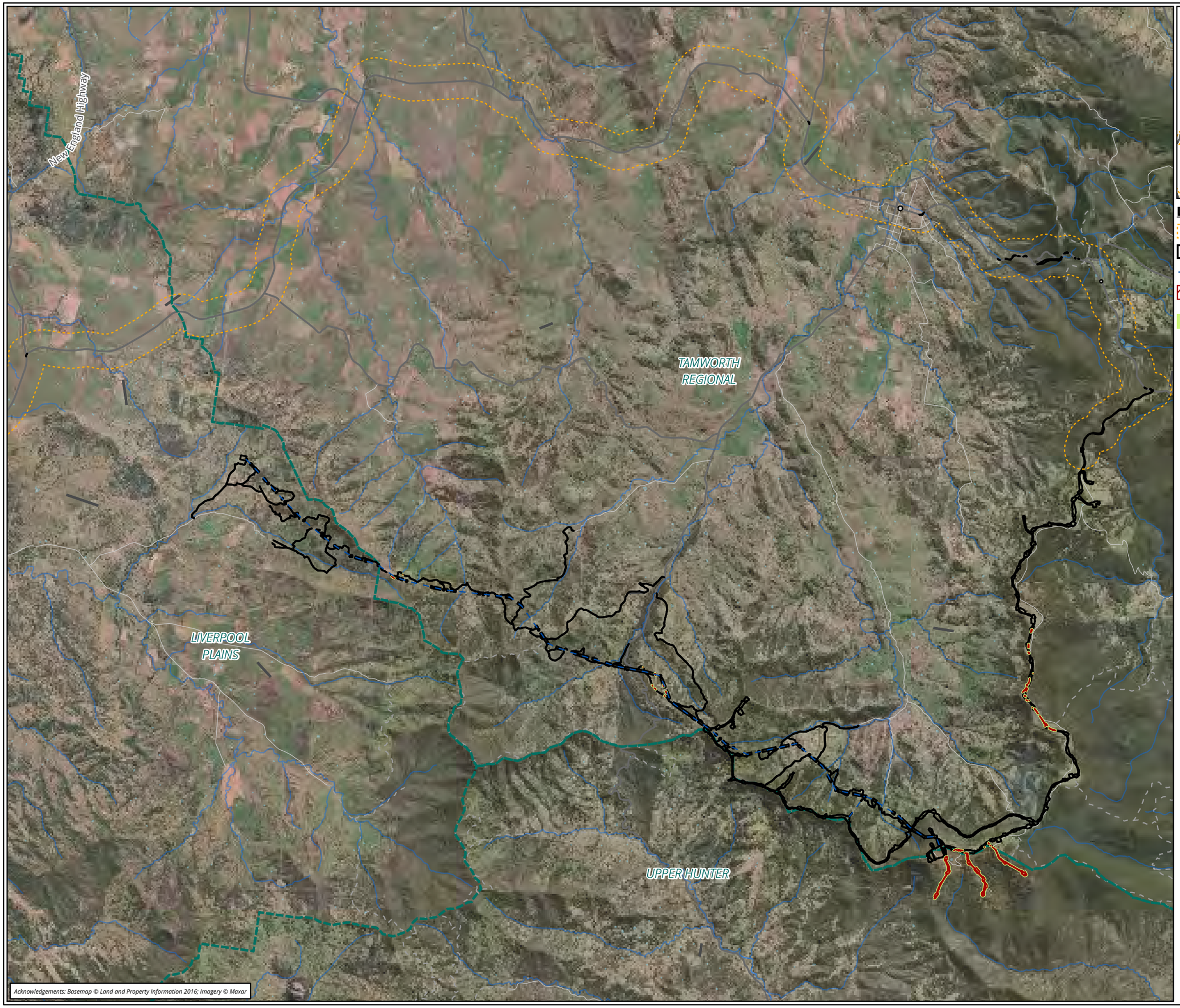

Legend

- Transport haul routes
- Infrastructure footprint
- Transmission line
- Eastern Cave Bat (forage habitat)
- Large-eared Pied Bat (forage habitat)

Figure 17 Cave bat habitat polygons, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F17_BatHabitat
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

Legend

- Transport haul routes
- Infrastructure footprint
- Transmission line
- Eastern Cave Bat (forage habitat)
- Large-eared Pied Bat (forage habitat)

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Figure 17 Cave bat habitat polygons, Page 2

0 50 100 150 200

Meters

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
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Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

Legend

- Transport haul routes
- Infrastructure footprint
- Transmission line
- Eastern Cave Bat (forage habitat)
- Large-eared Pied Bat (forage habitat)

Figure 17 Cave bat habitat polygons, Page 3

0 50 100 150 200

Meters

Scale: 1:5,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Date: 05 November 2021 ,
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Figure 17 Cave bat habitat polygons, Page 4

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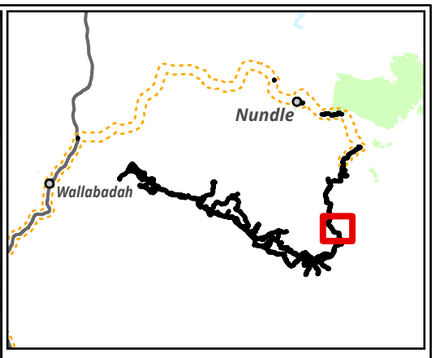

Legend

- Transport haul routes
- Infrastructure footprint
- Eastern Cave Bat (forage habitat)
- Large-eared Pied Bat (forage habitat)

Figure 17 Cave bat habitat polygons, Page 5

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F17_BatHabitat
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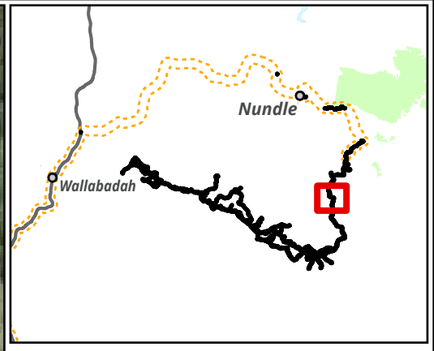

Legend

- Transport haul routes
- Infrastructure footprint
- Eastern Cave Bat (forage habitat)
- Large-eared Pied Bat (forage habitat)

Figure 17 Cave bat habitat polygons, Page 6

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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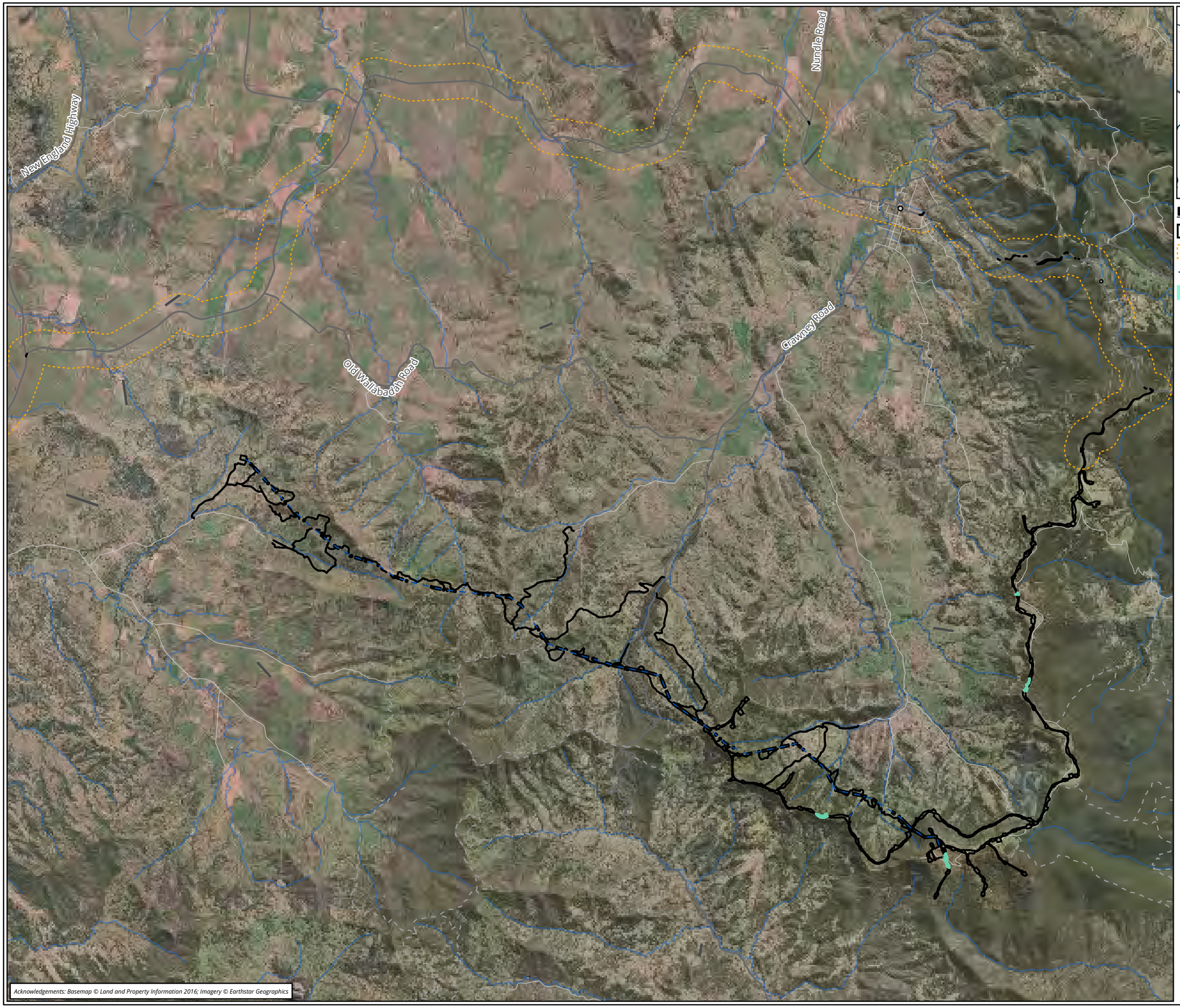

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Southern Myotis

Figure 18 Southern Myotis habitat polygons,
Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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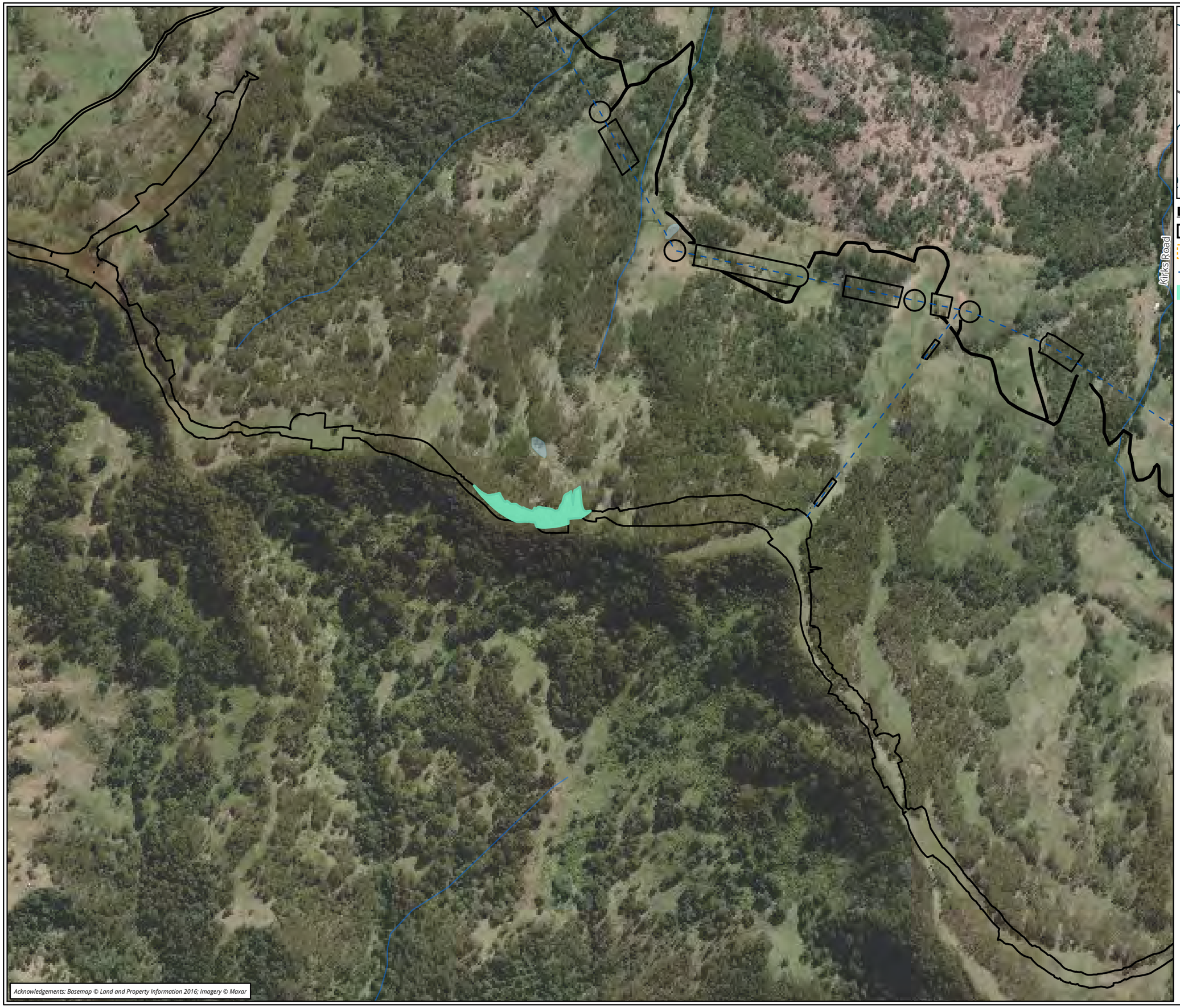

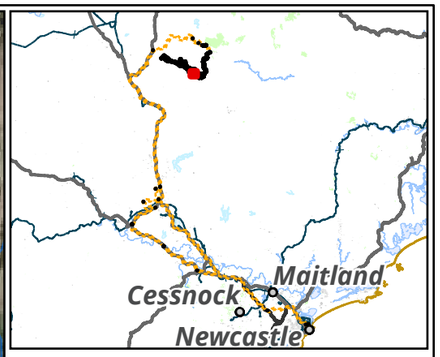

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Southern Myotis

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Figure 18 Southern Myotis habitat polygons,
Page 2

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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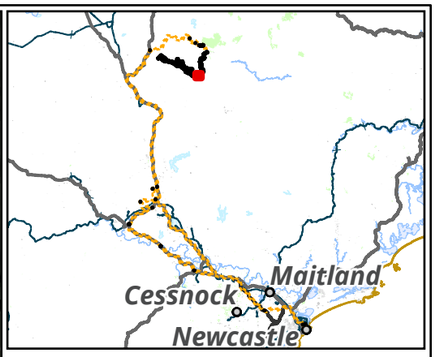

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Southern Myotis

Figure 18 Southern Myotis habitat polygons, Page 3

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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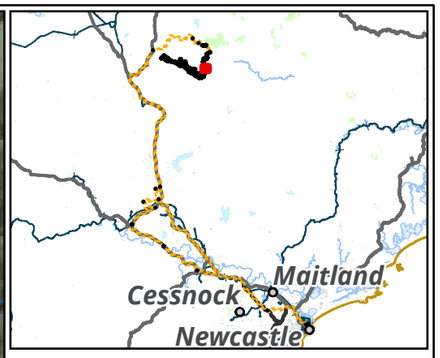

Legend

- Infrastructure footprint
- Transport haul routes
- Southern Myotis

Figure 18 Southern Myotis habitat polygons,
Page 4

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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biosis

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Legend

- Infrastructure footprint
- Transport haul routes
- Southern Myotis

Figure 18 Southern Myotis habitat polygons,
Page 5

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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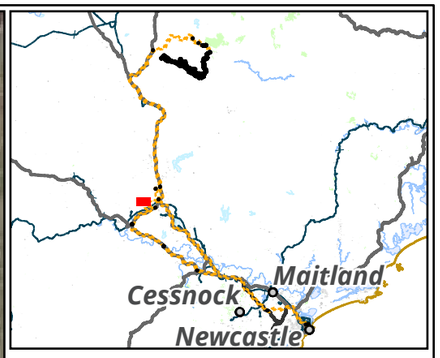

Legend

- Infrastructure footprint
- Transport haul routes
- Southern Myotis

Figure 18 Southern Myotis habitat polygons,
Page 6

0 20 40 60 80

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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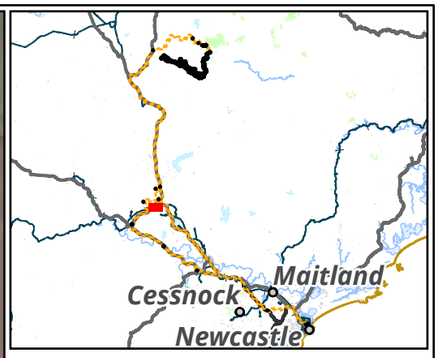

Legend

- Infrastructure footprint
- Transport haul routes
- Southern Myotis

Figure 18 Southern Myotis habitat polygons,
Page 7

0 20 40 60 80

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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biosis

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Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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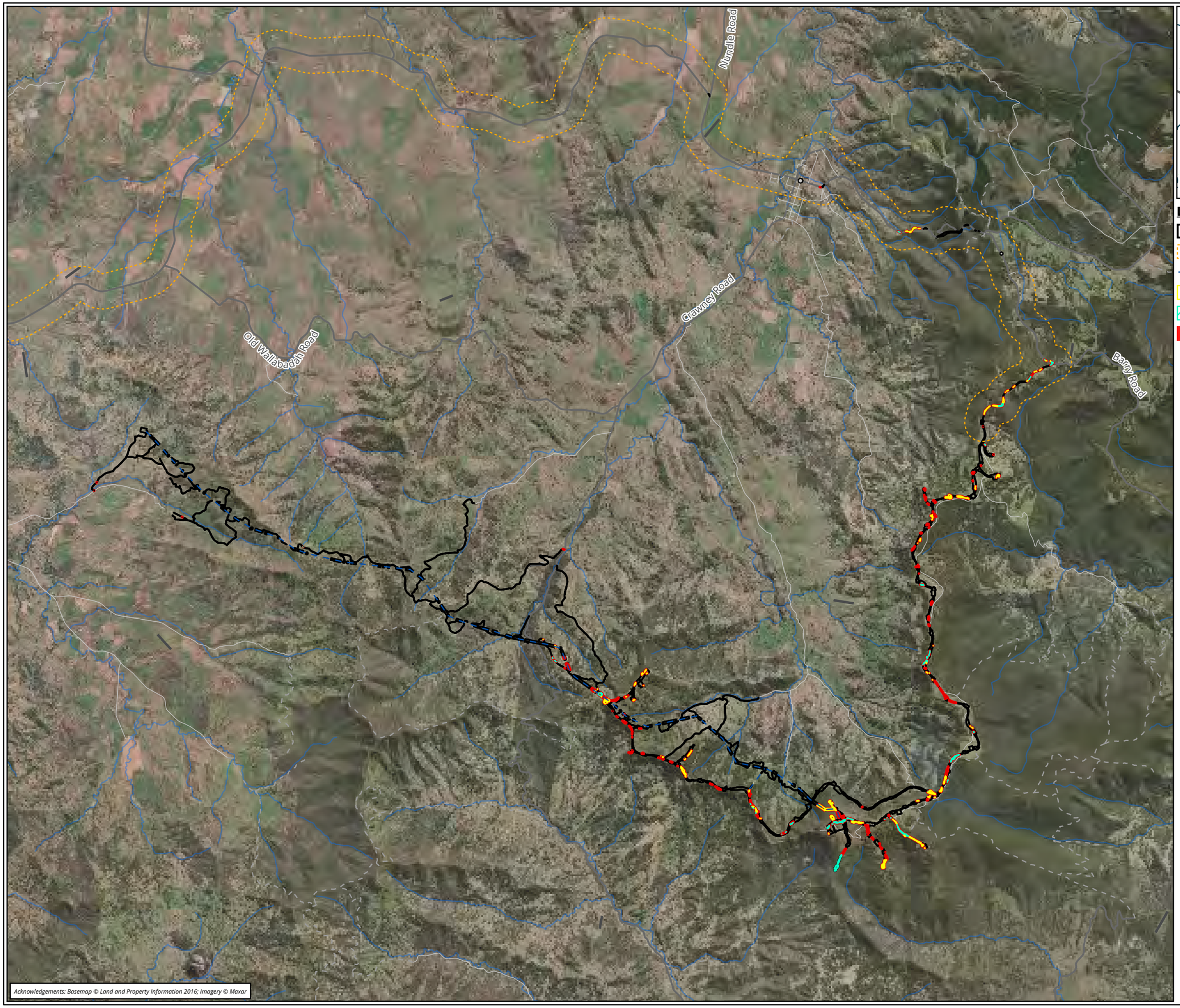

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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biosis

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Date: 05 November 2021 ,
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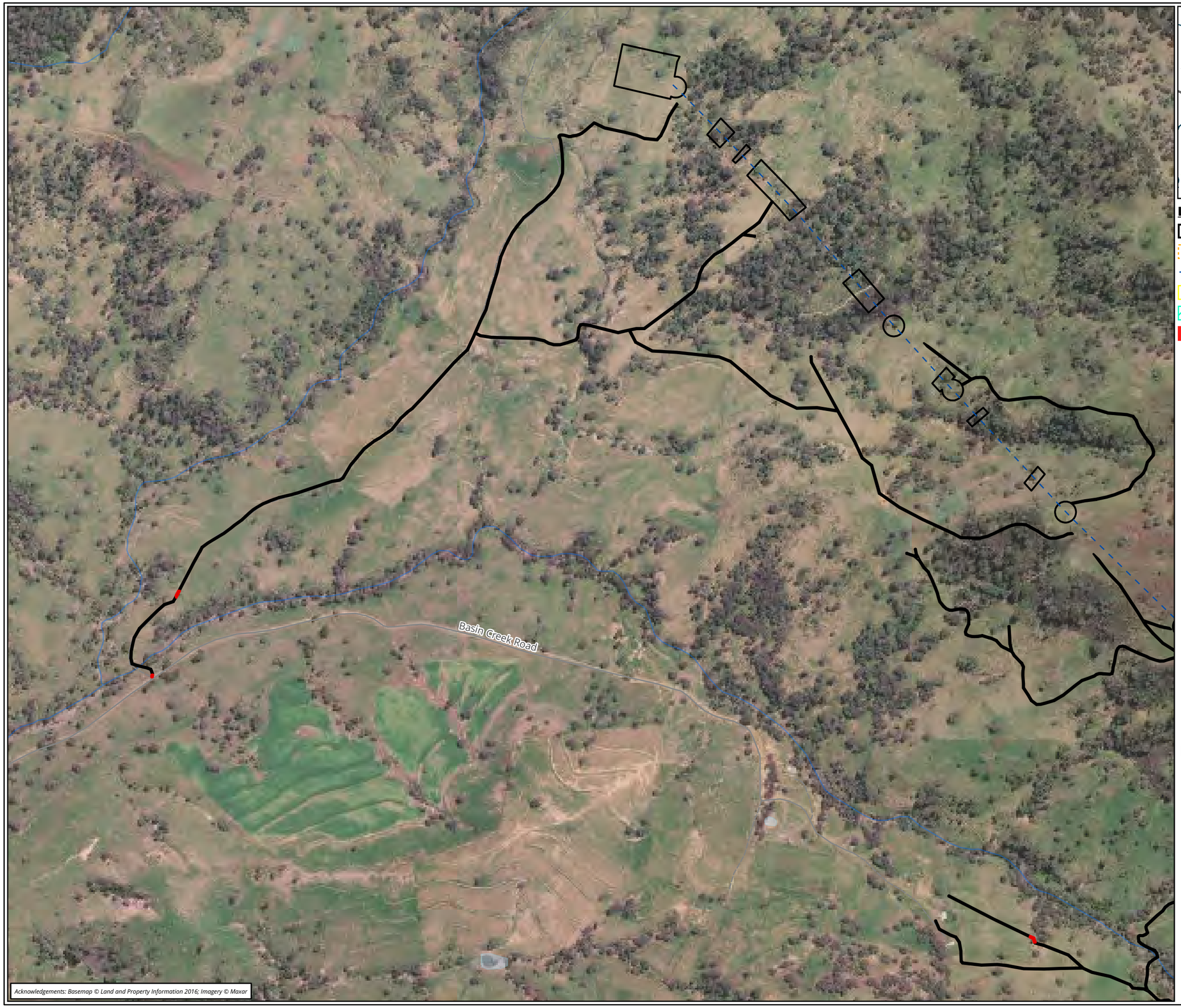

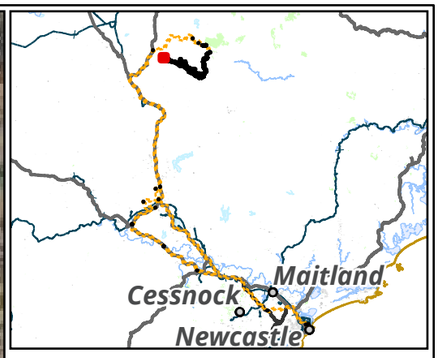

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 2

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F19_ArborealMammals
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Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

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Figure 19 Arboreal mammals habitat polygons, Page 3

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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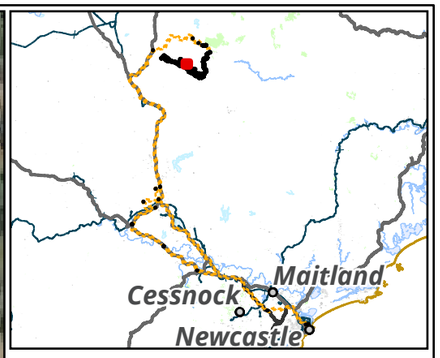

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 4

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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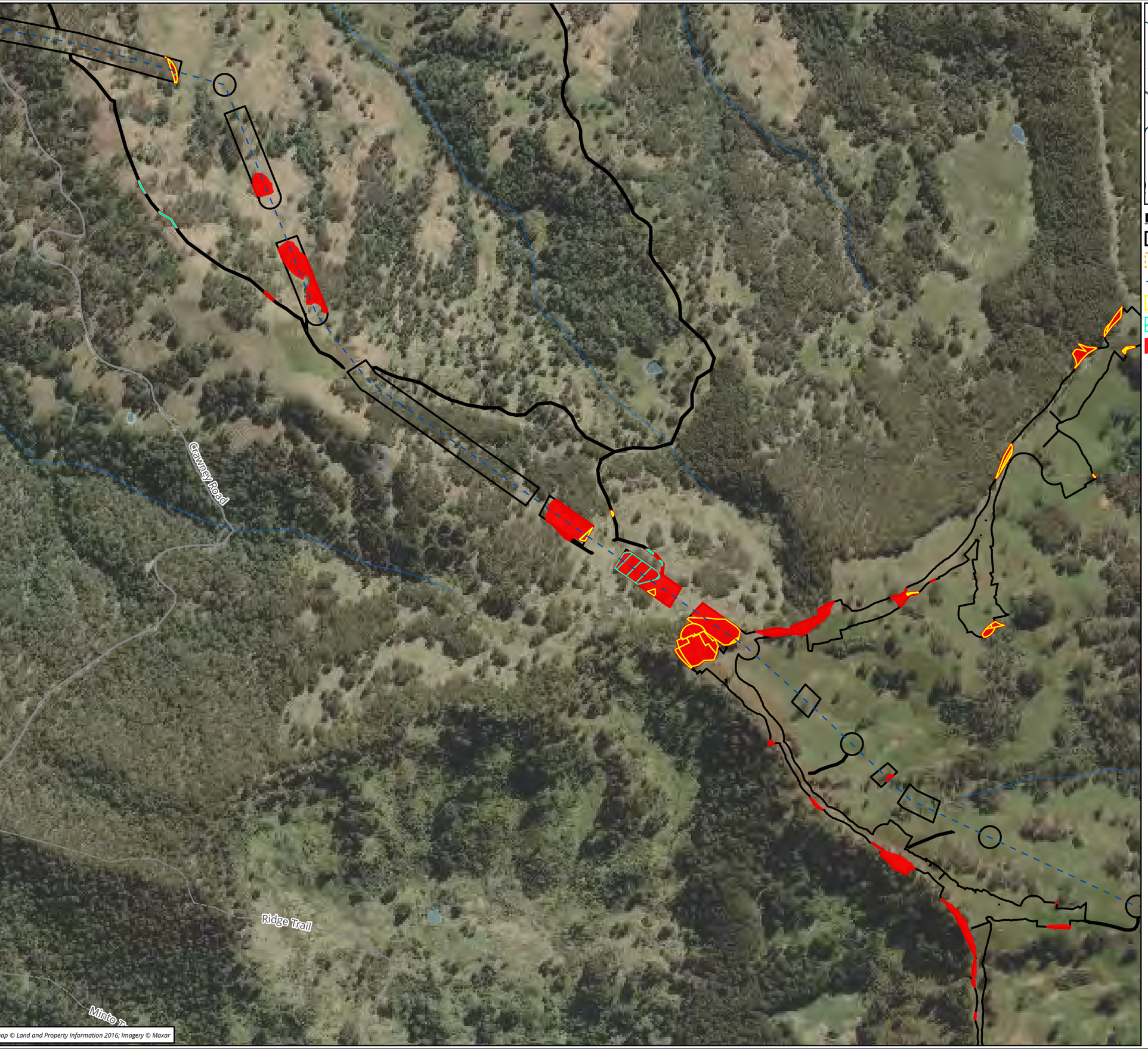

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 5

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 6

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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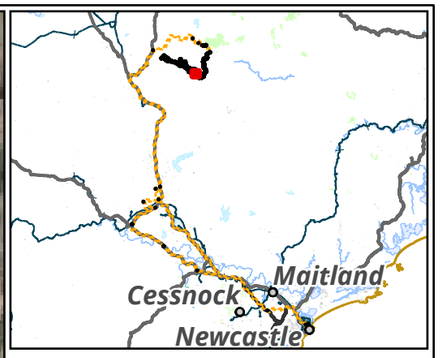

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 7

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

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Date: 05 November 2021 ,
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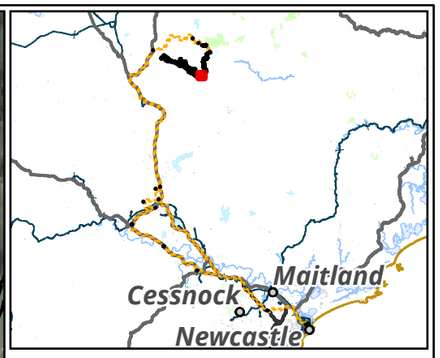

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 8

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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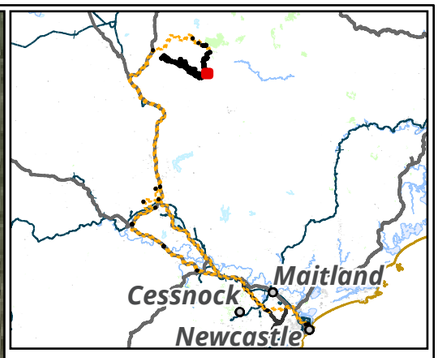

Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 9

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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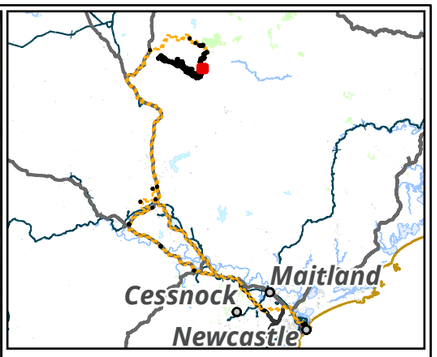

Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 10

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
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Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 11

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
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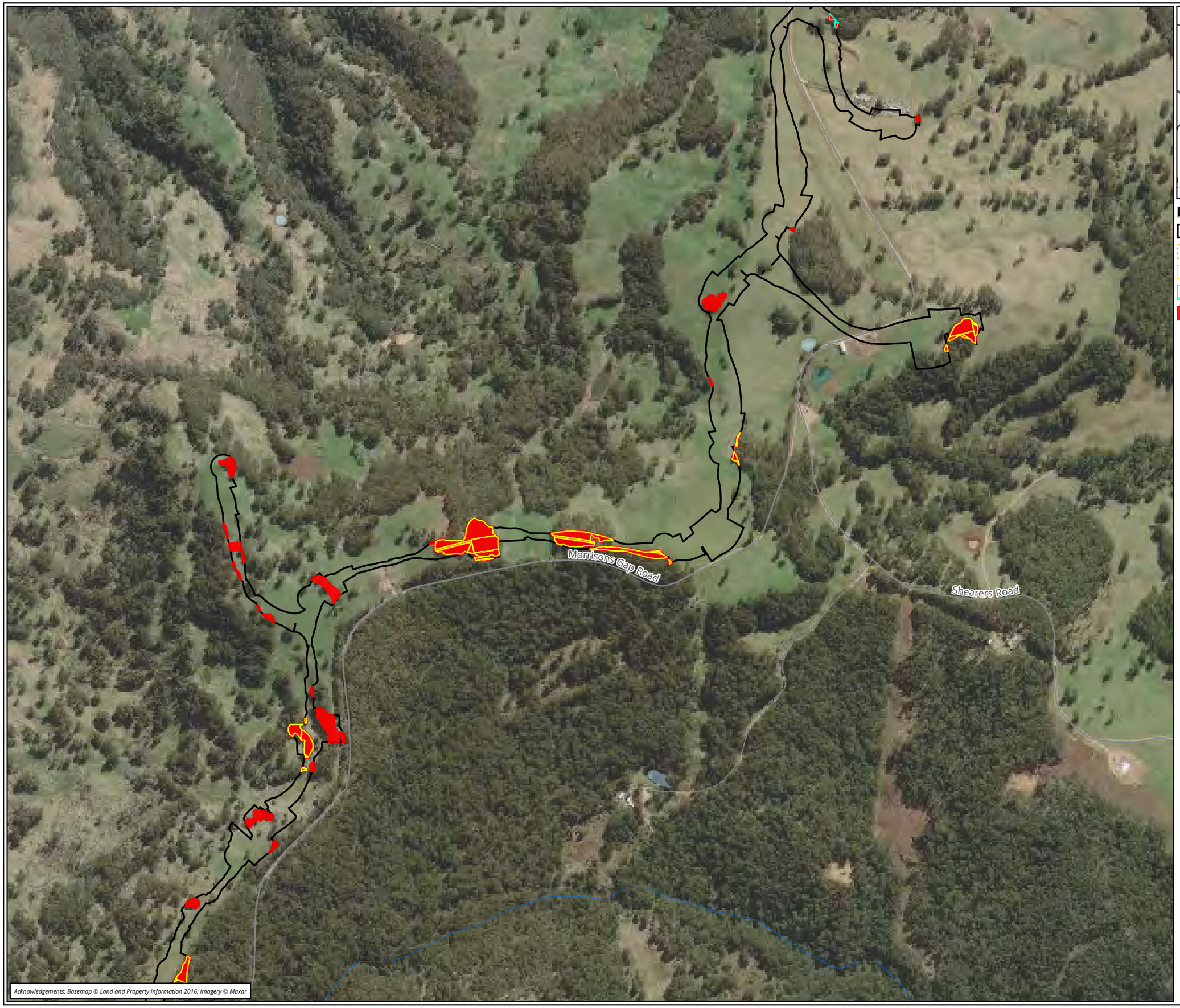

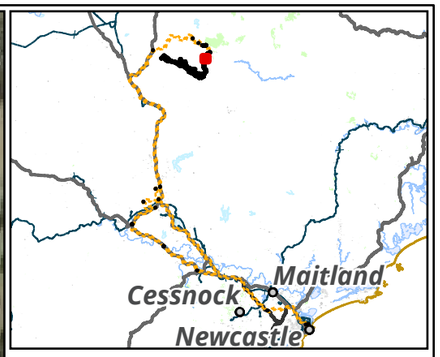

Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 12

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

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Figure 19 Arboreal mammals habitat polygons, Page 13

0 100 200 300 400

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F19_ArborealMammals
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Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 14

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Date: 05 November 2021 ,
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Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

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Figure 19 Arboreal mammals habitat polygons, Page 15

0 20 40 60 80

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
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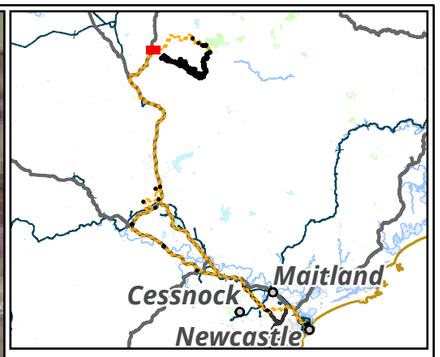

Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 16

0 20 40 60 80

Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F19_ArborealMammals
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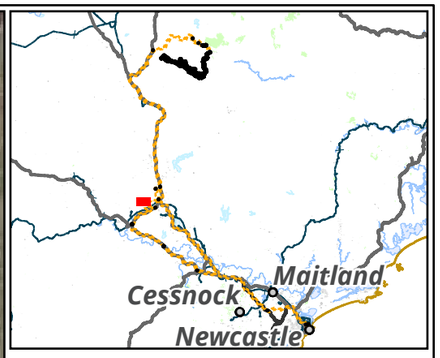

Legend

- Infrastructure footprint
- Transport haul routes
- Eastern Pygmy Possum
- Squirrel Glider
- Koala

Figure 19 Arboreal mammals habitat polygons, Page 17

0 20 40 60 80

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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biosis

Matter: 34963,
Date: 05 November 2021 ,
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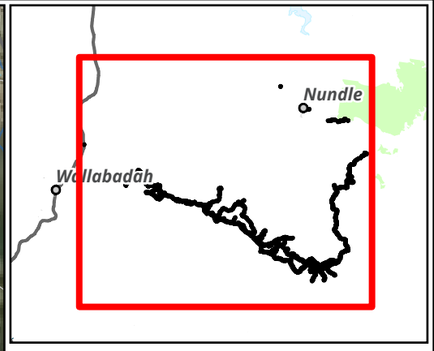

Legend

- Infrastructure footprint
- Transmission line
- Booroolong Frog
- Border Thick-tailed Gecko

Figure 20 Booroolong frog and Border Thick tailed Gecko habitat polygons, Page 1

0 1,000 2,000 3,000 4,000

Meters
Scale: 1:100,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F20_FrogGeckoHabitat
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

Legend

- Infrastructure footprint
- Transmission line
- Border Thick-tailed Gecko

Figure 20 Booroolong frog and Border Thick tailed Gecko habitat polygons,
Page 2

0 50 100 150 200

Meters
Scale: 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F20_FrogGeckoHabitat
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

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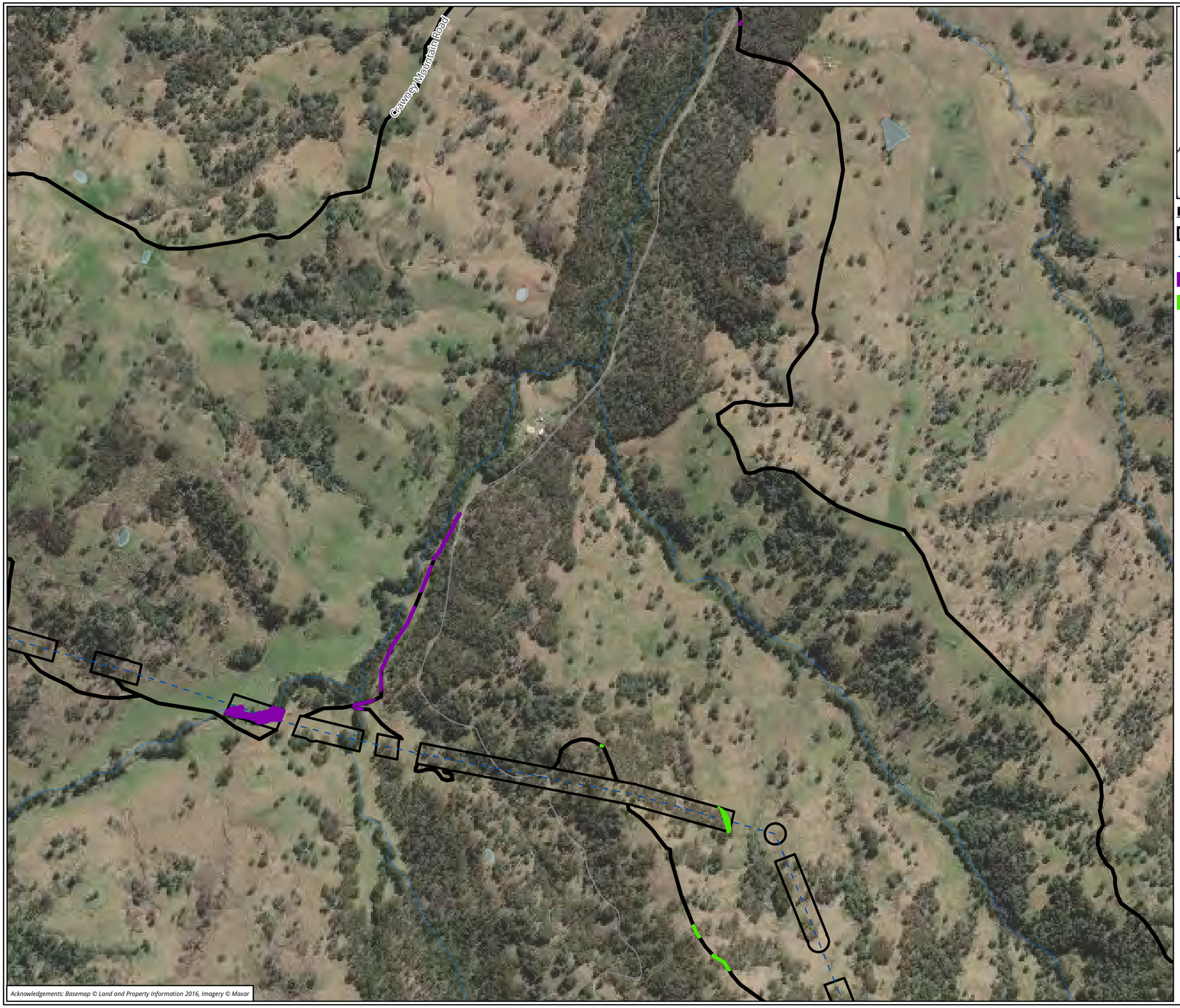

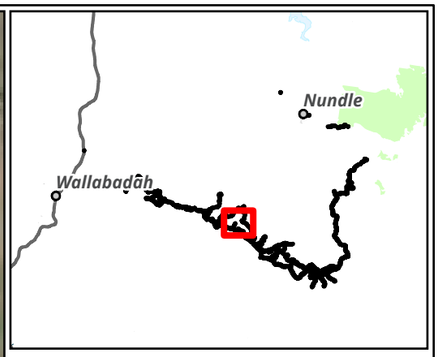

Legend

- Infrastructure footprint
- Transmission line
- Booroolong Frog
- Border Thick-tailed Gecko

Figure 20 Booroolong frog and Border Thick tailed Gecko habitat polygons,
Page 3

0 100 200 300 400

Meters
Scale: 1:10,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F20_FrogGeckoHabitat
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Maxar

Legend

- Infrastructure footprint
- Border Thick-tailed Gecko

Figure 20 Booroolong frog and Border Thick tailed Gecko habitat polygons,
Page 4

0 50 100 150 200

Meters
Scale: 1:5,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F20_FrogGeckoHabitat
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

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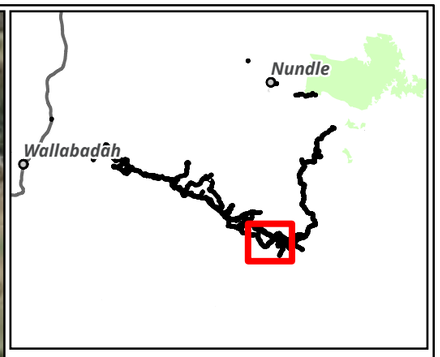

Legend

- Infrastructure footprint
- Transmission line
- Masked Owl
- Barking Owl, Sooty Owl, and Powerful Owl

Figure 21 Forest Owls species habitat polygons

0 160 320 480 640

Meters
Scale: 1:15,000 @ A3
Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F21_ForestOwlHabitat
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Maxar

6 Matters of National Environmental Significance

6.1 Commonwealth determination and controlling provisions

In accordance with the EPBC Act, a referral for the Project was submitted to the Commonwealth Department of Agriculture, Water and Environment (DAWE) (EPBC Ref 2019/8535).

On the 23 December 2019, the Commonwealth determined the Project was a controlled action under section 75 of the EPBC Act. Controlling provisions for the proposed action include listed threatened species and communities (section 18 and 18A) and listed migratory species (section 20 and 20A). Based on the referral documentation (EPBC 2019/8535), the Commonwealth determined there was likely to be significant impacts to the following matters:

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TEC, listed as critically endangered.
- Regent Honeyeater *Anthochaera Phrygia*, listed as critically endangered.
- Swift Parrot *Lathamus discolour*, listed as critically endangered.
- Booroolong Frog *Litoria booroolongensis*, listed as endangered.
- Fork-tailed Swift *Apus pacificus*, which is listed as migratory.

In addition, the Commonwealth identified potential for some risk of significant impacts to the following matters:

- Small Snake Orchid *Diuris pedunculata*, listed as endangered.
- Blackbutt Candlebark *Eucalyptus rubida* subsp*. barbigerorum*, listed as vulnerable.
- Fragrant Pepperbush *Tasmannia glaucifolia*, listed as vulnerable.
- Austral Toadflax *Thesium austral*, listed as vulnerable.
- Spotted-tailed Quoll *Dasyurus maculatus* (SE mainland population), listed as endangered.
- Koala *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT), listed as vulnerable.
- White-throated Needletail *Hirundapus caudacutus*, listed as vulnerable.
- *Euphrasia arguta*, listed as critically endangered.

Further information was requested by the Commonwealth to determine the extent of potential impacts associated with the transport route road upgrades for the following relevant protected matters:

- New England Peppermint Eucalyptus nova-anglica Grassy Woodlands ecological community, listed as critically endangered.
- Lowland Rainforest of Subtropical Australia TEC, listed as critically endangered.
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TEC, listed as critically endangered.
- Regent Honeyeater *Anthochaera Phrygia*, listed as critically endangered.
- *Euphrasia arguta*, listed as critically endangered.

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- Small Snake Orchid *Diuris pedunculata*, listed as endangered.
- Willi Willi Zieria *Zieria lasiocaulis*, listed as endangered.
- *Diuris eborensis*, listed as endangered.
- White-flowered Wax Plant *Cynanchum elegans*, listed as endangered.
- Milky Silkpod *Parsonsia dorrigoensis*, listed as endangered.
- Guthrie's Grevillea *Grevillea guthrieana*, listed as endangered.
- Craven Grey Box *Eucalyptus largeana*, listed as endangered.
- Manning Yellow Solanum *Solanum sulphureum*, listed as endangered.
- Blackbutt Candlebark *Eucalyptus rubida* subsp*. barbigerorum*, listed as vulnerable.
- Koala *Phascolarctos cinereus* (combined populations of Old, NSW and the ACT), listed as vulnerable.
- Earp's Gum *Eucalyptus parramattensis* subsp*. decadens*, listed as vulnerable.
- Austral Toadflax *Thesium australe*, listed as vulnerable.
- Greater Glider *Petauroides Volans*, listed as vulnerable.
- Leafless Tongue-orchid *Cryptostylis hunteriana*, listed as vulnerable.
- Fragrant Pepperbush *Tasmannia glaucifolia*, listed as vulnerable.
- Narrow-leaved Peppermint *Eucalyptus nicholii*, listed as vulnerable.
- Long-nosed Potoroo (SE Mainland) *Potorous tridactylus*, listed as vulnerable.
- Tall Velvet Sea-berry *Haloragis exalata* subsp*. velutina*, listed as vulnerable.
- Big Nellie Hakea *Hakea archaeoides*, listed as vulnerable.

6.2 Significant impact assessment

Based on the results of the desktop investigations, field surveys and the likelihood of occurrence assessments (contained in the EPBC assessment prepared by Arup), significant impact assessments were found to be required for the EPBC Act listed species and TECs that are known to occur or have a 'high' likelihood of occurrence, as listed below, with a detailed significant impact assessment provided in Section 8.8 of this BDAR.

Threatened Ecological Communities

- White Box-Yellow Box-Blakely's Red Gum Grassy TEC Woodland and Derived Native Grassland (critically endangered).

Listed threatened fauna species

- Booroolong Frog *Litoria booroolongensis* (Endangered).
- Large-eared Pied Bat *Chalinolobus dwyeri* (Vulnerable)
- Spotted-tailed Quoll *Dasyurus maculatus* (Endangered).
- Greater Glider *Petauroides volans* (Vulnerable).
- Koala *Phascolarctos cinereus* (Vulnerable).

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The significant impact assessment was completed in accordance with the EPBC Act *Significant Impact Guidelines 1.1 Matters of National Environmental Significance* (Commonwealth of Australia, 2003).

The results of the assessment in this BDAR identified the potential for a significant impact to the following MNES:

- Koala.
- Spotted-tailed Quoll.

As a result targeted field survey and the changes proposed to the project design, significant refinement has been achieved for previously assumed potential roosting / breeding habitat locations for cave dwelling bats including Large-eared Pied Bat within and surrounding the development footprint. The former conclusion of a potential significant impact to Large-eared Pied Bat has been updated based on the revised assessment which confirms that the amended project is unlikely to have a significant impact on the Large-eared Pied Bat.

Following re-design of project components and reassessment of impacts to Box Gum Woodland the former conclusion of a potential significant impact has also been updated based on the revised assessment which confirms that the amended project is unlikely to have a significant impact on Box Gum Woodland.

Impacts to Koala and Spotted-tailed Quoll have been minimised through project design amendments reducing direct impacts to Koala habitat by approximately 14 hectares and to Spotted-tailed Quoll by approximately 40-50 hectares (with the species being associated with all areas of moderate and high condition native vegetation in the development footprint). Impacts will be further minimised through construction and operational mitigation measures targeting these species and through the establishment of local offsets aimed to increase local habitat connectivity between the existing reserve network. Despite the efforts made to reduce impacts, the residual impacts to both species have been conservatively considered significant in accordance with the EPBC Act significant impact guidelines, and as such the species will require direct offsets in accordance with the EPBC Act Offsets Policy (Commonwealth of Australia 2016). Required offsets are expected to be achieved via a combination of establishment of local Biodiversity Stewardship Sites and the securing of biodiversity credits.

Further information is provided in Section 8.8.

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7 Avoid and minimise impacts

Measures to avoid and minimise impacts have been included throughout the development of the design for the Project, including the selection of wind farm layouts, access roads and the transmission line route.

The preliminary identification and mapping of biodiversity constraints occurred before the development of the wind farm layout and the selection of the preferred transmission line corridor, with preliminary biodiversity fieldwork completed in the wind farm and transmission line area in November 2018 before concept engineering design commenced. By collecting ecological data early, this allowed for consideration of biodiversity constraints during the concept design development.

Measures to minimise impacts associated with construction and operation have also been considered, with further detail on these provided in Section 8.9 and Section 8.10 of this BDAR.

The efforts made by the project to avoidance and minimise impacts to biodiversity are illustrated on Figure 1 and Figure 23.

7.1 Wind farm layout

A first pass technically feasible layout for the Project was produced based on the wind resource and required turbine spacing and resulted in a layout of up to 97 turbines. This layout was made publicly available during in the Preliminary Environmental Assessment to request the SEARs. Subsequent iterations of this layout reduced the layout to 78 turbines, then to up to 70 turbines for the project as assessed in the EIS and original BDAR, and now finally reduced to up to 65 turbines based on further design changes made in response to submissions. These updated layouts were derived based on updated turbine technology, the most up to date environmental survey information available, and additional biodiversity impact assessments. Various design rounds were held with civil, wind and biodiversity expertise and also incorporated community feedback into the project design process to minimise biodiversity impacts to the greatest extent practicable in light of Project requirements.

A high level review of the reduced impact associated with reducing the number of turbines from 97 to 78 was carried out prior to the development of the detailed engineering concepts. At this stage the area of impact was based on an indicative hardstand area for each turbine, with linking 6 metre wide access tracks only as earthworks modelling was not yet available to quantify the potential extent of cut and fill required for access roads. Based on this initial indicative assessment the 78 turbine layout impacted on 22% less native vegetation than the 97 turbine layout.

During the development of the wind farm layout as part of the preferred 78 turbine option, design workshop was held with the project ecologists, civil engineers and wind modellers to further optimise layout options to avoid impacts to significant biodiversity features, such as fauna habitat and microbat breeding areas. This review resulted in the wind farm layout being further reduced by an additional 8 turbines from a maximum of 78 turbines down to 70 turbines to further minimise biodiversity impacts and limit the clearing required to sensitive vegetation This further reduction on the number of turbines has contributed to a large reduction in the potential direct and indirect impacts, including potential impacts to habitat connectivity and turbine collision risk, associated with the project.

As part of the design workshop, preliminary ecological data from field surveys was overlaid with initial concept designs and opportunities to amend design elements were assessed. For this workshop, the following ecological data was provided:

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- Areas of potential microbat roosts, as mapped using the LiDAR classification process, with a 100m buffer included.
- PCT mapping identifying areas of moderate and high condition vegetation communities to be avoided as much as possible.
- TEC mapping showing the location of the Ribbon Gum-Mountain Gum-Snow Gum community within the wind farm infrastructure corridor.

Key outcomes of this design review included:

- Removal of turbine locations in areas of steep terrain and located within 100m of identified microbat roosting habitat on rocky outcrops.
- Removal of turbine locations on very steep sections of the site within close proximity to microbat habitat roosts.
- Refinement of the access track along Morrisons Gap Road to avoid required vegetation trimming and clearing.

Accordingly, the exhibited project layout in the EIS avoided all identified microbat roosting habitat and have been optimised to minimise the extent of clearing. An analysis of the wind farm infrastructure layout between the 78 and 70 turbine configurations, shows that this resulted in an approximately 30% reduction in clearing extents (Table 48) to certain PCTs. Following the additional changes made to the Project to further reduce biodiversity impacts in response to the issues identified in submissions, impacts to native vegetation have been further materially reduced as shown below.

Table 48 Review of native vegetation impacts after design refinements to minimise biodiversity impacts

PCT	78 Turbine Layout	70 Turbine Layout	Amended design 70 turbines	65 Turbine Layout	Total Change (ha)	Total Change (%)
1194	100.17	75.65	50.80	39.29	-60.88	-61
507	0.35	0.19	0.09	0.09	-0.26	-73
927	3.64	0.00	0.00	0.00	-3.64	-100
931	5.13	6.30	6.20	3.21	-1.92	-38
934	22.46	17.96	11.87	22.82	0.36	2
954	2.15	2.73	1.37	1.23	-0.92	-43
Total	**133.90**	**102.82**	**70.33**	**66.64**	**-67.26**	-50

The additional amendments to the design undertaken in response to submissions to further minimise impacts from internal roads, crane hardstands and laydowns/compounds were assisted by the results of the bushfire assessment which confirmed that sufficient fire protection is considered to be able to be achieved by the cleared areas themselves. Commitments for 10m APZ buffers from structures associated buildings, and infrastructure have been maintained.

It should be noted that the increase in impacts to PCT 934 have occurred as a result of detailed reviewed of plot data collected by Biosis, which showed an area mapped in the original BDAR as 'Exotic Grassland' was more representative of a Derived Native Grassland/Shrubland and was re-classified accordingly.

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Further avoidance of direct impacts has been achieved through the changes made to the Project in response to the issues raised in submissions including the removal and relocation of turbines and hardstands, details of which are provided in Table 49 below.

Table 49 Design amendments and impact avoidance

Project Amendment	Description	Impact avoidance
Development footprint revision	Exhibited project footprint (EIS) comprised: • Permanent Development Footprint: approximately 242 ha • Temporary Development Footprint: approximately 271 ha • Total development footprint approximately 513 ha. Design revisions have resulted in the amended project footprint now comprising: • Permanent Development Footprint: approximately 103ha • Temporary Development Footprint: approximately 197 ha • Total development footprint approximately 300 ha	Substantial reduction in direct impacts to biodiversity values have been realised through further ongoing detailed design revision and footprint/infrastructure amendments. This is combines with the indirect benefits through the removal and relocation of turbines as well as a reduction in bulk earthworks and associated project infrastructure.
Removal of WP1	WP1 was the closest turbine to the Crawney Pass National Par and its removal reduces biodiversity impacts, native vegetation removal and the requirement for bulk earthworks. The road required to access the turbine has also been removed, further benefitting biodiversity values in that location.	WP1 was considered a Moderate Risk turbine and its removal benefits locally occurring threatened and non-threatened fauna species including microbats, Koala, Greater Glider, as well as to approximately 2ha of Ribbon Gum TEC vegetation. Removal from the project design has the direct benefit of reducing native vegetation removal, but also reduces potential connectivity impacts as the turbine was acting as an outlier on the south-western extent of the array, and the turbines now occur in a more linear arrangement in that location.
Removal of WP19	WP19 has been removed reducing impacts to biodiversity values in the centre of the wind farm. It will reduce the earthworks and vegetation clearance needed to install the turbine, supporting hardstand area and access road.	The removal of WP19 results in an increase separation gap from 1 – 1.5km between turbines in this location, to approximately 2.1km between turbine WP18 and turbines WP20-22 reducing habitat connectivity impacts in an areas of the wind farm where moderate condition habitats occur on either side of the ridgeline. The removal of WP19 also allows for an approximate 600 metre reduction of the intrusion into intact vegetation to the south of the development footprint.
Removal of WP23, 27	WP23, 27 and 31 have all been removed to	All three of these turbines were assessed a

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Project Amendment	Description	Impact avoidance
and 31	reduce risk of direct and indirect impact biodiversity values including potential microbat breeding habitat, modelled owls breeding habitat, and intact vegetation. The removal of these turbines will reduce significant bulk earth works associated with hardstands and associated roads, and reduces the area of impact from the southern-most portion of the wind farm by 400 – 500m at each turbine location.	High Risk turbines (four assessed in total) relating to potential impacts to biodiversity values. WP23 was considered high risk due to its occurrence as southern outlier in high condition intact native vegetation considered likely to support habitat for numerous threatened species, WP27 was located in close proximity to confirmed potential microbat breeding habitat, and WP31 occurred in proximity to modelled large forest ole breeding habitat. The removal of these three turbines will substantially benefit biodiversity values utilising the habitats along this southern portion of the wind farm, both directly though a reduction in vegetation removal, and indirectly through a reduction in potential collision risk, breeding habitat disturbance, and connectivity impacts.
Reorientation of WP2 hardstand	The hardstand for WP2 has been reorientated such that it now occurs largely on exotic grassland.	This reorientation complements the reduction of impacts associated with the removal of WP1 and reduces impacts to Ribbon Gum TEC vegetation by another 0.3ha (on top of the 1ha reduction highlighted above from WP1).
Relocation of WP47	WP47 has been relocated 209 metres north east of the exhibited location. This is to reduce the extent of vegetation clearance in this location.	Increased buffer distance from retained native vegetation on the escarpment and reduction in clearing native vegetation benefits biodiversity values in that location.
Relocation of WP50	WP50 was been moved approximately 130m to the north-east to avoid indirect impacts to conformed microbat potential breeding habitat.	WP50 was the fourth (of four) turbines assessed as High Risk turbine, and has been substantially relocated to avoid indirect impacts to the conformed microbat potential breeding habitat that occurs to the south-west of the turbine and hardstand location. The turbine, turbine blade and additional zone of disturbance are now all located well outside the 100m BAM prescribed microbat breeding habitat buffer. The relocation of this turbine will benefit microbats potentially utilising the potential habitat through a reduction of potential collision risk, and potential vibration impacts during construction.

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7.1.1 Turbines along ridge line adjacent to Ben Halls Gap Nature Reserve

Turbines have been sited with the setbacks from the base of the turbine and maximum distance from the tip of the blade to the vegetation canopy within the Ben Halls Gap Nature Reserve (BHGNR) shown in Table 50. Turbines have been sited with consideration for the existing terrain and suitability to install turbines with consideration for constructability, soil erosion, and existing vegetation. Some turbines, in particular WP40-43 are located on a narrow ridgeline. Moving these turbines further from the BHGNR would result in loss of separation between canopy and turbine blade (as the turbines' bases move lower) and more significant earthworks and resulting impact. Turbines have been located to balance the potential impacts as far as practicable. The ridgeline in this area is well oriented to prevailing north-westerly and south-easterly wind direction maximising their exposure, minimising effects of wake and producing significant clean energy. Section 8.3.4 and Section 8.10.2 have been updated to provide further commitments to monitoring of these turbines for potential indirect impacts with commitments for mitigations to be further addressed in the BBAMP.

Table 50 Review of native vegetation impacts after design refinements to minimise biodiversity impacts

Turbine Name	Base Elevation (m ASL)	Setback distance to BHGNR (m)	Distance from blade tip to BHGNR canopy top (m)
WP39	1340	123	94
WP40	1280	102	59
WP41	1330	85	57
WP42	1340	85	58
WP43	1370	111	83
WP44	1380	162	117

7.2 Microbat and bird habitat

The results of the field investigations identified substantial species diversity in threatened microbats using the site, including both cave and hollow-dependent species. Some of these bats are assessed as ecosystem credit species, and their impacts are quantified as part of the impacts to native vegetation. These include Little Pied Bat *Chalinolobus picatus*, Eastern False Pipistrelle *Falsistrellus tasmaniensis* and Eastern Coastal Free-tailed Bat *Micronomus norfolkensis*. The presence of these bats is predicted based on vegetation type and geographic location. The field surveys also confirmed the presence of several species credit bats, where presence cannot be reliably predicted by PCT mapping Large-eared Pied Bat *Chalinolobus dwyeri*, Little Bent-wing Bat *Miniopterus australis*, Large Bent-wing Bat *Miniopterus orianae oceanensis* and Eastern Cave Bat *Vespadelus troughtoni*.

Due to the high level of activity recorded for threatened cave-dwelling bats within, and surrounding the development footprint, additional mapping and assessment was completed to maximise the buffer from this area of breeding habitat. Using the LDAR data, areas of potential roost habitat was mapped using the method described in Section 5.4.2 of this BDAR. These areas were then subject to ground-truthing to confirm the presence of rocky outcrops where cave-dwelling bats may roost (Figure 15). However, the success of these ground-truthing surveys in February 2020 were significantly hampered by rain and foggy weather making access to these areas, representing the steepest parts of the site, unsafe. As such the potential microbat roost habitat polygons were required to remain highly conservative in nature, with little refinement from ground surveys possible (refer Section 5.4.2). These highly conservative potential bat roost areas were then used to

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further refine the wind farm layout, allowing for avoidance of direct impacts to all areas of potential habitat, to be considered as part of the design process.

The wind farm layout was initially amended to avoid any direct impacts to areas of roost habitat for cave-dwelling bats and no project related infrastructure is proposed within these important areas. To further avoid impacts a 100 metre buffer was applied around all identified areas of roosting habitat on steep cliffs, and as much as possible, the placement of turbines was designed to avoid this buffer.

Follow-up desktop assessment and ground-truthing surveys (as described in Section 5.4.2) were able to be completed in March 2021 to further refine the original microbat roost polygons. Direct impacts from all but one of the 70 turbines were found to be outside the 100 metre buffer on high potential microbat roost habitats. Following on from ground-truthing assessments of microbat habitat qualitative risk assessments were completed for potential turbine impacts to microbats and birds, and a risk assessment was also completed on a turbine by turbine basis. As outlined in Sections 8.3.1, 8.3.2 and 8.3.3 a number of microbat and bird species were assessed as being at a moderate risk of impact at both the local site scale and the local population scale, and four turbines were assessed as presenting a high risk of impact to aerial biodiversity values.

Following consultation between Biosis ecologists and project designers and engineers three of the four turbines assessed as 'High Risk' have subsequently been removed from the project layout, and the fourth turbine has been relocated over 100 meters further from the area of confirmed potential microbat habitat (Table 49). This removal or relocation of turbines has resulted in no turbines occurring within 300 metres of confirmed potential microbat habitat, with rotor-swept area and additional zones of disturbance (refer Section 8.5) occurring within >170 metres from the edge of the habitat. This has resulted in potential serious and unavoidable impacts to cave roosting bats being avoided be the project. Additionally, one of the high risk turbines was previously located within the 100 metre owl breeding habitat buffer from a gully modelled as potentially suitable habitat for all four large forest owl species, assumed present within the subject land. The removal of this turbine ensures there is an additional 450 metre buffer from this potential breeding habitat.

Detailed assessment of the impacts associated with the location of turbines and confirmed microbat roost habitat are contained in the following sections of this BDAR, and mitigation measures have been developed, to be implemented through a Bird and Bat Adaptive Management Plan to ensure impacts are further minimised through the construction and operational phase of the project.

The location and siting of turbines also considered including suitable buffers to areas of potential foraging habitat by microbats. The assessment has used the formula for required buffers to areas of vegetation developed in Natural England Technical Information Note TIN051 – Bats and onshore wind turbines interim guidance. This method takes into consideration the hub height and blade length of adjacent turbines and identifies the required horizontal distance a turbine should be placed to maintain a suitable buffer (Figure 22).

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$$b = \sqrt{(50 + bl)^2 - (hh - fh)^2}$$

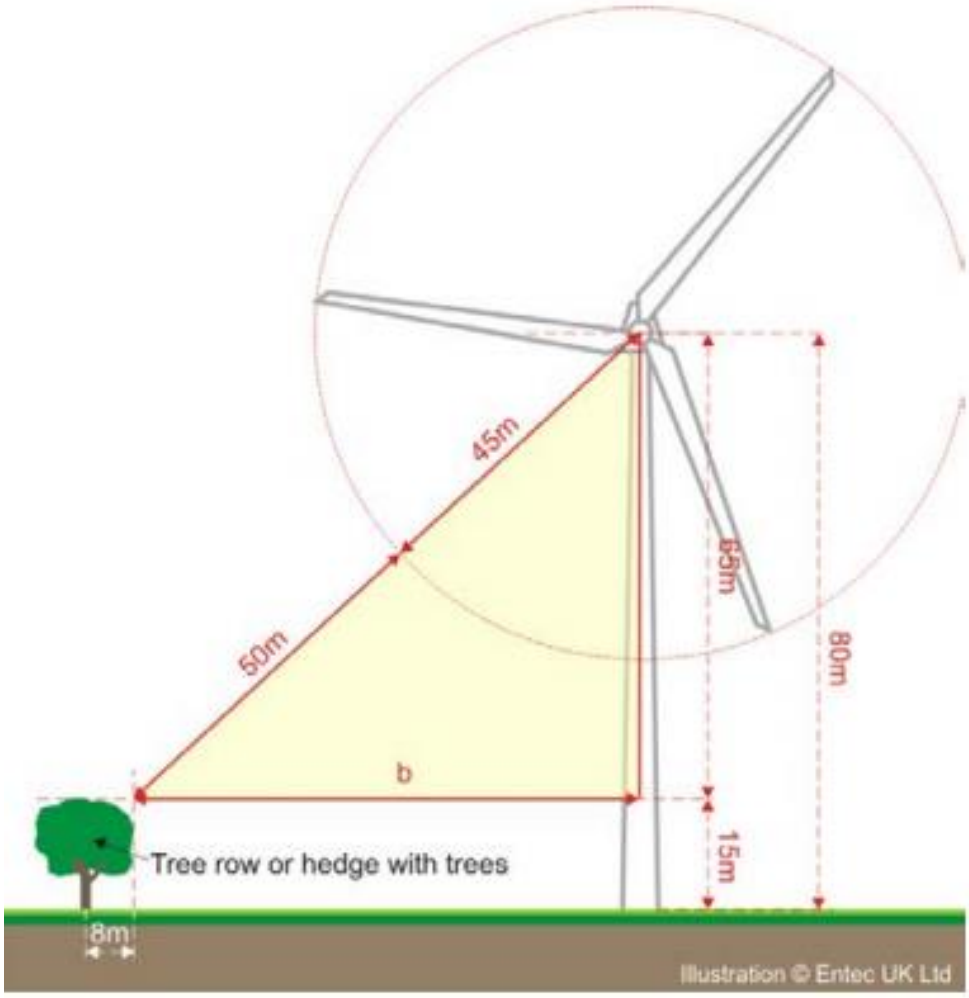

Figure 22 Extract from Technical Information Note TIN051 Bats and onshore wind turbines, showing how buffer distance is determined from top of canopy to blade tip

As field surveys identified a high diversity and relative abundance of threatened microbats across the subject land, further analysis was carried out on each of the turbines to assess the quantum of potential incursion into the required buffer (Table 45) and to determine the buffers for the Project.

In applying the buffer formula from TIN051, the following site specific parameters were input for the required variables to use for the formula to obtain the buffer:

- Turbine name is a unique identifier for each turbine and the spatial location of each turbine was mapped using GIS so it's position relative to the nearest foraging habitat feature was able to be measured.
- Distance to foraging habitat was determined using the measure tool in GIS to measure the distance from the wind turbine to the nearest patch of native vegetation, ground-truthed as part of the PCT mapping for the development footprint.
- Feature height is an estimate of the canopy height of the nearest patch of PCT assessed to be potential microbat foraging habitat. This tree height was taken to be a median height of the vegetation community type as defined by Walker and Hopkins, 1990.

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This assessment was completed on a turbine that provides a ground clearance of 58m from the blade tip.

Regarding the buffer assessment using the formula in TIN051, the project wind turbine layout achieves a minimum of 36m clearance from top of canopy to blade tip. The assessment shows that:

- 34% of turbines provide a buffer of 30-40m.
- 43% of WTGs provide a buffer of 40-50m.
- 23% of WTGs provide a buffer of > 50m.

Accordingly, the Project provides an average buffer of 51m from the tip of blades and the closest area of tree canopy.

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Table 51 Assessment of buffer from blade tip to top of canopy using TIN051

Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP31	21.15	931; 1194-high	23.5	36.42
WP1	22.11	1194- high	23.5	36.60
WP27	22.47	1194-high	23.5	36.67
WP33	22.74	931-high; 1194-mod	23.5	36.72
WP23	23.00	1194-mod	23.5	36.77
WP43	23.00	1194-mod	23.5	36.77
WP61	23.10	1194-mod&high; 927-high	23.5	36.79
WP18	23.17	1194-mod; 934-mod&high	23.5	36.80
WP21	23.58	1194-high	23.5	36.88
WP24	24.78	1194-mod	23.5	37.13
WP11	25.73	931-mod; 934-high	23.5	37.33
WP49	26.72	1194-low&high	23.5	37.55
WP22	26.99	1194; 934-high	23.5	37.61
WP70	28.16	1194-low; 931-high	23.5	37.88
WP16	29.47	1194-mod	23.5	38.20
WP9	30.14	931-mod; 1194-low	23.5	38.37
WP63	30.64	1194-mod	23.5	38.50
WP20	30.97	1194-high; 934-low	23.5	38.58
WP6	31.64	1194-high	23.5	38.76
WP28	31.79	1194-high	23.5	38.80
WP36	33.07	1194-low&mod	23.5	39.14

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Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP58	33.26	1194-mod	23.5	39.19
WP46	34.70	1194-mod&high	23.5	39.60
WP59	35.13	1194-low&high;934-high	23.5	39.72
WP2	36.10	1194- high	23.5	40.01
WP54	36.15	1194-low, mod&high	23.5	40.02
WP51	36.85	1194-low&mod	23.5	40.24
WP4	23.89	507-mod	20	40.38
WP48	37.74	1194-low&high	23.5	40.51
WP8	38.13	931-mod; 934-low	23.5	40.63
WP30	50.89	931-mod; 934-DNG&mod	28.5	40.66
WP64	38.66	1194-high; 927-high	23.5	40.80
WP57	39.46	1194-mod	23.5	41.05
WP7	39.75	1194-high	23.5	41.15
WP12	42.53	934-mod; 1194-high; 954-high	23.5	42.08
WP34	25.18	1194-mod&high	18.5	42.10
WP5	43.07	1194-mod	23.5	42.27
WP38	43.11	1194-high	23.5	42.28
WP15	43.57	1194-DNG&Mod; 954-High	23.5	42.44
WP65	44.33	1194-high	23.5	42.71
WP66	44.98	931-high;1194-mod	23.5	42.95
WP50	46.07	1194-low, mod&high	23.5	43.35
WP53	38.23	1194-low&high	18.5	45.42

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Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP68	51.78	1194-low&mod	23.5	45.57
WP13	54.16	954-high	23.5	46.57
WP69	54.66	1194-low	23.5	46.78
WP29	43.46	931-mod; 934-DNG&mod	18.5	47.10
WP62	55.81	1194-low&mod	23.5	47.28
WP3	56.31	1194- high; 934- mod	23.5	47.50
WP19	30.80	934-high	13.5	48.22
WP39	59.15	1194-mod&high	23.5	48.77
WP17	33.47	1194-mod; 934-high	13.5	48.89
WP14	59.73	931-mod; 1194-DNG; 954-high	23.5	49.03
WP60	60.22	1194-low&mod;934-high	23.5	49.26
WP32	51.47	931-high; 1194-DNG&mod	18.5	50.03
WP42	38.57	1194-low&high	13.5	50.29
WP41	39.16	934-high	13.5	50.47
WP10	66.42	931; 1194; 934-mod	23.5	52.24
WP52	68.19	1194-low	23.5	53.13
WP40	35.35	931-low; 934-high	8.5	54.20
WP37	78.76	1194-low&high	18.5	62.96
WP25	93.27	934-low	23.5	67.46
WP56	93.90	1194-mod	23.5	67.85
WP67	113.66	1194-low	23.5	81.05
WP44	95.29	NA		87.53

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Turbine Name	Distance to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)
WP47	169.27	1194-low&high	23.5	123.92
WP35	157.02	NA		128.70
WP55	161.17	NA		131.83
WP26	184.47	NA		149.97
WP45	184.62	NA		150.10

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7.3 Transmission line route selection and design optimisation

During the design development phase, a wider landscape assessment area was reviewed for potential transmission line corridor. Seven potential transmission line routes were identified and to understand visual impact and willingness to reach land agreements. Desktop and field validated vegetation and habitat maps where reviewed and transmission line options assessed for likely impacts to significant biodiversity features, with a focus on minimising impacts to TECs. A desktop assessment was undertaken to identify the potential impacts to native vegetation communities for each of the seven options using the State Vegetation Type Mapping for the alignments (Table 52). The initial alignment options are illustrated on Figure 23 below.

Table 52 Transmission line route selection and estimate of native vegetation impacts.

Transmission line option	Estimated area of PCT impacts
Route 1	105.02
Route 2	127.98
Route 3	118.70
Route 4	126.47
Route 5	127.03
Route 6	178.24
Route 7	138.91

Following the review of each of these seven options, two preferred routes were selected and an optimisation consisting of a 200 metre corridor was undertaken to adjust the routes to minimise further impact around mapped PCTs and TECs. The transmission line corridor was then further refined to a single option a 60 metre wide impact areas was determined, resulting in impacts to 31.4 hectares of exotic grassland, and 53.5 hectares of native vegetation, of which 3.1 hectares comprises Box Gum Woodland CEEC. This level of impact includes those areas determined as impacted by AECOM (2021) where the vegetation occurs within valleys spanned by the overhead lines (refer section 7.3 for more detail).

In March 2021, following exhibition of the EIS, another re-design of the transmission line alignment was completed, relocating approximately 3 kilometres of the transmission line corridor further reducing impacts to a number of patches of high condition native vegetation by locating the footprint now predominantly in areas of exotic grassland, further south and closer to the turbines. This design revision has resulted in materially reduced direct impacts to native vegetation and habits, including mapped habitat for Koala and Spotted-tailed Quoll.

As part of responding to concerns of impact along the transmission line route, AECOM was engaged to prepare a *330 kV Overhead Line vegetation Clearance Report* to further refine the impacts to biodiversity along the transmission line corridor. The scope of the assessment was to:

- Review the Lidar Survey to incorporate the vegetation data for upload into PLS-CADD.
- Prepare the PLS-CADD Maximum design temperature bottom conductor profile with a vegetation clearance line – 3.0 metres plus 1.0 metre regrowth (minimum 4.0 metre required).
- Prepare the structure clearance envelope of 60.0 metres around structure locations.
- Prepare the 50 degree C and 500 pa vegetation clearance envelopes for all spans on the Hills of Gold 330 kV transmission line.

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The assessment report (provide as Appendix I) confirms that vegetation occurring within valleys will be sufficiently spanned by the overhead lines so that clearing can be avoided. It should be noted that the AECOM report provided highly refined polygons mapping impacted vegetation to the scale of individual tree canopies, which have been conservatively expanded to the full 60 metre wide transmission line corridor footprint assessed for impacts as part of this BDAR. This has ensured that whilst impacts along the transmission line corridor have been reduced, the impacts assessed remain conservative in nature.

Opportunities to carry out ecological restoration works across the remaining portions of the transmission line corridor which require clearing will be investigated during detailed design, and are committed to in Section 8.9 of this BDAR. At a minimum, this will include native grass seeding, but where appropriate due to operational and safety constraints, planting with native shrubs and trees will be considered.

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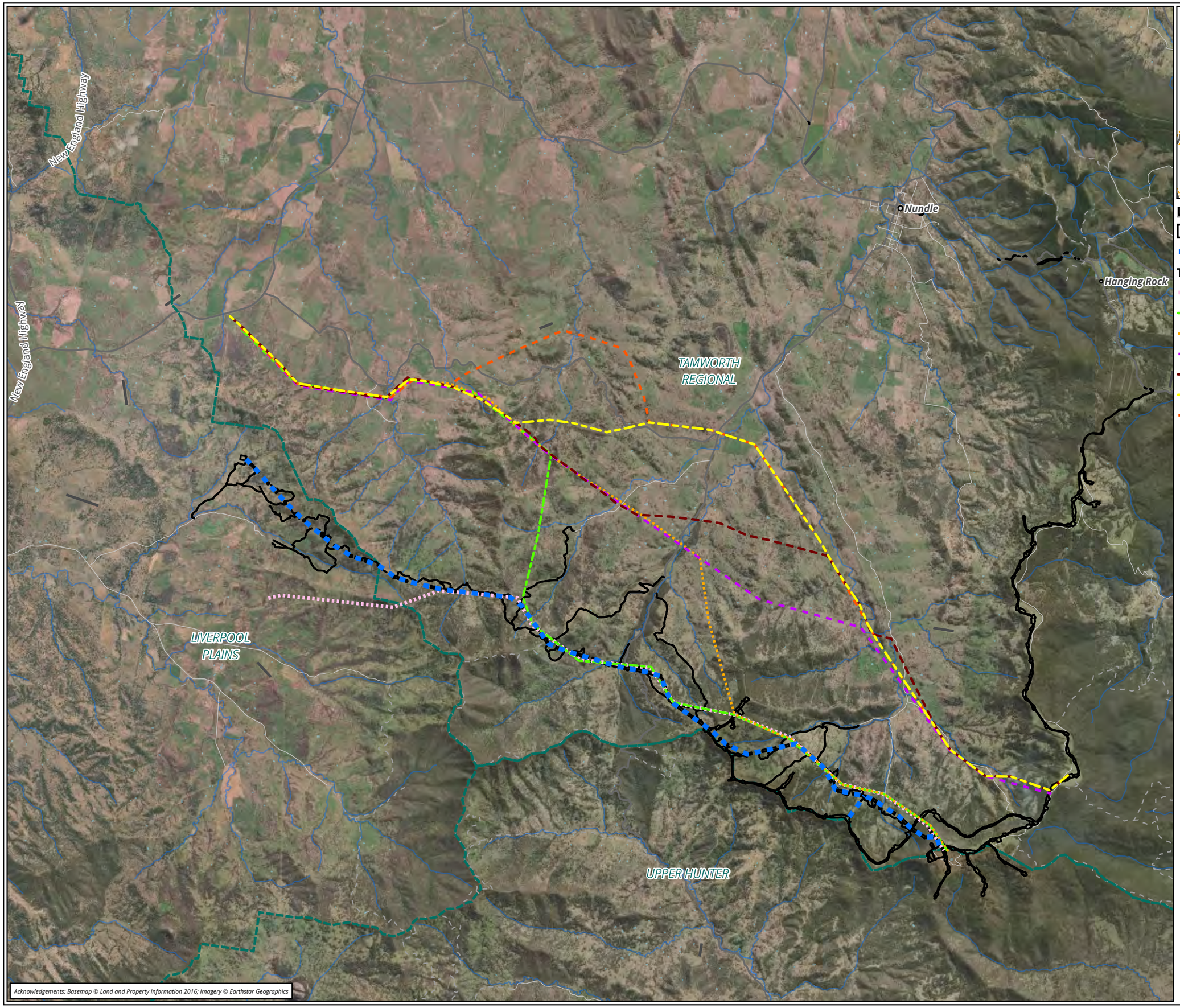

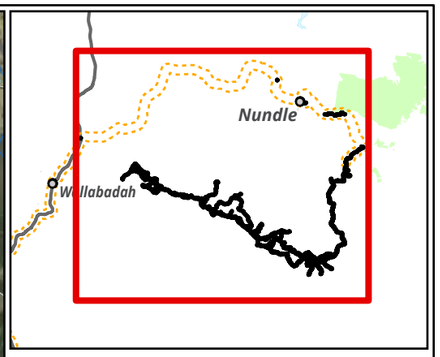

Legend

- Infrastructure footprint
- Transmission line

Transmission line - initial options

- Transmission line - Route 1
- Transmission line - Route 2
- Transmission line - Route 3
- Transmission line - Route 4
- Transmission line - Route 5
- Transmission line - Route 6
- Transmission line - Route 7

Figure 23 Avoid and minimise - Transmission Line options

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: LH, Last edited by: amackegard
Layout: 34963_F23_TransmissionLineOptions
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

7.4 Access roads – construction and operation

Existing road infrastructure was prioritised to provide construction access and operational tracks for the Project. This included locating primary construction access routes along the existing public access roads Head of Peel Road and Morrisons Gap Road. The alignment of the new sections of access tracks within the wind farm corridor largely follows the existing cleared sections of the site, and the development footprint has considered a 5 metre buffer for the majority of the access tracks.

Recent design updates made following preparation of the original BDAR have resulted in the following revisions to the project access roads and ancillary facilities and result in materially reduced impacts to biodiversity values, compared to those asessed in the original BDAR.

Table 53 Design amendments and impact / benefit

Project Amendment	Description	Impact/benefit
Traffic Access to Project Area	All Project traffic will access the Project Area via Morrisons Gap Road only. The Head of Peel Road will not be used for Project related construction and operational traffic and will be for emergency use only. As a result, road upgrades previously proposed along the Crawney Road / Head of Peel access route ('Southern Route') will not be undertaken	Reduction in number of waterway crossings and impacts to native vegetation and fauna habitat through removing access along Head of the Peel Road.
Removal and realignment of internal road networks	Removal of the internal road from the Project Area near southern end of Head of Peel Road into western area of the Project Site. Sections of track between WP16 to WP17, WP17 to WP18, WP46 to WP47 and WP66 to WP67 and have been reassessed to avoid biodiversity impact and following contractor input on reducing earthworks and required width of footprint.	Removal of internal roads will directly and indirectly benefit previously impacted biodiversity values due to a reduction in vegetation clearing, bulk earthworks and fragmentation of vegetation and habitats.
Key Intersection, Devils Elbow and Morrison Gap Road design update	The proposed road upgrades at Devils Elbow and the Barry Road/Morrison Gap Road intersection have been modified. Proposed upgrades would require vegetation clearing with the Devils Elbow footprint approximately 2.5 ha and the Barry Road/Morrison Gap Road proposed footprint is approximately 2.4 ha.	Impacts associated with the exhibited project footprint (EIS) at Devils Elbow comprised approximately 17ha of native vegetation generally in high condition. Substantial design revisions have reduced the impact assessed in this location to 2.5 ha of native vegetation (refer Plate 1 above), leading to direct and indirect benefits to previously impacted vegetation and habitats in this area. This includes Box Gum Woodland Critically Endangered Ecological Community and habitat for threatened fauna species. Previously exhibited impacts considered a number of design options of which only one was intended

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Project Amendment	Description	Impact/benefit
		to be constructed. The final route selected presented the lowest impact option and was further refined to avoid impacts.
Transport Route Updates	The transport route for OSOM from the Port of Newcastle to the Project Area has been amended by the following: • Removal of the tower route option via Tamworth; • Removal of the Head of Peel Road route ('Southern Route') (as stated above) and associated alternate routes through Nundle including Happy Valley Road, Jenkins St, Gill St, Innes St; • Inclusion of route optionality in Muswellbrook; • Two additional laybys for OSOM traffic on Lindsay Gap Road and Morrisons Gap Road to allow existing road users to pass slower moving Project traffic.	Refinement of designs ensure a more accurate assessment of impacts.
Ancillary Infrastructure Amendments	As a result of the removal of the Head of Peel Road access to the Project Area, the construction laydown area and batching plant at the top of the Head of Peel Road access route has been deleted. The laydown area / batch plant has been relocated to the footprint of the BESS / substation and O&M facility.	Overall design revisions to ancillary areas have resulted in a reduction to previously presented impacts biodiversity values.
	Substation, BESS and O&M configuration has been amended following further substation design works	
	Relocation of O&M to WP56 based on feedback in the Hazards and Risk Report	
	Laydown Area and Concrete Batching Plant optionality for all laydown areas with the exception of laydowns along Morrisons Gap Road to host concrete batching plants (total number of batching plants for the Project will not increase and will remain as two).	
	An additional temporary construction compounds are proposed adjacent to WTG 56 and at the eastern (downslope) extent of the Devils Elbow bypass in an existing cleared pullover bay. No impacts	

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Project Amendment	Description	Impact/benefit
	to vegetation will occur at the evils Elbow compound.	

In addition to minimising clearing associated with access tracks, it is proposed that up to 200 hectares of this development footprint (considered temporary impacts related to construction) will be rehabilitated with native species mixes. This will compensate for some of the impacts associated with earthworks for road batters. However, in order to ensure an appropriate degree of conservatism, all impacts, including temporary impacts have been fully assessed in this BDAR.

7.5 Overall direct impact reduction resulting from project amendments following the Original BDAR

The following tables highlight the reduction of impacts to native vegetation, TECs and threatened BAM species credit species, based on the additional field investigations and recent design revision undertaken following the preparation of the original BDAR.

Table 54 Revised vegetation impacts

Vegetation condition class	2020 BDAR Area (ha)	Updated BDAR Area (ha)	Reduction	% of mapped vegetation
Planted or urban vegetation	7.39	0.24	97%	0.08%
Exotic grassland	272.36	164.48	40%	55.35%
Derived Native Grasslands	30.91	29.06	6%	9.78%
Native vegetation – Low condition	37.11	19.28	48%	6.49%
Native vegetation – Moderate condition	73.8	46.18	37%	15.54%
Native vegetation – High condition	64.88	37.92	42%	12.76%
TOTAL	**486.45**	**297.15**	**39%**	**100%**

Table 55 Reductions in project refinements

Relevant matter	Details	2020 BDAR Direct impacts	2021 Updated BDAR Direct impacts	Total change
Native vegetation communities and ecosystem credit species habitats.	Direct loss of native vegetation communities associated with site clearing	207.7 ha	132.43 ha	-75.27 ha
Threatened ecological communities	Direct loss of Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	57.43 ha	23.36 ha	-34.07 ha

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Relevant matter	Details	2020 BDAR Direct impacts	2021 Updated BDAR Direct impacts	Total change
	Direct loss of White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	13.33 ha	6.07 ha	-7.26 ha
Habitat for threatened fauna species – species credit species	Large-eared Pied Bat*	61.08 ha	19.68 ha foraging habitat 0 ha breeding habit	-41.4 ha
	Eastern Cave Bat*	62.49 ha	19.68 ha foraging habitat 0 ha breeding habitat	-42.81 ha
	Large Bent-winged Bat*	23.12 ha	0 ha (foraging and breeding habitat)	-23.12 ha
	Little Bent-winged Bat*	23.12 ha	0 ha (foraging and breeding habitat)	-23.12 ha
	Southern Myotis	2.21 ha	3.97 ha	1.76 ha
	Eastern Pygmy-possum	70.03 ha	18.14 ha	-51.89 ha
	Koala	50.76 ha	36.44 ha	-14.32 ha
	Squirrel Glider	26.20 ha	16.06 ha	-10.14 ha
	Booroolong Frog	1.59 ha	0.64 ha	0.95 ha
	Border Thick-tailed Gecko	0.17 ha	0.17 ha	0 ha
	Powerful Owl	Assessed as not present as none were observed during surveys	1.99 ha based on assumed presence	No change. However, based the conservative assumption that this species is present despite not being located during surveys, 1.99 ha of potential habitat will be impacted.
	Sooty Owl	As above	As above	As above
	Barking Owl	As above	As above	As above
	Masked Owl	As above	As above	As above
Habitat for threatened fauna species – ecosystem credit species	State and Commonwealth listed threatened fauna species known or predicted to occur	207.7 ha	132.43 ha	-75.27 ha

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Relevant matter	Details	2020 BDAR Direct impacts	2021 Updated BDAR Direct impacts	Total change
Total Reduction				293.74 ha

These project amendments resulted in a total reduction in impacts to vegetation of 39 %, with a reduction of 42 % in areas of high condition native vegetation. A total of 72.41 hectares of low to high condition native vegetation has been assessed as avoided in this updated layout and BDAR.

As a result targeted field survey, significant refinement have been achieved for previously assumed potential roosting / breeding habitat locations for cave dwelling bats including the threatened Eastern Cave Bat, Large Bent-winged Bat, Little Bent-winged Bat and Large-eared Pied Bat within and surrounding the development footprint. The former conclusion of a potential significant impact to Large-eared Pied Bat has been updated to unlikely, and coupled with turbine removal and relocation, potential Serious and Irreversible Impacts to all four species have now been avoided. Further information is provided in Section 8.8.

7.6 Possible alternative site access footprint at Barry Road and Morrisons Gap Road

An alternative and less preferred option for site access exists at the corner of Barry Road and Morrisons Gap Road where road upgrades are required to allow for the delivery of turbine components to site. The current footprint and impact calculations included in this BDAR are based on the preferred access option, where the majority of the roadworks and associated impacts are mainly confined to the southern side of Barry Road, with some minor works required on the northern side of the road. The alternative design includes re-locating the majority of the roadwork to the northern side of Barry Road to create a large sweeping turning area.

The preferred and alternative options for site access at the corner of Barry Road and Morrisons Gap Road are illustrated on Plate 2 below.

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Plate 2 Preferred and alternative options for site access (approx areas)

As landowner negotiations are ongoing at the time of finalisation of this BDAR, impacts included and assessed herein are based on the preferred southern option only. Table 56 below provides a comparison of the potential impacts to biodiversity values in this location if the preferred southern, or less preferred northern option, are selected.

Table 56 Impact comparison for preferred and alternative options for site access

Biodiversity value	Preferred – Southern option impacts (Ha	Less preferred – Northern option impacts (ha)	Impact comparison if Northern option progressed (Ha)
PCT 1194 – High	0.01	0.58	+ 0.57
PCT 1194 – Moderate	0.15	0.06	- 0.09
PCT 1194 – DNG	0.10	0.04	- 0.06
Ribbon Gum-Mountain Gum-Snow Gum TEC (total of PCT 1194 impacts)	0.26	0.68	+ 0.42
Eastern Pygmy-possum	0.01	0.58	+ 0.57
Greater Glider	0.01	0.54	+ 0.53
Koala	0.16	0.65	+ 0.49
Spotted-tailed Quoll	0.16	0.65	+ 0.49

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Biodiversity value	Preferred – Southern option impacts (Ha	Less preferred – Northern option impacts (ha)	Impact comparison if Northern option progressed (Ha)
Squirrel Glider	0.16	0.65	+ 0.49

If the less preferred northern option is ultimately progressed, impacts will be formally recalculated as part of detailed design, however even with this eventuality, the Proponent is committed to ensuring total impacts are kept within the upper limits detailed in this BDAR, which will be made possible by expected savings made elsewhere within the current worst case scenario development footprint assessed herein.

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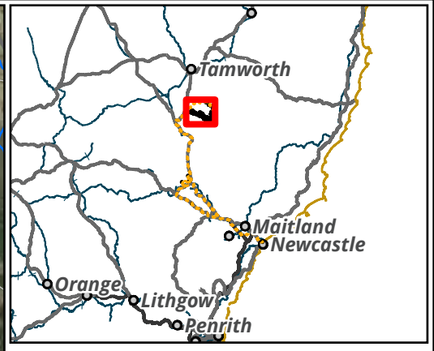
New England Highway

New England Highway



Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Transport haul routes
- Transmission line
- Wind turbine locations

Figure 24 Final development footprint, Page 1: Wind farm

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F24_FinalDevFootprint
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

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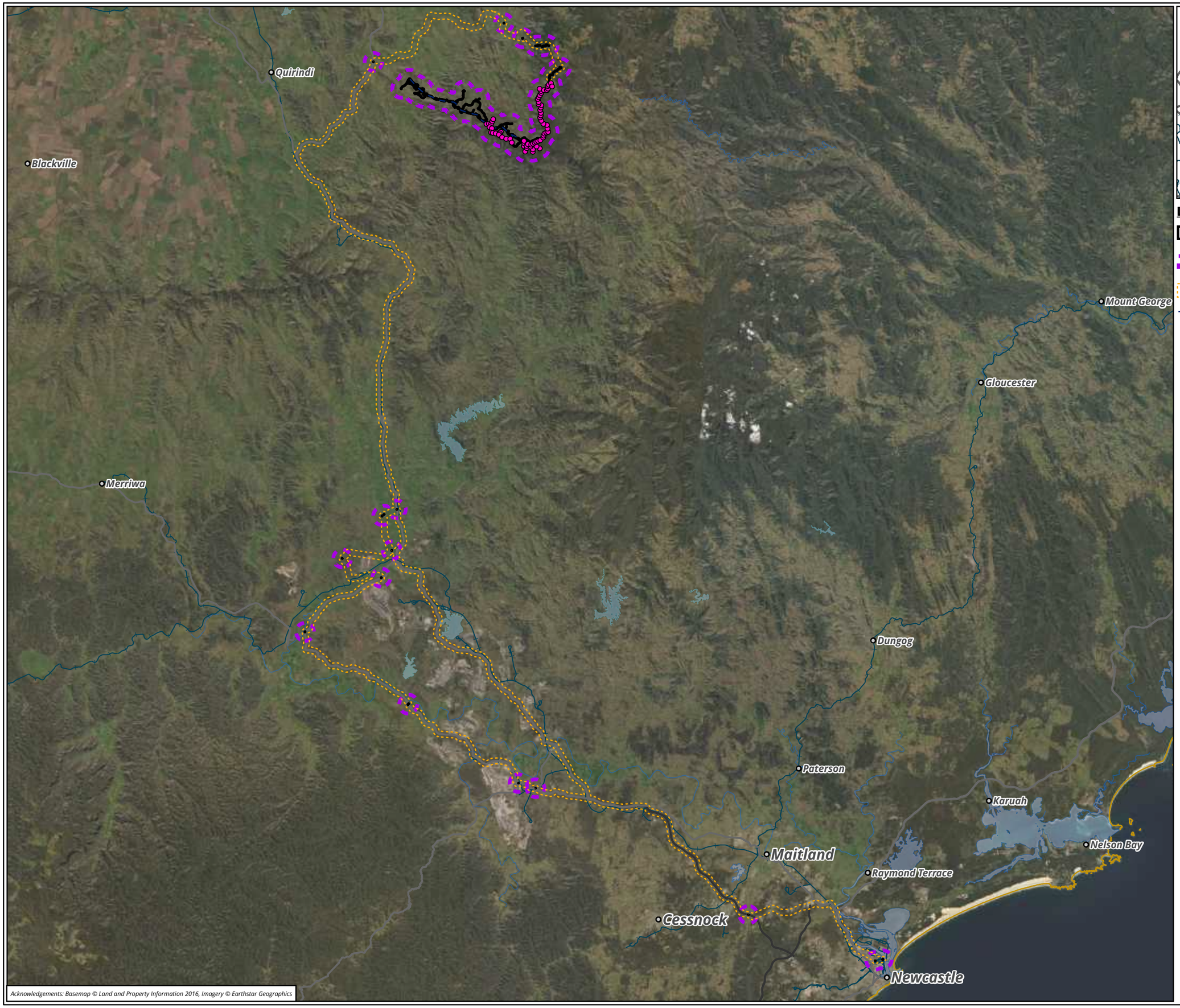

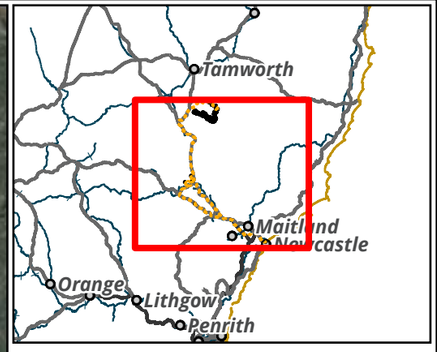

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Transport haul routes
- Transmission line
- Wind turbine locations

Figure 24 Final development footprint, Page 2: Transport route

0 6,000 12,000 18,000 24,000

Meters

Scale: 1:600,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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Matter: 34963,
Date: 05 November 2021 ,
Prepared for: CW, Prepared by: AM, Last edited by: amackegard
Layout: 34963_F24_FinalDevFootprint
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

8 Assessment of Impacts

8.1 Impact summary

The approach to impact assessment has included assessment of a worst-case scenario covering direct impacts associated with habitat loss and indirect impacts associated with construction and operation of the project.

Table 57 details the impacts of the optimised Project to biodiversity following the implementation of the measures outlined above to avoid and minimise impacts. Where biodiversity impacts are relevant for each proposal phase this has been identified accordingly. These are discussed further in the following sections.

Table 57 Potential impacts to biodiversity

Biodiversity value	Potential impact	Infrastructure type	Proposal phase	
			Construction	Operation
Direct impacts				
Native vegetation and ecosystem credit species habitats	Clearing of 132.43 ha of native vegetation, comprised of:	All	✓	
Threatened Ecological Communities	Clearing of 23.36 ha of Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	Wind turbine infrastructure Temporary construction footprint Transmission line Transport route upgrades Internal roads Ancillary	✓	
	Clearing of 6.07 ha of White Box Yellow Box Blakely's Red Gum Woodland	Transmission line Transmission line access tracks Transport route upgrades	✓	
Threatened fauna habitat – Species credit species and MNES	Clearing of 19.68 ha of foraging habitat for Large-eared Pied Bat	Wind farm infrastructure Transmission line Transmission line access tracks Internal roads Ancillary	✓	
	Clearing of 19.68 ha of foraging habitat for Eastern Cave Bat	Wind farm infrastructure Transmission line	✓	

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Biodiversity value	Potential impact	Infrastructure type	Proposal phase	
			Construction	Operation
		Transmission line access tracks Internal roads Ancillary		
	Clearing of 18.14 ha of habitat for Eastern Pygmy-possum	Wind farm infrastructure Transmission line Transmission line access tracks Internal roads Ancillary	✓	
	Clearing of 36.44 ha of habitat for Koala	Wind farm infrastructure Transmission line Transmission line access tracks Internal roads Ancillary Haul route upgrades	✓	
	Clearing of 0.17 ha of habitat for Border Thick-tailed Gecko	Transmission line Transport line access tracks Transport route upgrades	✓	
	Clearing of 3.97 ha of breeding habitat for Southern Myotis	Wind turbine infrastructure Transport route upgrades Internal roads	✓	
	Clearing of 32.30 ha of habitat for Greater Glider	Wind farm infrastructure Transmission line Transmission line access tracks Internal roads Ancillary Transport route upgrades	✓	
	Clearing of 40.67 ha of habitat for Spotted-tailed Quoll	Wind farm infrastructure	✓	

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Biodiversity value	Potential impact	Infrastructure type	Proposal phase	
			Construction	Operation
		Transmission line Transmission line access tracks Internal roads Ancillary Transport route upgrades		
	Clearing of 16.06 ha of habitat for Squirrel Glider	Wind farm infrastructure Transmission line Transmission line access tracks Internal roads Ancillary Transport route upgrades	✓	
	Clearing of 1.99 ha of habitat for Barking Owl	Internal roads	✓	
	Clearing of 0.99 ha of habitat for Masked Owl	Internal roads	✓	
	Clearing of 1.99 ha of habitat for Powerful Owl	Internal roads	✓	
	Clearing of 1.99 ha of habitat for Sooty Owl	Internal roads	✓	
	Clearing of 0.64 ha of impact for Booroolong Frog	Transmission line and access tracks	✓	
Indirect impacts				
Threatened fauna	Collision risk for birds and bats	Wind farm infrastructure		✓
Native vegetation, threatened ecological communities and habitat for threatened species	Edge effects and impacts to habitat viability	All lands in proximity of cleared areas	✓	✓
	Disturbance of habitats from noise and light	All land in proximity to operational infrastructure which generates noise or requires night lighting	✓	✓
	Disturbance from weeds, pests and pathogens	Wind farm and transmission line	✓	✓

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Biodiversity value	Potential impact	Infrastructure type	Proposal phase	
			Construction	Operation
		corridor		
	Fauna injury/ mortality	All lands	✓	✓
Prescribed impacts				
Native vegetation, threatened ecological communities and habitat for threatened species	Loss of habitat connectivity	Wind farm and transmission line corridor	✓	✓
	Impacts to hydrology and water quality	Wind farm and transmission line corridor	✓	
	Impacts to karst, caves, crevices, cliffs and other geological feature of significance	Low potential for wind farm corridor	✓	
Threatened fauna and migratory species	Impacts of wind turbine strikes on protected animals	Wind farm corridor		✓
	Potential impacts of barrier effect of wind turbine of protected animals	Wind farm corridor		✓
	Potential impacts to flight paths for raptors and resident aerial species	Wind farm corridor		✓
Other impacts				
Aquatic habitats	Impacts to hydrology and downstream water quality	Access/ transport routes	✓	
	Impacts to fish passage	Access/ transport routes	✓	

8.2 Direct impacts

Direct impacts associated with the development are primarily related to the proposed site clearing works. Site clearing will be carried out for the development footprint. As identified in Table 54, the amended Project has resulted in a total reduction in direct impacts to vegetation of 39%, with a reduction of 42% occurring in areas of high condition native vegetation. A total of 74.26 hectares of native vegetation previously proposed to be impacted has now been avoided as a result of the amended layout.

8.2.1 Clearing of native vegetation

The majority of the impacts to vegetation within the development footprint will be to exotic grassland and planted vegetation, with a total of 164.72 hectares of clearing of this vegetation type required.

A total of 132.43 hectares of native vegetation will be cleared from within the development footprint. This includes:

- 29.43 ha for temporary construction footprint.
- 15.05 ha for wind turbine infrastructure.

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- 20.29 ha for internal roads.
- 46.90 ha for the transmission line.
- 6.55 ha for the transmission line access tracks.
- 5.58 ha for the transport route upgrades.
- 8.62 ha for ancillary areas.

As described in Section 3 of this BDAR in detail, the condition of the native vegetation is highly variable and patchy, with the majority being derived native grassland, low or moderate condition.

The 132.43 hectares of native vegetation which is contained in the development footprint represents 0.6% of the approximately 21,540 hectares of native vegetation contained within the landscape assessment buffer area of 1,500m and is an even smaller fraction of the native vegetation which surrounds the assessment area

To mitigate impacts to native vegetation as a result of temporary impacts, site rehabilitation and ecological restoration works will be completed in areas such as batters for access tracks, temporary construction laydown areas and trenching for underground cabling. A Biodiversity Management Plan for the site will also look at opportunities for revegetation and restoration plans to buffer areas of important habitat, such as the adjacent Ben Halls Gap Nature Reserve and to provide for biodiversity corridors through the development footprint.

Estimates of areas to be subject to rehabilitation works (temporary impacts) through seeding or planting with native species, includes a total of 200 hectares and includes:

- 6.52 hectares within the wind farm infrastructure development footprint.
- 92.11 for bulk earthworks associated with the wind farm development footprint.
- 29.27 hectares for internal access roads development footprint.
- 63.82 hectares for the transmission line development footprint.
- 6.61 hectares for ancillary infrastructure development footprint.
- 1.47 hectares for the transport haul route development footprint.

These rehabilitation works will materially contribute towards minimising the impacts to native vegetation and fauna habitats within the development footprint. During detailed design, opportunities to include trees and shrubs in the rehabilitation species mix will be considered where site constraints regarding safety and operation permit. Based on these current estimates for areas to be subject to rehabilitation, the loss of 132.43 hectares of native vegetation can be compensated by the 200 hectares of restoration, including seeding areas currently mapped as exotic grasslands with native seeding or planting.

8.2.2 Threatened Ecological Communities

A total of 29.43 hectares of the vegetation which will be impacted by the updated development footprint is associated with two threatened ecological communities being White Box Yellow Box Blakely's Red Gum Woodland and Ribbon Gum-Mountain Gum-Snow Gum open forest or woodland (Table 58).

To provide some context on the significance of impacts to these TECs, an assessment of the potential extent of these communities in the assessment area has been carried out. The White Box-Yellow Box-Blakely's Red Gum Woodland TEC occurs within the transmission line corridor, so the assessment of area impacted considered the investigation area for corridor options. This provides a more focused assessment of the impacts for the local landscape which is considered more representative than looking at a bioregional or sub-bioregional scale where percent impacts would be further diluted.

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Table 58 Proposal impacts to threatened ecological communities

TEC	Area impacted (ha)	Area in investigation (ha)	% of investigation area impacted
White Box Yellow Box Blakely's Red Gum Woodland	6.07	1,693.6	0.4%
Ribbon Gum-Mountain Gum-Snow Gum open forest or woodland	23.36	1,059	2.2%

Based on an estimate of the likely extent of these TECs within the assessment area, the project is unlikely to result in a significant impact to these TECs, as there are substantial areas retained in the area for investigation associated with the wind farm and transmission line easement. The estimate of area of TECs for White-Box-Yellow-Box-Blakely's Red Gum extent was derived from the State Vegetation Map for Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a), with associated PCTs that comprise the TEC calculated within the transmission line investigation area.

For the area of Ribbon Gum-Mountain Gum-Snow Gum TEC estimated within the wind farm corridor investigation area, a combination of the State Vegetation Map State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020 and field survey data was used.

Mitigation measures during detailed design to further reduce impacts to these TECs will be investigated. In particular, the current development footprint considers a 'worst case' clearing footprint for the transmission line easement, assessing complete clearing within the easement. Depending on the height of the towers and the topography of the easement, there will be locations where the existing eucalypt forest can be retained, while still maintaining the required safety and operational clearance to the transmission lines.

- State Vegetation Type Map: Border Rivers Gwydir / Namoi Region Version 2.0. VIS_ID 4467 (OEH, 2020a).
- State Vegetation Type Map: Upper Hunter Version 1.0. VIS_ID 4894 (OEH, 2020b).
- Greater Hunter Native Vegetation Mapping Version 4.0. VIS_ID 3855 (DPIE, 2015).

8.2.3 Clearing of habitat for threatened fauna species

Direct impacts to threatened fauna habitat within the development footprint has been calculated using the species polygons developed using the methodology described in Section 5.5 of this BDAR. Table 59 presents a summary of estimated impacts to habitat for threatened fauna within the development footprint. In addition to the habitat mapped for species credit species, a number of threatened fauna were directly observed on site. These species, and others considered likely to occur are ecosystem credit species (in accordance with the BAM) and their habitat comprise part or all of the native vegetation to be impacted by the Project. This generally includes forage and potential breeding habitat for species with less specific habitat requirements, that can utilise large amount of the undisturbed habitat present within and surrounding the subject land.

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Table 59 Direct impacts to habitat (or potential habitat based on assumed presence) for species credit species

Species	Habitat polygons impacted (ha)							
	Temporary construction footprint	Wind turbine infrastructure	Internal roads	Transmission line	Transmission line access tracks	Transport route upgrades	Ancillary	Total
Large-eared Pied Bat (foraging)	9.94	6.45	1.75	0.24	0.09	0	1.21	**19.68**
Eastern Cave Bat (foraging)	9.94	6.45	1.75	0.24	0.09	0	1.21	**19.68**
Large Bent-winged Bat (breeding)	0	0	0	0	0	0	0	**0**
Little Bent-winged Bat (breeding)	0	0	0	0	0	0	0	**0**
Southern Myotis	2.42	1.30	0.22	0	0	0.04		**3.97**
Koala	14.93	7.77	3.70	6.85	0.17	2.26	0.76	**36.44**
Eastern Pygmy-possum	7.15	4.18	1.95	3.61	0.02	1.22	0.01	**18.14**
Squirrel Glider	6.01	4.03	1.16	2.32	0.06	1.76	0.72	**16.06**
Border Thick-tailed Gecko	0	0	0	0.06	0.04	0.07	0	**0.17**
Sooty Owl	0	0	1.99	0	0	0	0	**1.99**
Powerful Owl	0	0	1.99	0	0	0	0	**1.99**
Masked Owl	0	0	0.99	0	0	0	0	**0.99**

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8.3 Indirect impacts

This section details potential indirect impacts associated with the construction and operation of the proposal following the implementation of proposed avoidance and minimisation measures. The likely extent and nature of these impacts is discussed in further detail below in relation to each element of the proposal.

Overall, the indirect impacts of the amended Project are materially reduced as compared to the Project as assessed in the original BDAR.

8.3.1 Indirect/uncertain impacts to microbats

By its nature as a wind farm, the project has the potential to cause indirect impacts to identified threatened and non-threatened species of microbats recorded within the development footprint. Direct impacts to loss of breeding and foraging habitat are addressed above, and indirect impacts associated with construction are detailed below, however there are also potential operational phase impacts that are required to be addressed. Indirect impacts, many of which are considered uncertain in relation to microbats, have the potential to occur during the operational phase of the project include:

- Loss of habitat connectivity.
- Avoidance of areas of habitat due to air disturbance surrounding operational turbines.
- Turbine strike and possibly barotrauma.

Potential impacts to local populations of microbats that could occur as a result of loss of habitat connectivity and as a result of air disturbance around operational turbines are assessed in the prescribed impacts section of this BDAR. The potential for and likely consequences of turbine strike and possibly barotrauma are included herein.

It has been confirmed as part of this assessment that a range of microbat species recorded within the project area occur at varying frequencies at elevations that put them at risk of collision with the turbine rotor blades. Based on the specifications of the turbine options being considered for the operational phase of the project, the 'worst case scenario' turbine will result in a rotor swept area of 162 metres occurring between 58 and 220 metres above ground level. As outlined in Section 5.4.2 of this BDAR, 19 out of the total 28 species of microbats recorded during the field surveys were recorded by acoustic detectors mounted at approximately 60 meters elevation on met masts, representing air space within rotor swept area. Of the 19 species recorded at 60 metres elevation, eight are listed as threatened under either or both the NSW BC Act and Commonwealth EPBC Act. These include:

- Eastern Coastal Free-tailed Bat.
- Eastern False Pipistrelle.
- Greater Broad-nosed Bat.
- Large Bent-winged Bat.
- Large-eared Pied Bat.
- Little Bent-winged Bat.
- Little Pied Bat.
- Yellow-bellied Sheath-tailed Bat.

Activity levels for threatened microbats at elevations within rotor swept area range from a mean of 1.8 calls per night for Greater Broad-nosed Bat, 1.5 calls per night for Little Bent-winged Bat and 1.1 calls per night for

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Eastern False Pipistrelle, down to 0.2 calls per night for Little Pied Bat and 0.1 calls per night for Large-eared Pied Bat (averaged over the three detectors installed). These activity levels are considered low when compared to the White-striped Free-tail Bat, the most commonly recorded bat during the field survey, with an average of 39 calls per night recorded at 60 metres elevation, but activity levels quickly reduce for the remainder of the species in the bat population with only three other species more active than Greater Broad-nosed Bat within the range of rotor swept area.

As outlined in Section 5.4.2 of the BDAR, rates of impact cannot be quantified for microbats to the same degree they can for birds as to do so requires the number of individuals present within the project area to be determined, and microbats cannot realistically be counted. As such, assessment of potential impacts to microbats as a result of turbine strike has been undertaken by way of a qualitative risk assessment used to determine the likelihood of impact and the potential consequences of any impact that may occur.

The criteria used to establish likelihood of impact and potential consequences of turbine strike are provided in Table 60 below.

Table 60 Qualitative risk assessment criteria for likelihood and consequences of the impacts of turbine strike for microbats

Likelihood	Criteria	Consequence	Criteria
Rare	An event may occur only in unusual circumstances (<5%).	Negligible	Occasional individuals lost but no impact to the viability of the local or broader population.
Unlikely	An event could occur during some circumstances (>5 - <50%).	Minimal	Repeated loss of small number but no impact to the viability of the local or broader population.
Possible	An event could occur during most circumstances (>50% - <95%).	Moderate	Repeated loss of individuals that may cause changes to the local abundance of a species and affect the viability of the local or broader population.
Probable	An event is expected to occur in most circumstances (>95%).	Significant	Major loss of individuals that may cause changes to the regional or state population and affect the viability of the local or broader population.

The matrix used to qualify the risk associated with of the potential impacts established in accordance with the criteria outlined in Table 60 is provided in below in Table 61, with reference to the information provided in Table 44.

Table 61 Qualitative risk assessment matrix for significance of impacts of potential turbine collisions for microbats

Likelihood	Consequence			
	Negligible	**Minimal**	**Moderate**	**Significant**
Rare	Low	Low	Moderate	High
Unlikely	Low	Low	Moderate	High
Possible	Low	Moderate	High	High
Probable	Moderate	High	High	High

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The project specific risk assessment for the potential for turbine strike impacts for microbats is provided below in Table 62. The risk to nine species of bat is confirmed to be moderate, indicating that during the operational phase individual bats are likely to be injured. However, the risk to populations of each species is low as they occur in high densities throughout the Project Area and beyond.

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Table 62 Qualitative risk assessment for potential blade strike impacts to microbats

Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
White-striped Free-tailed bat	*Austronomus australis*	-	Recorded via ultrasonic detection in RSA	Prefers open foraging areas above canopy. A very common widespread species recorded in high numbers during site surveys. Recognised as an at risk bat species in relation to wind farm developments due to their foraging and flight behaviour. Due to its poor ability to detect and avoid obstacles, particularly mobile ones, such as turbine blades, White-striped Free-tail Bats are one of the most commonly recorded species in carcass monitoring at Australian windfarms. Highly susceptible to collision mortality regularly, however, populations generally secure and dense to withstand moderate instances of mortality should it occur.	Possible	Minimal	**Moderate**
Large-eared Pied Bat	*Chalinolobus dwyeri*	V - BC Act and V - EPBC Act	Recorded via ultrasonic detection in RSA	Declining species that roosts in caves and recorded onsite. Prefers edge or fringing areas of canopy for foraging, however may forage on occasion within RSH and therefore susceptible to collision risk where distances of RSH to canopy is <30m. Only two identified areas onsite that could potentially consist of breeding/roosting habitat. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.	Unlikely	Moderate	**Moderate**
Gould's Wattled Bat	*Chalinolobus gouldii*	-	Recorded via	A common and widespread large microbat	Unlikely	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
			ultrasonic detection in RSA	that is fast, high flier with restricted manoeuvrability. Like the White-striped Freetail Bat, this species has a poor ability to detect and avoid obstacles while pursuing prey, particularly mobile ones such as turbine blades. Highly susceptible to collision mortality regularly, however populations generally secure and dense to withstand moderate instances of mortality should it occur.			
Chocolate Wattled Bat	*Chalinolobus morio*	-	Recorded via ultrasonic detection in RSA	A relatively common and widespread microbat that is fast with increased manoeuvrability than the Gould's Wattled Bat. Generally restricted to canopies and fringing vegetation, may be susceptible to collision mortality on occasion, however populations generally secure and dense to withstand low instances of mortality should it occur.	Unlikely	Minimal	**Low**
Little Pied Bat	*Chalinolobus picatus*	V - BC Act	Recorded via ultrasonic detection in RSA	A declining species that occurs in dry open forest and woodlands. The subject land is within its most easterly distribution limit. Roosts in cave and occasionally within trees hollows and other structures. Relatively confined to canopies and timbered areas but may fly within RSH on occasion. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V - BC Act	Recorded via ultrasonic detection in RSA	A declining species generally confined to tall forests and woodlands. Generally known to fly below canopies and within RSH, recorded on site in low numbers, but one of the more common threatened species present within RSH. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.	Rare	Moderate	**Moderate**
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	V - BC Act	Recorded via ultrasonic detection in RSA	A declining species found within wide ranging habitats. recorded regularly during site surveys. Known to fly within or above canopies and within RSH, was recorded on site within RSH and therefore at risk of collision. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.	Rare	Moderate	**Moderate**
Little Bent-winged Bat	*Miniopterus australis*	V - BC Act	Recorded via ultrasonic detection in RSA	Little Bent-wing Bats is a small microbat that roosts in caves and disperse widely through a range of habitats. This species is migratory and are a fast-flying species that often forage beneath canopy height however may fly with RSH. May co-habitat with other cave dwelling microbats. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.	Rare	Moderate	**Moderate**
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	V - BC Act	Recorded via ultrasonic detection	Large Bent-wing Bats roost in caves and disperse widely through a range of	Unlikely	Moderate	**Moderate**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
			in RSA	habitats. Recorded regularly during site surveys. This species is migratory and are a fast-flying species that often forage above canopy height and may fly with RSH. Nearest maternity site likely to be used by individuals present within the project area is over 250 km to the south of the subject land. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.			
Southern Myotis	*Myotis macropus*	V - BC Act	Recorded onsite	Generally found around riparian areas. Not known to fly within RSH and not considered to be at risk of collision due to their favoured foraging and roosting preferences in gullies and surrounding waterways	Rare	Minimal	**Low**
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	-	Recorded onsite	A relatively common and widespread microbat that is fast with high manoeuvrability. Generally restricted to foraging within or beneath the canopy however may forage within open areas, especially where lights have attracted large insect numbers. Should a collision occur, it is likely only to occur to a very small number of individuals that would be impacted.	Rare	Minimal	**Low**
Northern Free-Tailed Bat	*Ozimops lumsdenae*	-	Recorded via ultrasonic detection in RSA	Widespread species of varying habitats, but rare within the locality. Fast and direct fliers of unobstructed air-spaces from just above to well above the canopy as well as above	Rare	Minimal	**Low**
Inland Free-tailed	*Ozimops petersi*	-	Recorded via		Unlikely	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
Bat			ultrasonic detection at canopy height	grasslands. Two species were recorded in low numbers within RSH at the site. Should a collision occur, it's likely only to occur to a very small number of individuals that would be impacted.			
South-eastern Free-tailed Bat	*Ozimops planiceps*	-	Recorded via ultrasonic detection at canopy height		Rare	Minimal	**Low**
Ride's Free-Tailed Bat	*Ozimops ridei*	-	Recorded via ultrasonic detection in RSA		Rare	Minimal	**Low**
Golden-tipped Bat	*Phoniscus papuensis*	V - BC Act	Recorded onsite	Generally found within wet sclerophyll and rainforest areas and not generally at high altitudes, which makes these observations somewhat unique. However, not known to fly within RSH and not considered to be at risk of collision due to their favoured foraging and roosting preferences.	Rare	Negligible	**Low**
Grey-headed Flying Fox	*Pteropus poliocephalus*	V - BC Act and V-EPBC Act	Sub-optimal habitat onsite and potential to move throughout the broader locality	A declining species that inhabits wide ranging habitats and moves large distances foraging, however generally roosts/breeds close to or near riparian areas. May occur on an intermittent bases transiting through the landscape, however the occurrence of known camps and forage resources mean regular flights through the development footprint are considered unlikely. Recent instances in Victoria have seen an increased rate of collision mortality. Should a collision occur, it is likely only to occur to a very small number of individuals that would be impacted.	Rare	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
Smaller Horseshoe Bat	*Rhinolophus megaphyllus*	-	Recorded via ultrasonic detection in RSA	Widespread and common cave dependent species. Often roost together in large numbers. Generally, fly close to the ground and beneath canopies, but on occasion fly with RSH and susceptible to collisions. Should a collision occur, it is likely only to occur to a very small number of individuals that would be impacted.	Rare	Negligible	**Low**
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	V - BC Act	Recorded via ultrasonic detection in RSH	Widespread species within a range of habitats including rainforest, woodland and grassland. High and fast flier over the forest canopy, but lower in more open areas and fringing vegetation. Roosts within tree hollows. Has potential to fly within RSH. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.	Unlikely	Moderate	**Moderate**
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V - BC Act	Recorded via ultrasonic detection in RSA	A declining species generally confined to timbered gullies and near riparian areas. Not commonly known to fly above canopies or within RSH but was recorded on site within RSH. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.	Unlikely	Moderate	**Moderate**
Inland Broad-nosed Bat	*Scotorepens balstoni*	-	Recorded via ultrasonic detection at canopy height	A widespread species that generally fly within riparian areas but may also fly above canopies and RSH on occasion. Highly mobile, however, not recorded within RSH and not considered to be at risk of collision	Rare	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
				due to their favoured foraging and roosting preferences. In the unlikely event a collision occurs, populations generally secure and dense to withstand low instances of mortality should it occur.			
Little Broad-nosed Bat	*Scotorepens greyii*	-	Recorded via ultrasonic detection in RSA	A common widespread species recorded regularly during site surveys. Generally, fly within riparian areas and woodland along the fringing areas of vegetation, but may also fly above canopies and RSH on occasion. Highly mobile and susceptible to collision mortality, however populations generally secure and dense to withstand moderate instances of mortality should it occur.	Possible	Minimal	**Moderate**
Eastern Broad-nosed Bat	*Scotorepens orion*	-	Recorded via ultrasonic detection at canopy height	A common coastal species, however on its most westerly distribution limit. Generally found within moist forests and woodlands. Generally fly within gullies and riparian areas but may also fly above canopies and RSH on occasion. Highly mobile, however, should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Negligible	**Low**
Large Forest Bat	*Vespadelus darlingtoni*	-	Recorded via ultrasonic detection at canopy height	A large widespread bat with restricted manoeuvrability due to its size. Not known to fly within RSH and not considered to be at risk of collision due to their favoured foraging and roosting preferences. In the	Unlikely	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
				unlikely event a collision occurs, populations generally secure and dense to withstand low instances of mortality should it occur.			
Southern Forest Bat	*Vespadelus regulus*	-	Recorded via ultrasonic detection at canopy height	A moderate sized widespread bat. Not known to fly within RSH and not considered to be at risk of collision due to their favoured foraging and roosting preferences. In the unlikely event a collision occurs, populations generally secure and dense to withstand low instances of mortality should it occur.	Rare	Minimal	**Low**
Eastern Cave Bat	*Vespadelus troughtoni*	V - BC Act	Recorded onsite	A cave dependent and uncommon species. Generally confined to forage beneath canopies and fringing vegetation but may make rapid skirmishes across open areas. Not recorded within RSH, however should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**Low**
Little Forest Bat	*Vespadelus vulturnus*	-	Recorded via ultrasonic detection in RSA	A small sized, very common and widespread bat. They are highly agile fast fliers with high manoeuvrability. May fly beneath and above canopy height and on occasion within RSH. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Unlikely	Minimal	**Low**

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Based on the table above, a total of nine species have been assessed as being subject to a Moderate risk of impact resulting from blade strike. Moderate risks relate to either an expectation for more frequent collisions with turbines due to a species proclivity for flights within rotor swept height, or more substantial impacts to local populations due to individuals comprising a more significant and/or substantial portion of the local population.

The nine species considered to be subject to a moderate risk of impact from turbine strike, include:

- White-striped Free-tailed bat (not listed).
- Large-eared Pied Bat – Vulnerable, BC Act and Vulnerable, EPBC Act.
- Eastern False Pipistrelle – Vulnerable, BC Act.
- Eastern Coastal Free-tailed Bat – Vulnerable, BC Act.
- Little Bent-winged Bat – Vulnerable, BC Act.
- Eastern Bent-winged Bat – Vulnerable, BC Act.
- Yellow-bellied Sheath-tailed Bat – Vulnerable, BC Act – Vulnerable, BC Act.
- Greater Broad-nosed Bat – Vulnerable, BC Act.
- Little Broad-nosed Bat (not listed).

As impacts associated with blade strike to the above species cannot be quantified and are considered somewhat uncertain, adaptive management is required through the preparation and implementation of an operational Bird and Bat Adaptive Management Plan (BBAMP) that will be prepared prior to operation of the wind farm. The BBAMP will allow for ongoing monitoring of any bat mortality, continually test the assumptions of this impact assessment and enable adaptive management measures to be implemented, if required, to reduce measured impacts. The plan will include methods for monitoring of bat mortality, provide any acceptable thresholds for mortality and adaptive management regimes if thresholds are exceeded.

Further detail on adaptive management and the likely contents of the BBAMP are provided in Section 8.10.2 below.

Whilst impacts to microbat species may occur as a result of turbine strike, it is considered unlikely that additional impacts will occur as a result of barotrauma. A paper published in December 2020 in the journal PLOS One, by Lawson et al, describes how mortality as a result of barotrauma is unlikely to occur due to the areas where exposure to the level of pressure variation required to cause mortality are present only in the immediately vicinity of the turbine blades, and that flight paths required for bats to be exposed to these areas are highly improbable. As such, even a small change in flight path would result in the bat being hit by the blade or experiencing a much smaller pressure change. Furthermore, the magnitude of the low-pressures bats could experience when flying near wind turbines is approximately 8 times smaller than the pressure that causes mortality in rats, the smallest mammal for which data are available. The magnitude of the high-pressures that bats may experience are approximately 80 times smaller than the exposure level that causes 50% mortality in mice, which have a body mass similar to several bat species that are killed by wind turbines in the United States (Lawson et al 2020).

The study concludes that, if bats have a physiological response to rapid low- and high-pressure exposure similar to that of other mammals, that it is unlikely that barotrauma is responsible for a significant number of turbine-related bat fatalities, and that impact trauma is the likely cause of the majority of wind-turbine-related bat fatalities. (Lawson et al 2020)

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The above information is not considered to lessen the overall likelihood or risk of mortality for microbats interacting with turbine blades, it is simply presented to address the potential for barotrauma specifically, to cause potential mortality.

8.3.2 Collision risk (birds)

The SEARs and the BAM require an impact assessment to migratory species and any resident raptors that may be subject to indirect impacts associated with blade strike during the operational phase of the project. The results of the bird utilisation survey and the Collision Risk Model (Appendix D) indicate that there are no migratory bird species at risk of collision with turbines during the operation of the wind farm. Three resident raptors were identified, including Wedge-tailed Eagle, Nankeen Kestrel and Brown Goshawk. It should be noted that this assessment was based on the Project's previous 70 turbine layout, and as such potential impacts are likely to have been reduced.

Using additional site based information from field surveys, as well as literature reviews, population estimates were able to be obtained for Wedge-tailed Eagle and Nankeen Kestrel to inform a more detailed assessment of the significance of impacts to these species. Based on this assessment it is considered unlikely that the project will have a significant impact on the population of resident raptors.

Cherriman (2007) provided an overview of studies that have investigated the size of Wedge-tailed Eagle territories in temperate regions. Territory sizes in studies near Perth (Cherriman 2007); at two other sites in the south-east of Western Australia (Ridpath and Brooker 1987); near Canberra in south- eastern Australia (Leopold and Wolfe 1970); and, in South Australia (Rowe et al. 2017) were all between 31 km² and 42 km². Foster and Wallis (2010) studied the species west of Melbourne and recorded nearest- neighbour distances averaged 4.7 kilometres. In a study in western NSW, Sharp et al. (2001) found the mean distance to nearest neighbour between Wedge-tailed Eagle nests was in the order of 1 pair per 3–9 km2. They noted this was considerably higher than that noted in other semi-arid zone studies (~1 pair per 40–48 km2).

Using a conservative mean Wedge-tailed Eagle territory size of 30 km², the average diameter of a territory would be slightly greater than 12 kilometres. As a consequence, we have based the modelling exercise for Wedge-tailed Eagles on the assumption that the 26 kilometre linear array of the proposed wind farm may intersect with three territories, occupied by six adult birds.

Cherriman (2013) reported that breeding productivity (number of chicks fledged) was 0.73 young per pair, across 15 occupied territory-years. Debus et al. (2007) recorded very similar results with 10 young produced in 12 pair-years, equating to 0.8 young fledged per pair per year. On the basis of those studies, we have conservatively assumed that, on average, three pairs will be accompanied by a total of three flying juveniles, bringing the average site-population of Wedge-tailed Eagles to a total of 9.

During field investigations of the site, field staff documented one instance each in which three, four and five Wedge-tailed Eagles were observed simultaneously.

Informed assumptions were able to be developed and employed for the potential site-population sizes of Nankeen Kestrels and Wedge-tailed Eagles and this permitted the model to provide projections expressed as average numbers of potential collisions per annum for those two species. Depending upon avoidance capacity and all other assumptions used for Nankeen Kestrels the model returned a likely range of between 0.07 and 0.36 collisions for that species per annum. Under the same caveats for Wedge-tailed Eagles, the likely range was between 0.98 and 5.86 collisions per annum.

Further to the quantitative Collision Risk Model undertaken to the project, an additional qualitative risk assessment for the impacts of turbine strike has been prepared for avian species known or considered to have the potential to occur within the project area, as provided above for microbats.

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Forest owl species assumed present within, and/or immediately surrounding, the development footprint (refer Section 5.4.2) are included as part of this risk assessment and have all been assessed as Low risk of impact through blade strike. This is due largely to their behaviour of flying within or just above the canopy, and therefore below rotor swept height.

The criteria used to establish likelihood of impact and potential consequences of turbine strike are provided in Table 63 below.

Table 63 Qualitative risk assessment criteria for likelihood and consequences of the impacts of turbine strike for birds

Likelihood	Criteria	Consequence	Criteria
Rare	An event may occur only in unusual circumstances (<5%).	Negligible	Occasional individuals lost but no impact to the viability of the local or broader population.
Unlikely	An event could occur during some circumstances (>5 - <50%).	Minimal	Repeated loss of small number but no impact to the viability of the local or broader population.
Possible	An event could occur during most circumstances (>50% - <95%).	Moderate	Repeated loss of individuals that may cause changes to the local abundance of a species for up to 5 years.
Probable	An event is expected to occur in most circumstances (>95%).	Significant	Major loss of individuals that may cause changes to the regional or state population of a species for up to 10 years.

The matrix used to qualify the risk associated with of the potential impacts established in accordance with the criteria outlined above is provided in below in Table 64.

Table 64 Qualitative risk assessment matrix for significance of impacts of potential turbine collisions for birds

Likelihood	Consequence			
	Negligible	**Minimal**	**Moderate**	**Significant**
Rare	Low	Low	Moderate	High
Unlikely	Low	Low	Moderate	High
Possible	Low	Moderate	High	High
Probable	Moderate	High	High	High

The project specific risk assessment for the potential for turbine strike impacts for birds is provided below in Table 65.

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Table 65 Qualitative risk assessment for potential blade strike impacts to birds

Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
Australian Magpie	*Cracticus tibicen*	-	Observed in subject land	Common widespread species within varying habitats. Generally prefer more open space and woodlands and not generally found within dense forests. May suffer collision mortality, however populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Australian Raven	*Corvus coronoides*	-	Observed in subject land	Common widespread species found within all habitats. Highly disturbance tolerant species. May suffer collision mortality due to unmitigated or opportunistic carcass predation, however populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Barking Owl	*Ninox connivens*	V - BC Act	Habitat onsite and potential to occur within the broader locality	Distributed widely but declining and uncommon species within woodlands, fringing forests and rural areas. Roosts often occur near or adjacent to riparian areas. Generally moves throughout or just above canopy, and unlikely to move within the RSH. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**Low**
Black Kite	*Milvus migrans*	-	Habitat onsite and potential to occur within the broader locality	Common widespread species within varying habitats. Highly disturbance tolerant species and may occur in large numbers at times due to other environmental factors i.e. foraging opportunities. Soars on thermals and often undertakes aerobatic displays increasing collision risk. Populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Brown Falcon	*Falco berigora*	-	Habitat onsite and	Common widespread species within varying habitats.	Rare	Negligible	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
			potential to occur within the broader locality	May suffer collision mortality regularly due to unmitigated or opportunistic carcass predation. Not known to be deterred by wind turbines, Brown Falcons are been found regularly in carcass searches at Victorian wind farms. Populations generally secure and robust to withstand low instances of mortality should it occur.			
Brown Goshawk	*Accipiter fasciatus*	-	Observed in subject land	Widespread but uncommon species found within woodland and forest habitats, often nesting near riparian areas. Populations generally secure and robust to withstand low instances of mortality in the unlikely event it should occur.	Unlikely	Minimal	**Low**
Crimson Rosella	*Platycercus elegans*	-	Observed in subject land	Widespread and common species of woodland and forest habitats within the tablelands. Generally occur in small flocks or pairs and move generally within or just above canopy height. Populations generally secure and robust to withstand low instances of mortality in the unlikely event it should occur.	Rare	Negligible	**Low**
Dusky Woodswallow	*Artamus cyanopterus*	V - BC Act	Habitat onsite and potential to occur within the broader locality	Widespread but declining species of open woodlands that can be resident, nomadic or seasonally migratory. Often seen at foraging at varying heights in small to moderate sized flocks, often with other aerial foragers. At risk of collision as may fly within RSH, however, should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**Low**
Fork-tailed Swift	*Apus pacificus*	M	Habitat onsite and potential to occur	Widespread however sparsely distributed often following weather events. Soars within and above RSH	Unlikely	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
			within the broader locality	so at risk of collision. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted			
Galah	*Eolophus roseicapilla*	-	Observed in subject land	Common widespread species within varying habitats. Generally prefer more open space and woodlands and not generally found within dense forests. May occur in large flocks. May suffer collision mortality on occasion, however populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Glossy Black Cockatoo	*Calyptorhynchus lathami*	V - BC Act	Habitat onsite and potential to occur within the broader locality	Widespread but rare species highly dependent on woodland and open forests with substantial distribution of Allocasuarina within the midstorey. Hollow dependent. Moving throughout the landscape more readily due to bushfire impacts, but generally move just above canopy height, and unlikely to fly within RSH regularly. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**Low**
Laughing Kookaburra	*Dacelo novaeguineae*	-	Observed in subject land	Widespread disturbance tolerant species that inhabits most vegetation types. Mostly confined to skirmishes from perched positions but may move throughout the landscape above canopy height. Unlikely to suffer collision mortality regularly, however populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Little Eagle	*Hieraaetus morphnoides*	-	Habitat onsite and potential to occur	Widespread but rare and declining species of woodlands, open forests and rural areas. When seen,	Unlikely	Moderate	**Moderate**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
			within the broader locality	often soaring within thermals above or within RSH. Not recorded during site surveys however may occur in future in low densities and at risk of collision. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.			
Little Lorikeet	*Glossopsitta pusilla*	V - BC Act	Observed in subject land	Uncommon but widespread species within woodland and forest habitats on tablelands and coastal regions. Generally sparse on the tablelands however may suffer collision mortality on occasion. Should a collision occur, it's likely only to occur to a very small number of individuals that would be impacted.	Rare	Minimal	**Low**
Little Wattlebird	*Anthochaera chrysoptera*	-	Observed in subject land	Inhabits varying coastal habitats and on the edge of it is westerly distribution. Prefers dry heathy habitats and woodlands. May suffer collision mortality on occasion, however populations generally secure and robust to withstand low instances of mortality should it occur	Rare	Negligible	**Low**
Masked Owl	*Tyto novaehollandiae*	V - BC Act	Habitat onsite and potential to occur within the broader locality	Distributed widely but declining and uncommon species within woodlands, fringing forests and rural areas. Generally moves throughout or just above canopy, and unlikely to move within the RSH. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**Low**
Nankeen Kestrel	*Falco cenchroides*	-	Observed in subject land	Widespread species often in high densities across varying habitats, but commonly encountered in open woodland and farmland areas. One of the most commonly encountered species in mortality surveys at established wind farms in Australia. May suffer	Possible	Minimal	**Moderate**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
				collision mortality regularly, however populations generally secure and robust to withstand low instances of mortality should it occur.			
Pied Currawong	*Strepera graculina*	-	Observed in subject land	Common altitudinal nomadic species but now more common and widespread within varying habitats. Aggressive and disturbance tolerant species. May suffer collision mortality on occasion, however populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Powerful Owl	*Ninox*	V - BC Act	Habitat onsite and potential to occur within the broader locality	Largest of Australia's owls and generally distributed in tall forests east of the Great Dividing Range, and rarely seen in recent times on the western slopes, however this is likely dependent on abundance of suitable hollows and preferred large prey abundance. Generally moves throughout or just above canopy in forested areas, and unlikely to move within the RSH, however some juveniles may disperse further and higher than normal. In the rare event that a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**Low**
Rainbow Lorikeet	*Trichoglossus moluccanus*	-	Observed in subject land	Disturbance tolerant and widespread species within woodland and forest habitats on tablelands and coastal regions. Generally sparse on the tablelands however may suffer collision mortality on occasion. Populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Red Wattlebird	*Anthochaera carunculata*	-	Observed in subject land	Aggressive honeyeater that inhabits varying coastal habitats and on the edge of it is westerly distribution.	Rare	Negligible	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
				Prefers dry forest and woodland habitats. Sparsely distributed throughout the tablelands and unlikely to suffer from collision mortality, however populations generally secure and robust to withstand low instances of mortality should it occur			
Regent Honeyeater	*Anthochaera phrygia*	CE - BC Act and CE - EPBC Act	Habitat onsite and potential to occur within the broader locality	A highly mobile critically endangered species that is cryptic and nomadic and generally follows blossoming eucalypts and mistletoes through eucalypt forest and woodlands. Associated with the inland/eastern slopes of the Great Dividing Range, particularly Capertee Valley, Bingara/Barraba regions and the Hunter Valley and Central Coast of NSW (Bird Life Australia 2016). Generally sticks to canopies and number of individuals and flights over the turbine locations is likely to be low.	Rare	Minimal	**Low**
Sooty Owl	*Tyto tenebricosa*	V - BC Act	Habitat onsite and potential to occur within the broader locality	Distributed widely but declining and uncommon species within woodlands, fringing forests and rural areas. Generally moves throughout or just above canopy, and unlikely to move within the RSH. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Rare	Minimal	**LOW**
Square-tailed Kite	*Lophoictinia isura*	V - BC Act	Habitat onsite and potential to occur within the broader locality	Uncommon species that inhabits open eucalypt forests and woodlands, often where there is a broken canopy, but it also ranges into nearby open habitats to forage. Generally nests along or near riparian areas. The NSW Scientific Committee (2009) considers that "windfarms may cause occasional collision mortalities of Square-tailed Kites, although this species is a very manoeuvrable, slow flyer and is probably capable of generally avoiding collisions with turbines blades." Not	Rare	Moderate	**Moderate**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
				recorded during site surveys however may occur in future in low densities and at risk of collision. In the unlikely event that collisions occur, impacts to the local population of the species may eventuate.			
Spotted Pardalote	*Pardalotus punctatus*	-	Observed in subject land	Common widespread species within forest canopies and woodlands habitats, that nest within hollows in tunnels on the ground. Unlikely to suffer collision mortality as tends to stick within canopies for foraging and movement, however populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Sulphur-crested Cockatoo	*Cacatua galerita*	-	Habitat onsite and potential to occur within the broader locality	Common resident and widespread species within varying timbered habitats. Generally prefer more open space and woodlands and not generally found within dense forests. May occur in large flocks. May suffer collision mortality on occasion, however populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
Swift Parrot	*Lathamus discolor*	E - BC Act and CE - EPBC Act	Foraging and transient habitat onsite and potential to occur within the broader locality	Highly mobile winter non-breeding migrants to NSW and Vic, Swift Parrots move nomadically through the landscape, using a diversity of foraging habitats within coastal and tableland regions. Generally move along lower slopes and gullies. Likelihood of collision risk is considered very low.	Rare	Minimal	**Low**
Turquoise Parrot	*Neophema pulchella*	V- BC Act	Habitat onsite and potential to occur within the broader locality	Declining species that favours open, grassy woodland with dead trees that fringe large patches of remnant vegetation and near permanent water. A fast flier at a range of heights, this species may be susceptible to	Rare	Minimal	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
				collision risk if moving throughout the site. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted			
Wedge-tailed Eagle	*Aquila audax*	-	Observed in subject land	Widespread and disturbance tolerant species but most exposed risk of collision due to soaring of thermals whilst foraging. Have been known to be struck at other wind farms in NSW and Vic. Populations generally secure and robust but may suffer collision mortality regularly and therefore, impacts to the local population of the species may eventuate.	Possible	Minimal	**Moderate**
Whistling Kite	*Haliastur sphenurus*	-	Habitat onsite and potential to occur within the broader locality	Widespread species often seen in pairs and commonly encountered in open woodland, farmland areas and wetlands. Generally nests near riparian areas and waterways. May suffer collision mortality on occasion, however populations generally secure and robust to withstand low instances of mortality should it occur.	Unlikely	Minimal	**Low**
White-breasted Woodswallow	*Artamus leucorynchus*	-	Observed in subject land	Widespread species of open woodlands generally close to water. Often seen at foraging at varying heights in small to moderate sized flocks, often with other aerial foragers. At risk of collision as may fly within RSH, however, should a collision occur, its likely only to occur to a very small number of individuals that would be impacted and populations generally secure and robust to withstand low instances of mortality should it occur.	Rare	Negligible	**Low**
White-throated	*Cormobates*	-	Observed in	Resident species of forest, woodlands and	Rare	Negligible	**Low**

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Common name	Scientific name	Status	Reasoning	Habitat values and behavioural considerations	Indirect impact - Collision risk		
					Likelihood	Consequence	Risk
Treecreeper	*leucophaea*		subject land	occasionally rainforest habitats. Generally occurs within low canopy and not at risk of collision.			
White-throated Needletail	*Hirundapus caudacutus*	V - EPBC Act	Habitat onsite and potential to occur within the broader locality	Widespread non-breeding migratory species within Australia that is an aerial forager, infrequently coming to timbered areas for respite, and therefore often fly within or above RSH. Mortality has been known to occur at other wind farms however is uncommon. Should a collision occur, its likely only to occur to a very small number of individuals that would be impacted	Unlikely	Minimal	**Low**
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	-	Observed in subject land	Common widespread species within a range of eucalyptus and pine dominated woodland and forest habitats. May occur in large flocks and move above around the landscape through RSH. May suffer collision mortality on occasion, however populations generally secure and robust to withstand low instances of mortality should it occur.	Unlikely	Negligible	**Low**

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Based on the table above, a total of four species have been assessed as being subject to a Moderate risk of impact resulting from blade strike. Moderate risks relate to either an expectation for more frequent collisions with turbines due to a species proclivity for flights within rotor swept height, or more substantial impacts to local populations due to individuals comprising a more significant and/or substantial portion of the local population.

The four species considered to be subject to a moderate risk of impact from turbine strike, include:

- Little Eagle – Vulnerable, BC Act
- Nankeen Kestrel
- Square-tailed Kite – Vulnerable, BC Act
- Wedge-tailed Eagle

As impacts associated with blade strike are considered somewhat uncertain in accordance with the BAM, and as previously mentioned, adaptive management is required through the preparation and implementation of an operational BBAMP that will be prepared prior to operation of the wind farm.

8.3.3 Turbine risk assessment

To further assess potential risk of impact to threatened species associated with turbine placement, barriers to movement and potential collision with turbine blades, a qualitative risk assessment has been prepared on a per turbine basis. Factors considered when assessing the risk associated with the turbines include:

- Proximity to potential microbat roosts.
- Connectivity.
- Presence of raptor nests.
- Fauna sightings within the development footprint and surrounds.
- Presence of hollow-bearing trees.
- Proximity to National Park's estate.
- Canopy buffer to rotor swept height.
- Turbine proximity and predicted zone of disturbance.

Table 66 provides guidance on how the above consideration have been applied with regards to potential turbine risk. Table 57 provides the results of the risk assessment for the 70 turbines proposed for the project. The risk assessment table is based on that contained in Section 7.2 of this BDAR.

Table 66 Qualitative risk consideration for turbines

Risk	Collision Risk	Barrier Effect Risk
Low	Potential unacceptable triggers considered unlikely. Adaptive management and monitoring of impact triggers may be required within the BBAMP	Negligible impacts on connectivity or for the turbine to influence altered flight behaviour or sterilse habitat for a species
Minimal		Minor impacts on connectivity and potential for turbines to influence altered flight behaviour or sterilse habitat for a species

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Risk	Collision Risk	Barrier Effect Risk
Moderate	Potential unacceptable triggers considered possible. Stringent mitigation may be required pending adaptive management to be identified within the BBAMP	Considerable impacts on connectivity and likely for turbines to influence altered flight behaviour or sterilse habitat for a species
High	Potential unacceptable triggers considered probable. Stringent mitigation measures required prior to construction and detailed within BBAMP	Significant impacts on connectivity and likely for turbines to influence altered flight behaviour or sterilse habitat for a species

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Table 67 Qualitative risk assessment for turbines for full 70 turbine layout

Turbine No.	Dist. to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)	Collison Risk	Barrier effect Risk	Comments
WP1	22.11	1194- high	23.5	36.6	Moderate	Low	**Removed from project layout**
WP2	36.1	1194- high	23.5	40.01	Low	Low	Relocated within project layout
WP3	56.31	1194- high; 934-mod	23.5	47.5	Low	Low	
WP4	23.89	507-mod	20	40.38	Moderate	Low	
WP5	43.07	1194-mod	23.5	42.27	Low	Low	
WP6	31.64	1194-high	23.5	38.76	Moderate	Low	
WP7	39.75	1194-high	23.5	41.15	Low	Low	
WP8	38.13	931-mod; 934-low	23.5	40.63	Low	Low	
WP9	30.14	931-mod; 1194-low	23.5	38.37	Moderate	Low	
WP10	66.42	931; 1194; 934-mod	23.5	52.24	Moderate	Low	
WP11	25.73	931-mod; 934-high	23.5	37.33	Moderate	Low	
WP12	42.53	934-mod; 1194-high; 954-high	23.5	42.08	Low	Minimal	
WP13	54.16	954-high	23.5	46.57	Low	Minimal	
WP14	59.73	931-mod; 1194-DNG; 954-high	23.5	49.03	Low	Minimal	
WP15	43.57	1194-DNG&Mod; 954-High	23.5	42.44	Low	Low	
WP16	29.47	1194-mod	23.5	38.2	Moderate	Low	
WP17	33.47	1194-mod; 934-high	13.5	48.89	Low	Low	
WP18	23.17	1194-mod; 934-mod&high	23.5	36.8	Moderate	Low	
WP19	30.8	934-high	13.5	48.22	Low	Low	**Removed from project layout**
WP20	30.97	1194-high; 934-low	23.5	38.58	Low	Low	
WP21	23.58	1194-high	23.5	36.88	Moderate	Low	
WP22	26.99	1194; 934-high	23.5	37.61	Moderate	Low	

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Turbine No.	Dist. to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)	Collison Risk	Barrier effect Risk	Comments
WP23	23	1194-mod	23.5	36.77	High	Low	**Removed from project layout**
WP24	24.78	1194-mod	23.5	37.13	Moderate	Low	
WP25	93.27	934-low	23.5	67.46	Low	Low	
WP26	184.47	NA		149.97	Low	Low	
WP27	22.47	1194-high	23.5	36.67	High	Low	**Removed from project layout**
WP28	31.79	1194-high	23.5	38.8	Moderate	Minimal	
WP29	43.46	931-mod; 934-DNG&mod	18.5	47.1	Low	Minimal	
WP30	50.89	931-mod; 934-DNG&mod	28.5	40.66	Low	Minimal	
WP31	21.15	931; 1194-high	23.5	36.42	High	Minimal	**Removed from project layout**
WP32	51.47	931-high; 1194-DNG&mod	18.5	50.03	Moderate	Minimal	
WP33	22.74	931-high; 1194-mod	23.5	36.72	Moderate	Minimal	
WP34	35.18	1194-mod&high	18.5	42.1	Low	Minimal	
WP35	157.02	NA		128.7	Low	Minimal	
WP36	33.07	1194-low&mod	23.5	39.14	Moderate	Minimal	
WP37	78.76	1194-low&high	18.5	62.96	Moderate	Minimal	
WP38	43.11	1194-high	23.5	42.28	Moderate	Minimal	
WP39	59.15	1194-mod&high	23.5	48.77	Moderate	Minimal	
WP40	35.35	931-low; 934-high	18.5	54.2	Moderate	Minimal	
WP41	39.16	934-high	13.5	50.47	Moderate	Minimal	
WP42	38.57	1194-low&high	13.5	50.29	Moderate	Minimal	
WP43	23	1194-mod	23.5	36.77	Moderate	Minimal	
WP44	95.29	NA		87.53	Low	Low	
WP45	184.62	NA		150.1	Low	Low	
WP46	34.7	1194-mod&high	23.5	39.6	Low	Low	
WP47	169.27	1194-low&high	23.5	123.92	Low	Low	Relocated within project layout

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Turbine No.	Dist. to foraging habitat (m)	PCTs and condition in 100m buffer	Feature height (m)	Buffer distance (m)	Collison Risk	Barrier effect Risk	Comments
WP48	37.74	1194-low&high	23.5	40.51	Low	Low	
WP49	26.72	1194-low&high	23.5	37.55	Moderate	Low	
WP50	46.07	1194-low, mod&high	23.5	43.35	Moderate	Low	**Previously high risk for collision** Relocated within project layout
WP51	36.85	1194-low&mod	23.5	40.24	Moderate	Low	
WP52	68.19	1194-low	23.5	53.13	Low	Low	
WP53	38.23	1194-low&high	18.5	45.42	Low	Low	
WP54	36.15	1194-low, mod&high	23.5	40.02	Low	Low	
WP55	161.17	NA		131.83	Low	Low	
WP56	93.9	1194-mod	23.5	67.85	Low	Low	
WP57	39.46	1194-mod	23.5	41.05	Low	Low	
WP58	33.26	1194-mod	23.5	39.19	Moderate	Low	
WP59	35.13	1194-low&high;934-high	23.5	39.72	Moderate	Low	
WP60	60.22	1194-low&mod;934-high	23.5	49.26	Low	Low	
WP61	23.1	1194-mod&high; 927-high	23.5	36.79	Moderate	Low	
WP62	55.81	1194-low&mod	23.5	47.28	Low	Low	
WP63	30.64	1194-mod	23.5	38.5	Low	Low	
WP64	38.66	1194-high; 927-high	23.5	40.8	Moderate	Low	
WP65	44.33	1194-high	23.5	42.71	Low	Low	
WP66	44.98	931-high;1194-mod	23.5	42.95	Low	Low	
WP67	113.66	1194-low	23.5	81.05	Low	Low	
WP68	51.78	1194-low&mod	23.5	45.57	Low	Low	
WP69	54.66	1194-low	23.5	46.78	Low	Low	
WP70	28.16	1194-low; 931-high	23.5	37.88	Moderate	Low	

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Based on the table above, a total of four turbines were assessed as representing a High risk of impact to threatened species (WP23, WP27, WP31, WP50), based largely on proximity to threatened microbat and potential owl breeding habitat, and also relating to their location, canopy buffer and surrounding intact vegetation. Three of these turbines (WP23, WP27, WP31) have all subsequently been removed from the project due in a large part to the high level of risk to biodiversity values assessed as part of the above analysis. WP50 has also been substantially relocated to ensure no direct or indirect impacts will occur within the 100 metre BAM prescribed microbat breeding habitat buffer on adjacent habitat, reducing its risk to moderate. The removal of these turbine from the Project means that serious and irreversible impacts to microbats are unlikely to occur as a result of development in proximity to confirmed potential breeding habitat. The High risk rating for WP50 has been downgraded to moderate, however a high level of monitoring an additional mitigation will occur from the outset given it is the closest turbine to potential microbat breeding habitat (refer Section 8.10 for further detail).

Two additional turbines (WP1 and WP19) have also been removed from the Project which has resulted in decreased direct and indirect impacts to biodiversity values, and turbines WP2 and WP47 have also been relocated or re-orientated resulting in reduced impacts to biodiversity values. Removing WP19 creates a gap of over 2 kilometres between turbine WP18 and turbines WP20-22, and the removal of WP19 allows for an approximate 600 metre reduction of the intrusion into intact vegetation to the south of the development footprint, allowing more available airspace for aerial fauna around the southern extent of the wind farm corridor. The removal of turbines WP19, WP23, WP27 and WP31 have resulted in reduced impacts to habitat connectivity in the southern portion of the development footprint. More information is provided in Section 8.5.

In total, 30 have been assessed as representing a Moderate risk based on current data and assessment. Additional operational mitigation strategies have been developed for higher risk turbines and with tier triggers outlined in Section 8.9 and 8.10 of this BDAR. The remaining 35 turbines have been assessed as Low risk however will also be subject to additional mitigation strategies to reduce potential impacts to threatened species.

8.3.4 Barrier effect risk assessment

In order to predict and account for the uncertainty of the impacts of barrier effects, a precautionary approach was undertaken. The criteria used to establish likelihood of impact and potential consequences of barrier effects and altered flight behaviour at a species level is based largely on;

- Animal behaviour (including forage flight characteristics (refer Table 44 for microbats)).
- Landscape setting (topography, distance to habitat),
- Turbine clusters within zones.
- Individual turbine spacing accounting for blade to blade width and assumed zone of disturbance (maximum of 135m from the rotor hub).

Where individual spacing (<200m) and/or potential zone of disturbance overlap or become in close proximity to each other, this represents identified turbines clusters that may have a slight increase in an inherent risk associated with barrier effects or altered flight behaviour. Some evidence suggests from studies at windfarms abroad that turbines to closely spaced (<200m) did have an mild effect of flight behaviour, with a preference for routes taken between turbines spaced between 200-400m apart (Tulp et al. 1999 and Percival 2001). It should be noted that these studies were based on seabirds and offshore wind farms, however directly comparable data is lacking (i.e. Australian studies). It does however illustrate that birds will fly between turbines where sufficient space exists.

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The zoning of turbines represent the western, central and northern zones of the subject land as defined below and shown in Figure 25;

- Western Zone –WT 2 to WT 18
- Central Zone – WT 20 to WT 48
- Northern Zone – WT 49 to WT 70

Table 70 demonstrates the overall risk assessment on individual species that are known or may occur within the subject land is low, taking into account parameters mentioned above. Risk associated with turbine clusters or and individual turbines is demonstrated in Table 67. Although the overall risk of barrier effects and altered flight behaviour based on the information available and literature review is considered low (refer Section 8.5 for further detail), adaptive management, additional mitigation and compensatory measures may be required should a residual impact resulting from barrier effects occur. Following completion of baseline monitoring, and during operational monitoring, if there is a noted discernible statistical reduction or anomaly in abundance of an at risk or threatened species, additional investigations into possible causes would occur. If it is determined that the operational wind farm was a key factor, additional assessment against key relevant Test of Significance criteria or Significant Impact Criteria would be used to quantify or measure the level of impact, and if determined that an event resulting from barrier effects warranted additional mitigation, compensatory measures or species specific offsetting, these would be employed. This detail and decision framework will be provided within the Bird and Bat Adaptive Management Plan (BBAMP).

Additionally, detailed prescribed impact assessment in relation to connectivity and barrier effects can be found in Sections 8.3.1, 8.3.2 and 8.5.1.

Table 68 Qualitative risk assessment criteria for likelihood and consequences of the impacts associated with barrier effects, connectivity or altered flight behaviour

Likelihood	Criteria	Consequence	Criteria
Rare	An event may occur only in unusual circumstances (<5%).	**Negligible**	Negligible impacts to connectivity or for the potential for altered flight behaviour or habitat sterilisation for a local population.
Unlikely	An event could occur during some circumstances (>5 - <50%).	**Minimal**	Minor impacts to connectivity resulting in the potential for altered flight behaviour or habitat sterilisation for a local population.
Possible	An event could occur during most circumstances (>50% - <95%).	**Moderate**	Considerable impacts to connectivity resulting possible altered flight behaviour or habitat sterilisation for a local population.
Probable	An event is expected to occur in most circumstances (>95%).	**Significant**	Significant loss of connectivity resulting in substantial altered flight behaviour or habitat sterilisation for a local population.

Table 69 Qualitative risk assessment matrix for significance of impacts associated with barrier effects, connectivity or altered flight behaviour

Likelihood	Consequence			
	Negligible	**Minimal**	**Moderate**	**Significant**
Rare	Low	Low	Moderate	High

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Likelihood	Consequence			
	Negligible	**Minimal**	**Moderate**	**Significant**
Unlikely	Low	Low	Moderate	High
Possible	Low	Moderate	High	High
Probable	Moderate	High	High	High

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Table 70 Qualitative risk assessment for potential barrier effect impacts to birds and bats

Common name	Scientific name	Status	Western Zone			Central Zone			Northern zone		
			Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
Australian Magpie	*Cracticus tibicen*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Australian Raven	*Corvus coronoides*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Barking Owl	*Ninox connivens*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Minimal	**Low**
Black Kite	*Milvus migrans*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
Brown Falcon	*Falco berigora*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
Brown Goshawk	*Accipiter fasciatus*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Chocolate Wattled Bat	*Chalinolobus morio*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Crimson Rosella	*Platycercus elegans*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Dusky Woodswallow	*Artamus cyanopterus*	V - BC Act	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Eastern Bent-winged Bat	*Miniopterus orianae oceanensis*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Minimal	**Low**
Eastern Broad-nosed Bat	*Scotorepens orion*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Eastern Cave Bat	*Vespadelus troughtoni*	V - BC Act	Unlikely	Negligible	**Low**	Unlikely	Minimal	**Low**	Unlikely	Negligible	**Low**
Eastern	*Micronomus*	V - BC	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**

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Common name	Scientific name	Status	Western Zone			Central Zone			Northern zone		
			Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
Coastal Free-tailed Bat	*norfolkensis*	Act									
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Minimal	**Low**
Fork-tailed Swift	*Apus pacificus*	M	Rare	Minimal	**Low**	Rare	Minimal	**Low**	Rare	Minimal	**Low**
Flame Robin	*Petroica phoenicea*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Galah	*Eolophus roseicapilla*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Glossy Black Cockatoo	*Calyptorhynchus lathami*	V - BC Act	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Golden-tipped Bat	*Phoniscus papuensis*	V - BC Act	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Gould's Wattled Bat	*Chalinolobus gouldii*	-	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V - BC Act	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Grey-headed Flying Fox	*Pteropus poliocephalus*	V - BC Act and V- EPBC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Inland Broad-nosed Bat	*Scotorepens balstoni*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Inland Free-	*Ozimops petersi*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**

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Common name	Scientific name	Status	Western Zone			Central Zone			Northern zone		
			Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
tailed Bat											
Large-eared Pied Bat	*Chalinolobus dwyeri*	V - BC Act and V - EPBC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Negligible	**Low**
Large Forest Bat	*Vespadelus darlingtoni*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Laughing Kookaburra	*Dacelo novaeguineae*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Little Broad-nosed Bat	*Scotorepens greyii*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Little Bent-winged Bat	*Miniopterus australis*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Negligible	**Low**
Little Eagle	*Hieraaetus morphnoides*	-	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Little Forest Bat	*Vespadelus vulturnus*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Little Lorikeet	*Glossopsitta pusilla*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Little Pied Bat	*Chalinolobus picatus*	V - BC Act	Rare	Minimal	**Low**	Rare	Minimal	**Low**	Rare	Minimal	**Low**
Little Wattlebird	*Anthochaera chrysoptera*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**

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Common name	Scientific name	Status	Western Zone			Central Zone			Northern zone		
			Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
Masked Owl	*Tyto novaehollandiae*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Negligible	**Low**
Nankeen Kestrel	*Falco cenchroides*	-	Possible	Negligible	**Low**	Possible	Negligible	**Low**	Possible	Negligible	**Low**
Northern Free-Tailed Bat	*Ozimops lumsdenae*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Pied Currawong	*Strepera graculina*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Powerful Owl	*Ninox*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Negligible	**Low**
Rainbow Lorikeet	*Trichoglossus moluccanus*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Red Wattlebird	*Anthochaera carunculata*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Regent Honeyeater	*Anthochaera phrygia*	CE - BC Act and CE - EPBC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Negligible	**Low**
Ride's Free-Tailed Bat	*Ozimops ridei*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Smaller Horseshoe Bat	*Rhinolophus megaphyllus*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Sooty Owl	*Tyto tenebricosa*	V - BC	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Rare	Negligible	**Low**

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Common name	Scientific name	Status	Western Zone			Central Zone			Northern zone		
			Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
		Act									
South-eastern Free-tailed Bat	*Ozimops planiceps*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Southern Forest Bat	*Vespadelus regulus*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
Southern Myotis	*Myotis macropus*	V - BC Act	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Square-tailed Kite	*Lophoictinia isura*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Spotted Pardalote	*Pardalotus punctatus*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Sulphur-crested Cockatoo	*Cacatua galerita*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
Swift Parrot	*Lathamus discolor*	E - BC Act and CE - EPBC Act	Rare	Minimal	**Low**	Rare	Minimal	**Low**	Rare	Negligible	**Low**
Turquoise Parrot	*Neophema pulchella*	V- BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Negligible	**Low**
Wedge-tailed Eagle	*Aquila audax*	-	Possible	Negligible	**Low**	Possible	Negligible	**Low**	Possible	Negligible	**Low**
Whistling Kite	*Haliastur sphenurus*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**

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Common name	Scientific name	Status	Western Zone			Central Zone			Northern zone		
			Likelihood	Consequence	Risk	Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
White-breasted Woodswallow	*Artamus leucorynchus*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Rare	Negligible	**Low**
White-striped Free-tailed bat	*Austronomus australis*	-	Possible	Negligible	**Low**	Possible	Negligible	**Low**	Possible	Negligible	**Low**
White-throated Treecreeper	*Cormobates leucophaea*	-	Rare	Negligible	**Low**	Rare	Negligible	**Low**	Rare	Negligible	**Low**
White-throated Needletail	*Hirundapus caudacutus*	V - EPBC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*	V - BC Act	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**	Unlikely	Minimal	**Low**
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	-	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**

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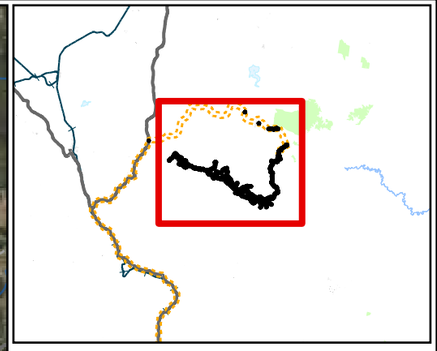

Legend

- Landscape assessment buffer (study area)
- Infrastructure footprint
- Transport haul routes
- 85m zone of distrubance
- 135m zone of disturbance

Wind turbine risk

- Low
- Moderate

Wind turbine barrier effect risk

- Minimal
- Negligible

Zone

- Central
- Northern
- Western

Figure 25 Barrier effects, Page 1

0 1,250 2,500 3,750 5,000 Meters

N

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 23 March 2022 ,
Prepared for: CW, Prepared by: LH, Last edited by: jtownsend
Layout: 34963_F25a_BarrierEffects
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

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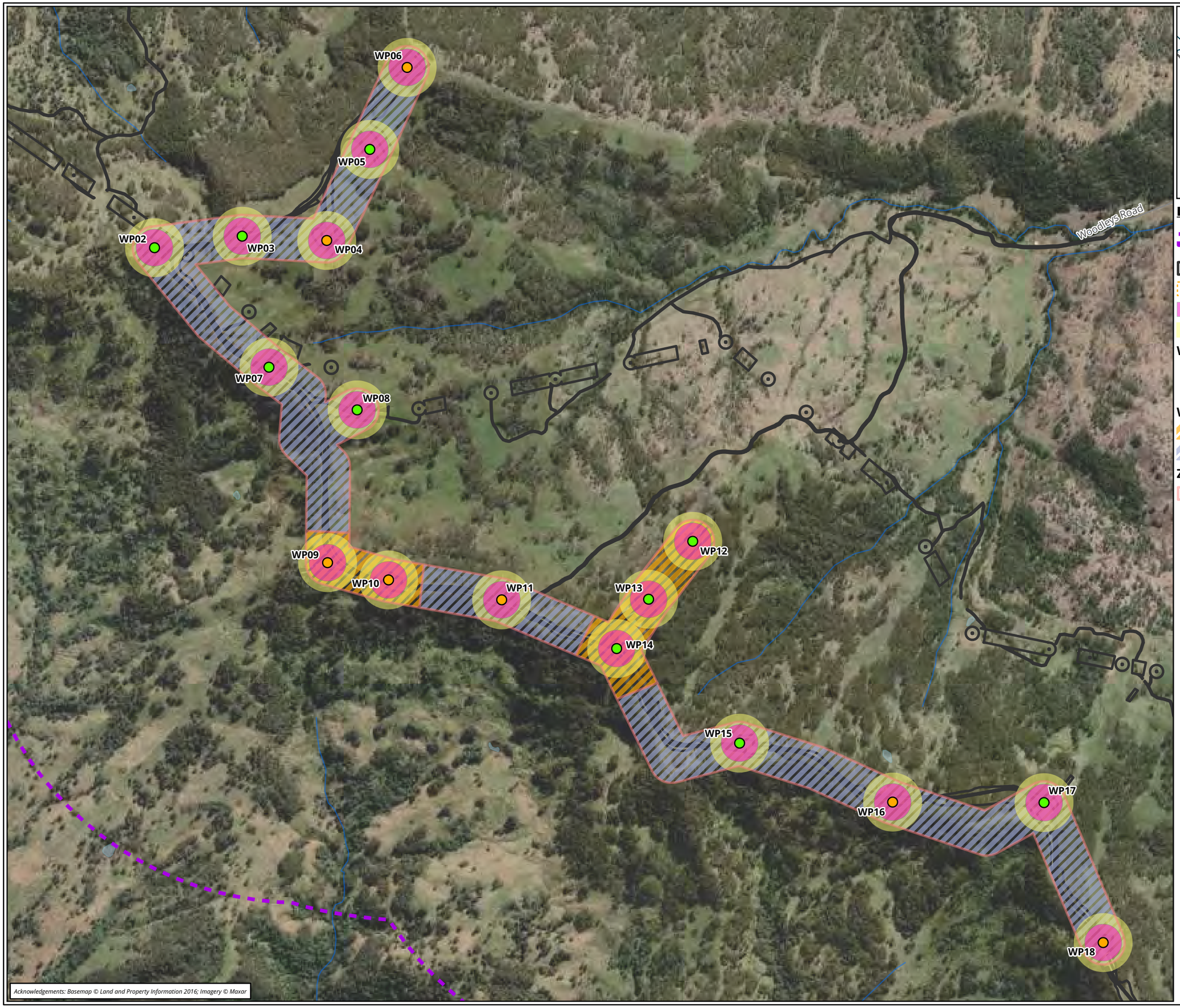

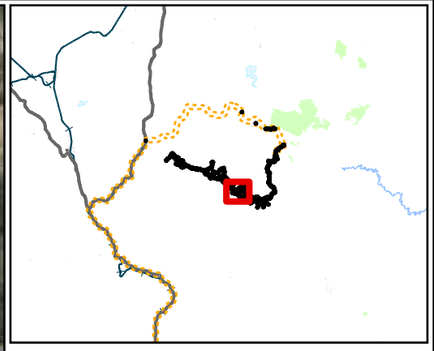

Legend

- Landscape assessment buffer (study area)
- Infrastructure footprint
- Transport haul routes
- 85m zone of distrubance
- 135m zone of disturbance

Wind turbine risk

- Low
- Moderate

Wind turbine barrier effect risk

- Minimal
- Negligible

Zone

- Western

Figure 25 Barrier effects, Page 2

0 200 400 600 800 N

Meters

Scale: 1:16,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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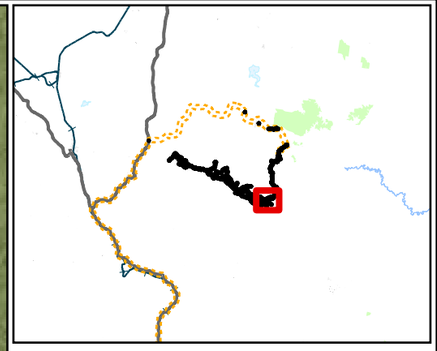

Legend

- Landscape assessment buffer (study area)
- Infrastructure footprint
- Transport haul routes
- 85m zone of distrubance
- 135m zone of disturbance

Wind turbine risk

- Low
- Moderate

Wind turbine barrier effect risk

- Minimal
- Negligible

Zone

- Central

Figure 25 Barrier effects, Page 3

0 200 400 600 800 N

Meters

Scale: 1:16,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Layout: 34963_F25a_BarrierEffects
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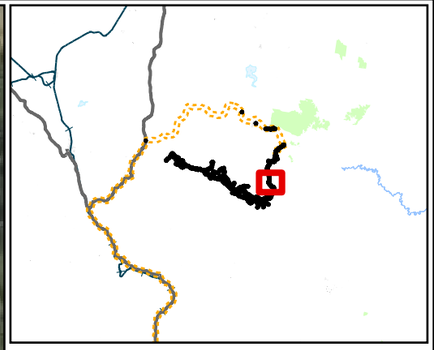

Legend

- Landscape assessment buffer (study area)
- Infrastructure footprint
- Transport haul routes
- 85m zone of distrubance
- 135m zone of disturbance

Wind turbine risk

- Low
- Moderate

Wind turbine barrier effect risk

- Negligible

Zone

- Central
- Northern

Figure 25 Barrier effects, Page 4

0 200 400 600 800

Meters

N

Scale: 1:16,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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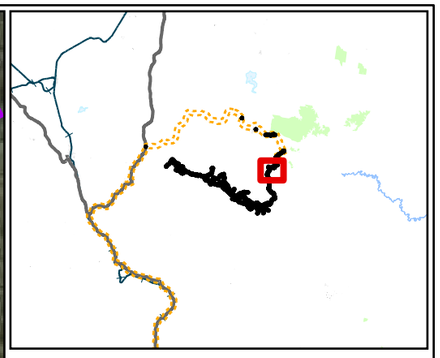

Legend

- Landscape assessment buffer (study area)
- Infrastructure footprint
- Transport haul routes
- 85m zone of distrubance
- 135m zone of disturbance

Wind turbine risk

- Low
- Moderate

Wind turbine barrier effect risk

- Negligible

Zone

- Northern

Figure 25 Barrier effects, Page 5

0 200 400 600 800 N

Meters

Scale: 1:16,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

8.3.5 Summary of collision risks and indirect impacts

The following provides a summary and conclusions for impacts relating to possible bird and bat collision with wind turbines.

- The vast majority of bird and bat species recorded or have the potential to utilise the vegetation within or surrounding the subject land are considered to have a low or negligible risk of collision mortality, with no significant broader impacts to regional populations anticipated.
- Nine species of microbats are considered to be subject to a moderate risk of impact from turbine strike, and include:
  - White-striped Free-tailed bat (not listed).
  - Large-eared Pied Bat – Vulnerable, BC Act and Vulnerable, EPBC Act.
  - Eastern False Pipistrelle – Vulnerable, BC Act.
  - Eastern Coastal Free-tailed Bat – Vulnerable, BC Act.
  - Little Bent-winged Bat – Vulnerable, BC Act.
  - Eastern Bent-winged Bat – Vulnerable, BC Act.
  - Yellow-bellied Sheath-tailed Bat – Vulnerable, BC Act – Vulnerable, BC Act.
  - Greater Broad-nosed Bat – Vulnerable, BC Act.
  - Little Broad-nosed Bat (not listed).
- Four species of birds are considered to be subject to a moderate risk of impact from turbine strike, and include:
  - Little Eagle – Vulnerable, BC Act.
  - Nankeen Kestrel.
  - Square-tailed Kite – Vulnerable, BC Act.
  - Wedge-tailed Eagle.
- There are no bird or bat species that are considered to be subject to be a high risk of collision mortality.
- Risk of impact to threatened and non-threatened species is considered highest for turbine WP50.
- Potential low level impacts to habitat connectivity for migratory bird and bat species, and/or long-range foragers, for species recorded within the development footprint, or considered highly likely to occur.
- All known or predicted bird and bat species within the subject land have low or negligible risk associated with barrier effects or avoidance behaviour resulting from aerial fauna flying near/within the zone of disturbance or from habitat sterilisation surrounding the operational wind turbines.
- However, where individual spacing and potential zone of disturbance overlap or become in close proximity to each other, this represents identified turbines clusters that may have a slight increase in an inherent risk associated with barrier effects or altered flight behaviour in that area.
- The protection, management and enhancement of vegetation and fauna habitat outside the approved disturbance areas within or surrounding the subject land toward a benchmark state will contribute to effectively minimising indirect impacts.

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The magnitude of known and expected impacts to threatened species resulting from prescribed and indirect impacts is not considered to be significant enough to warrant additional offsetting. Further offsetting may be considered as part of ongoing adaptive management if trigger levels are realised which are determined to be of a level significant enough to warrant additional offsets. These trigger levels referred to in Section 8.3.4 will be developed in further detail during the preparation of the BBAMP, but are discussed further in Section 8.10.

As outlined in Section 5.4.2 a combination of acoustic call data analysis, desktop/on-ground assessment of potential habitat locations, and geomorphological analysis and advice has been undertaken to determine the likelihood of microbat species roosting and/or potentially breeding within the development footprint or immediate surrounds.

Call data was analysed based on the time each call was recorded relative to sunset/sunrise to assess potential correlations that suggest bats may be roosting within, or in the vicinity of, the development footprint. It could be expected that if bats were roosting within the development footprint, calls would be clustered around sunset when the bats are exiting the roost for nightly forage activity, especially so give the proximity of the majority of the detectors to areas of possible microbat habitat. Furthermore, if bats were roosting elsewhere in the landscape and travelling to the site as part of foraging activity, calls would be expected to be less clustered towards sunset and be spread more throughout the remainder of the night. It could also be expected that if bats were roosting in the immediately vicinity of the development footprint there would be another spike in activity before dawn.

Based on the analysis of the time ranges which species' calls were recorded (refer Section 5.4.2), it is concluded that whilst some species, including Large Bent-winged Bat, Little Bent-winged Bat and White-striped Free-tailed Bat, are arriving on site during the early parts of the night, there is no clear evidence to suggest that regularly utilised roosts are present within the development footprint or immediate surrounds. There are no strong correlations around sunset, and many of the calls are occurring after twilight and later into the night.

Desktop and on-ground assessment of areas of potential microbat cave roosts found two areas to support high potential for roosting and potentially breeding bats within the subject land. These areas comprised a steep cliffline on the southern portion of the development footprint and pillar like outcrop with many deep and vertical fissures in the central/eastern portion of the development footprint, both outside the development footprint. No direct evidence of bats, such as guano or odours, were recorded at either habitat feature, suggesting the features were not currently utilised by microbats, but the potential for their use into the future exists. The Geomorphological assessment found that whilst the development footprint and broader landscape are likely to support a diverse range of rocky terrain forming many opportunities for potential microbat habitat, there were unlikely to be any large caves present proximal to the development footprint, and that the development footprint in no way stood out as supporting particularly higher quality habitat than the surrounding landscape (Environmental Geosurveys 2021).

It is concluded that whilst roosting opportunities may exist for both cave dependent and non-cave dependent microbat species within and immediately surrounding the development footprint, the potential for large roost sites is low, and that roosting opportunities (both rocky and within tree hollows) are unlikely to be limited in the wider landscape. As such, the potential for the development to result in significant or substantial impacts to microbat roosts is considered low.

Limitations of the field investigation relating to microbat trapping surveys to attempt to determine the presence of breeding bats within the development footprint are provided in Section 5.4.2. However, to address the potential for impacts to breeding bats, call data and temporal abundance/activity within the development footprint was analysed for the four BAM species credit bats, which are considered at highest risk from potential impacts to breeding habitat/activity. Each of these four species of microbat; Large-eared Pied Bat, Large Bent-winged Bat, Little Bent-winged Bat and Eastern Cave Bat are known to seasonally

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migrate to colonial maternity sites, with Large Bent-winged Bat and Little Bent-winged Bat known to travel large distances and congregate in large numbers. Due to this behaviour of communal breeding, activity data can be used to infer whether bats are present or absent from the development footprint during known breeding season, and to determine relative level of activity before during and after these seasons.

Relative abundance of Large-eared Pied Bat indicates that breeding roosts are unlikely to be present within or immediately surrounding the development footprint as higher levels of activity would be expected in November, with activity levels dropping in late March. Neither of these trends were observed for the species. Eastern Cave Bat can be seen to be most active within the project area in April, with low levels of activity recorded in February and March. Little is known about the breeding biology of this species; however, it could be expected that some activity would have been recorded in November if maternity roosts were present. Large Bent-winged Bat activity suggests that individuals occurring within the project area are unlikely to be breeding females, who are known to leave maternity roosts in February, which would lead to a reduction in activity through March and into April. Little Bent-winged Bat activity shows little evidence to suggest breeding behaviour in the immediately vicinity of the development footprint, and that overall activity for the species is comparatively low. Furthermore, Little Bent-winged Bat is known to co-occur in maternity roosts with Large Bent-winged Bat, especially in colder environment, and based on activity data for Large Bent-winged Bat, there is again little evidence to suggest either species is breeding in the area.

Whilst it is acknowledged that without trapping surveys, microbat breeding activity cannot be conclusively ruled out from occurring within and surrounding the project area, however analysis temporal activity patterns do not suggest that this is occurring. It is concluded that based on the low potential for large numbers of bats roosting in the immediate vicinity of the development footprint, combined with the lack of evidence to suggest microbats are congregating within the development footprint during known breeding seasons, that the potential for impacts to breeding microbats as a result of the development are low.

These conclusions are based on the evidence outlined in this BDAR and the trends observed which do not show strong signs of breeding and/or large scale roosting behaviour. Furthermore, the development and implementation of the BBAMP will allow for these conclusions to be tested with stringent adaptive management criteria through the operational phases of the project.

8.3.6 Disturbance of habitats from noise and light

Habitats within and adjacent to the development footprint are likely to be subject to some increased disturbance from noise and light, primarily during the construction phase of the project. Noise and light impacts during operation will be negligible, with limited impacts to native fauna from the operation of the wind turbines. There may be some minor impacts associated with lighting of access tracks, site offices and other ancillary sites during operation, however these can be mitigated through lighting design measures.

The majority of the threatened fauna that have been identified to be potentially impacted by the project are nocturnal, so measures to manage noise and light from construction at night will be implemented. Aviation hazard lighting is not expected to have an impact on nocturnal fauna using the habitats within and adjacent to the development footprint. Considering the high elevation of the turbines and implementation of shields, any light spill is unlikely to occur below the tree canopy impacting on the behaviour of any terrestrial or arboreal fauna.

8.3.7 Disturbance from weeds, pests and pathogens

There is the potential for weeds and pathogens to be introduced and spread during construction as a result of machinery movements and increased foot traffic.

Works associated with the proposed road upgrades on the haul route are considered low risk as these will be limited to the road corridor where lands are already subject to disturbance from adjacent transport activities.

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Pathogens, including Root Rot *Phytophthora cinnamomi*, Myrtle Rust *Austropuccinia psidii* and Chytrid Fungus *Batrachochytrium dendrobatidis*, have the potential to be introduced to the site during construction and, if so, terrestrial and aquatic habitats within the development footprint could be impacted. Mitigation measures to control the spread of weeds, pests and pathogens will be detailed in a Biodiversity Management Plan.

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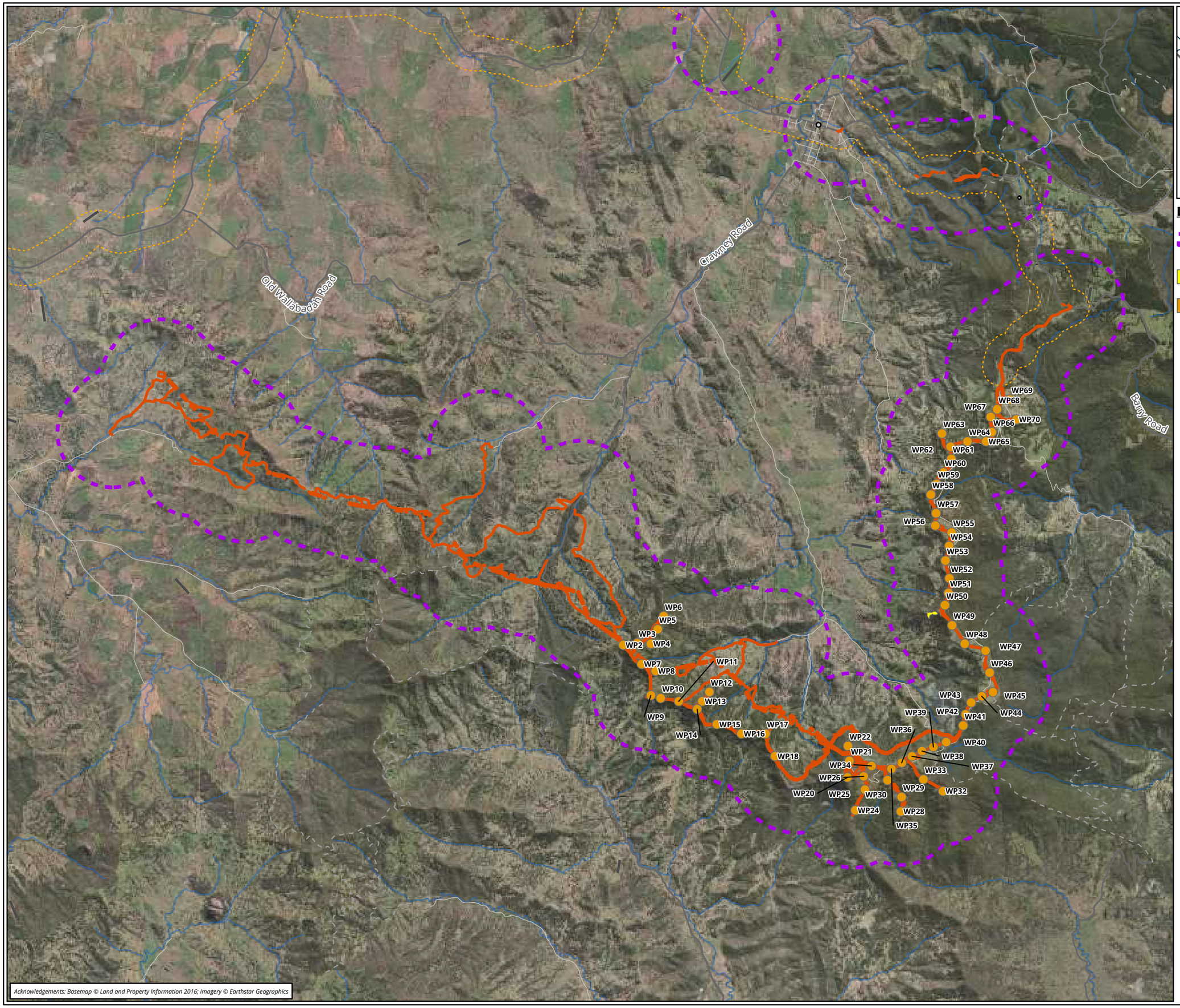

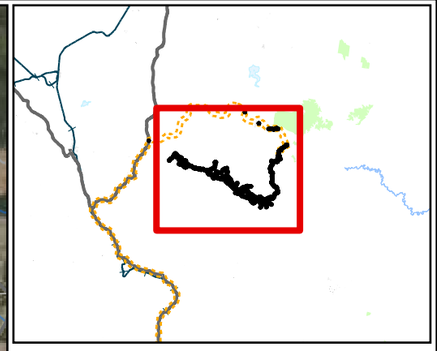

Legend

- Landscape assessment buffer (study area)
- Confirmed potential microbat roost habitat
- Wind turbine zone of disturbance

Figure 26 Estimated zones of indirect impact for the proposal

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 23 March 2022 ,
Prepared for: CW, Prepared by: LH, Last edited by: jtownsend
Layout: 34963_F25_IndirectImpacts
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx

8.4 Waterway crossings

A desktop assessment was carried out to identify and map aquatic habitat values and potentially occurring threatened aquatic species for the development footprint. The assessment incorporated the review of relevant spatial datasets and documentation as outlined in Section 1.8 of this document and was supported by general observations of aquatic values during fieldwork.

There is no suitable habitat for any threatened aquatic species within the development footprint and any indirect impacts are not considered likely to results in any impacts to potential habitat downstream.

Streams identified for the assessment area were classified according to the Strahler (1952) stream ordering system. Riparian buffers were identified and mapped for each stream in accordance with Appendix E of the BAM. The majority of the streams within the development footprint for the turbines, internal roads, transmission line and access tracks are first order streams being located high in the catchment. There is limited value for any aquatic threatened species within these environments and no targeted surveys for aquatic species were required under the BAM.

There are 15 locations that require upgrades of creek crossings along the transport haul route. In these locations there is an existing crossing structure that is likely to require upgrading to allow for the safe transport of turbine infrastructure, raising the vertical clearance of the crossing to allow clearance of long elements such as turbine blades.

Where there is an existing bridge that has been identified for upgrades, the works will generally include additional strengthening to accommodate additional weight or widening. This may involve new foundations, piers and carriageway with these works resulting in minimal impacts to the existing waterway channel. A similar approach will be adopted for any existing culverts that are required to be strengthened.

Where there is an existing causeway, additional assessment will be required during detailed design to determine if any upgrade works are required. If the causeway crossing is suitable for the transport requirements no works will be completed. If added vertical clearance is required a culvert will be the likely crossing structure. A summary of the existing crossing locations which may potentially require upgrades subject to further assessment, and the type of fish habitat for each crossing is provided in Table 71.

Table 71 Assessment of fish habitat class at waterway crossings

Site number	Crossing location and existing structure type	Stream order	Fish habitat class
3	Goonoo Goonoo Creek crossing, Lindsay's Gap Road, Garoo Bridge	3	Class 2
5	Middlebrook Creek crossing, Lindsay's Gap Road, Garoo Bridge	3	Class 2
6	Wardens Brook, Head of Peel Road, Nundle Causeway	3	Class 2

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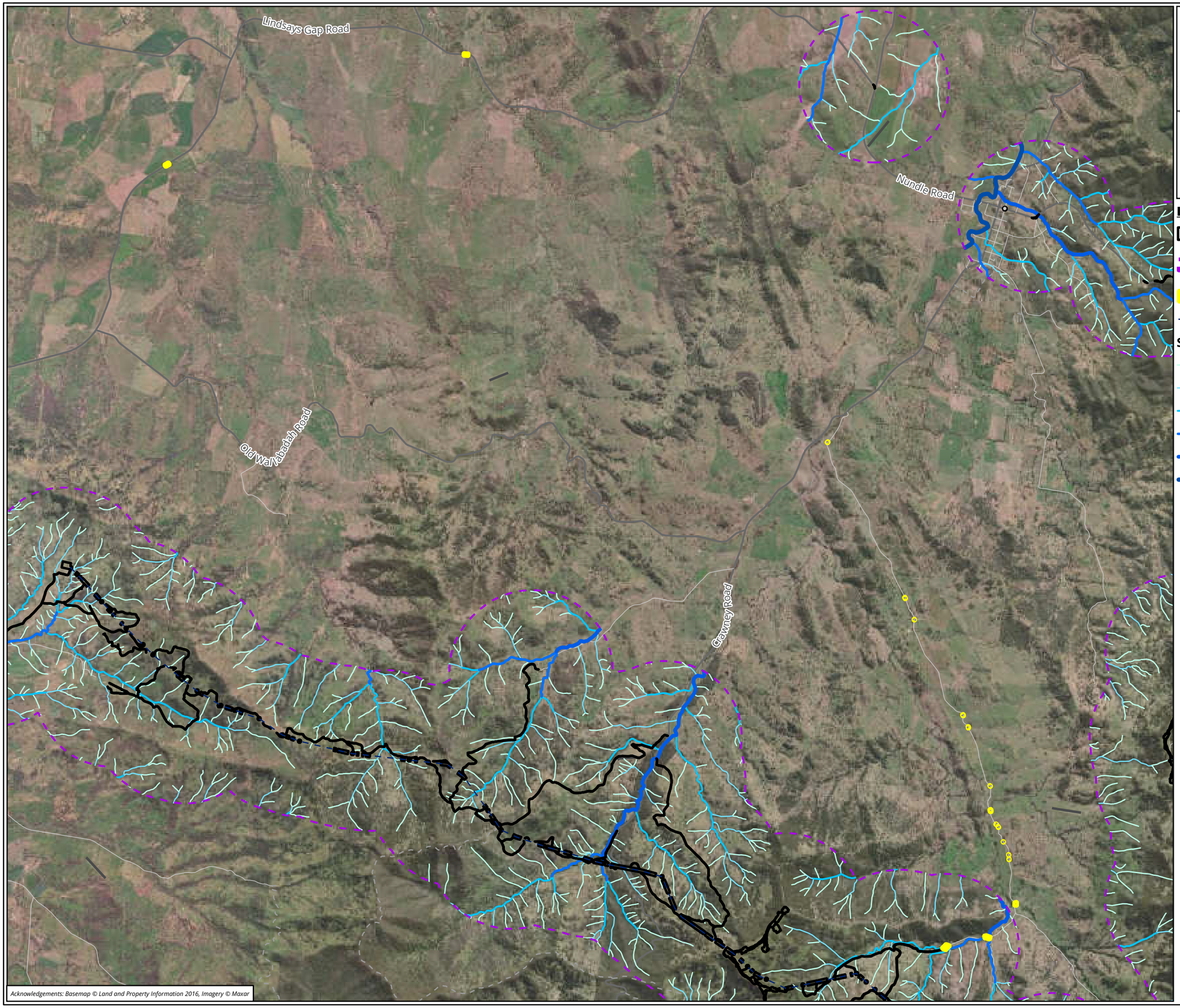

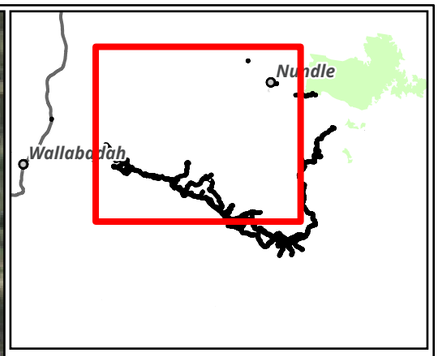

Legend

- Infrastructure footprint
- Landscape assessment buffer (study area)
- Waterway crossing locations
- Transmission line

Strahler Order

- 1
- 2
- 3
- 4
- 5
- 6

Figure 27 Waterway crossing locations and stream order

0 750 1,500 2,250 3,000

Meters

Scale: 1:70,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 23 March 2022 ,
Prepared for: CW, Prepared by: AM, Last edited by: jtownsend
Layout: 34963_F27_Waterway_crossings
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_AM.aprx

Acknowledgements: Basemap © Land and Property Information 2016, Imagery © Maxar

8.5 Prescribed impacts

The following section provides an assessment of prescribed impacts as required by Section 8.3 of the BAM (DPIE 2020), information is provide in Table 72.

Table 72 Assessment of BAM prescribed biodiversity impacts

Karst, caves, crevices, cliffs, rocks and other geological features of significance
Assessment of the impacts of the proposal on threatened entities associated with karst, caves, crevices, cliffs, rocks and other geological features of significance must:
Predict the nature, extent and duration of short-term and long-term impacts to karst, caves, crevices, cliffs, and other geological features of significance
The project will not directly impact upon any karst, caves, crevices, cliffs, and other geological features of significance. Such features may be utilised as habitat for roosting and possibly breeding for locally occurring cave-dependent microbat species. Potential habitat within and immediately surrounding the development footprint was assessed via desktop and follow-up ground confirmation surveys in February 2020 and again in March 2021. Detailed methods and results of these assessments are provided in Section 5.4.2 of this BDAR, however in summary, two areas supporting geological features suitable for microbat roosting were found to the north-west and south of the development footprint, with other areas targeted during surveys confirmed not to support suitable habitat features. In order to provide additional scientific advice on the likelihood of the project area and surrounding landscape to provide roosting and potential breeding habitat opportunities for microbats, a desktop geomorphological assessment was undertaken by Environmental Geosurveys Pty Ltd (Environmental Geosurveys 2021) (Appendix F). The assessment found that whilst the basalt lithology present at the project area may support opportunities for microbat roosts, no substantial caves were likely to be present, and that no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another. Furthermore, it was concluded that the diverse terrain and lithology, and dynamic geomorphology result in high potential for microbat roosting sites to occur across the landscape as a whole, at all elevations within the expected flight range of microbats (estimated to be 50-75 kilometres) that may be present within the project area (Environmental Geosurveys 2021). The assessment notes that the project area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland. The basement rocks developed from the Cambrian to the Carboniferous, and over time have been altered by multiple episodes of deformation and igneous intrusions, and further sedimentation during the Permian prior to the break-up of Gondwana. The exposed basement geology includes stratified silicic and calcareous sedimentary beds, granitoids and interbedded volcanics previously subjected to and altered by metamorphism, large-scale folding and faulting. Widespread volcanism in the Cenozoic covered much of the surface of the New England Orogen, but the areal extent of volcanics has been reduced by denudation (Environmental Geosurveys 2021). Thus, the diverse geology present in the landscape surrounding the project area continues to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen). Habitats present in the locality of the project area are therefore also likely to occur elsewhere within broader geological landscape and are therefore unlikely to form a substantial portion of the potential habitat available to microbats, or be significant at a bioregional scale. As the project will not result in direct impacts to karst, caves, crevices, cliffs and other features of geological significance, the habitat feature present will remain available to be utilised by microbats into the future, and the project has avoided all impacts in close proximity (<150 metres) the confirmed potential microbat habitat features.

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Indirect impacts with the potential to occur during the construction phase of the project are expected to be able to be suitably mitigated such that no substantial consequences would occur to cave bats potentially utilising the areas of high potential bat roosting in the vicinity of the development footprint. Further information on the proposed construction and operational mitigations measures and commitments are provided in Section 8.9 of this BDAR.

Predict the consequences of impacts on the threatened entities potentially present within the subject land associated with karst, caves, crevices, cliffs and other geological features of significance

The project will not result in direct impacts to karst, caves, crevices, cliffs and other features of geological significance suitable to provide roost or breeding habitat for cave dependent bat species.

Threatened species known to occur within the project area most likely to use potential habitat provided by geological features of significance include:

- Eastern Cave Bat
- Eastern False Pipistrelle
- Large Bent-winged Bat
- Large-eared Pied Bat
- Little Bent-winged Bat

Indirect impacts to these species have the potential to occur during the construction phase of the project. Impacts may occur via noise and vibration impacts, and vegetation removal within the vicinity of two high potential roost locations, although substantial redesign works have been undertaken to reduce the potential for such impacts, with construction works now occurring no closer than 100 metres and 430 metres from the habitat features. It is difficult to predict how microbats potentially using these habitat features may be impacted by construction impacts as there is limited literature available on vibration impacts to microbats. As such the project has committed to monitoring for the presence of microbats and implementing mitigation measures if bats are found to be present during breeding or winter torpor seasons (refer Section 8.9.1).

Further indirect impacts may occur as a result of avoidance and blade strike, with these impacts addressed in Section 8.3 of this BDAR.

Justify predictions with appropriate modelling, relevant literature and other published sources (if available), or advice from experts for impact to species associated with karst, caves, crevices, cliffs and other geological features of significance

The Preliminary Geotechnical and Geophysical Interpretative Report (Tetra Tech Coffey 2021) prepared for the development states that at this stage it is expected that the design preference will be to support each turbine on a single reinforced, or mass concrete block gravity footing. Whilst indicative footing or sizing information have not been supplied, it is expected that such a footing would be square, or hexagonally shaped in plan, at least 20 to 25 metres wide, and 3 to 5 metres deep. With reference to the preliminary project geotechnical models for the Windfarm Ridgelines, it is expected that founding conditions for the majority of Wind Turbine Generator footings would then comprise residual soils and/or extremely weathered basalt. (Tetra Tech Coffey 2021). The report goes on the state that it is understood that earthworks and excavations are proposed to both construct the turbine footings, form laydown areas, and for service roads. Excavation of this material is expected to require a hydraulic rock breaker, blasting, or mechanical splitting to fracture and loosen the in-situ rock. As block sizes in this type of material may be large, there is also a significant potential for overbreak (Tetra Tech Coffey 2021).

Based on this advice, and as outlined above it is recommended that disturbance to roosting microbats as a result of ground vibration during breeding season (November to February) or winter torpor season (May to September) will be avoided and minimised as far as practicable, and mitigation measures and project commitments have been made to implement this recommendation (refer Section 8.9.1). It is not expected that direct impacts will occur to the habitat features due to the excavations being no closer than 100 meters from potential habitat.

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Predict the nature, extent and duration of short-term and long-term impacts to rocks

As outlined above, additional assessment of the geomorphological characteristics of the project area was undertaken by Geosurveys Pty Ltd (Environmental Geosurveys 2021) (Appendix F), who concluded that there was no data found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another, and that similar geomorphological characteristic were likely to occur in the medium distance (50-75 kilometres) and far broader bioregional landscape.

Whilst the subject land contains rocky areas, no areas could be said to be significant at the local or bioregional scale, with regards to providing high quality habitat for threatened species, not provided in similar or higher condition elsewhere, such as within the adjacent National Parks estate.

As such it is not expected that the project will result in significant of substantial impacts to rocks, or the threatened species associated with rocks, in the short or long term.

Predict the consequences of impacts on the threatened entities potentially present within the subject land associated with rocks

Threatened species considered as part of this assessment, associated with rock, and most likely to use rock as a habitat component include:

- Booroolong Frog
- Border Thick-tailed Gecko
- Brush-tailed Rock-wallaby
- Spotted-tailed Quoll

Rocks are provide a range of generalist and specific habitat components for these species based on the following information provided in the BioNet Threatened Biodiversity Data Collection:

Booroolong Frog

- Adults occur on or near cobble banks and other rock structures within stream margins.
- Shelter under rocks or amongst vegetation near the ground on the stream edge.
- Sometimes bask in the sun on exposed rocks near flowing water during summer.
- Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools.

Border Thick-tailed Gecko

- Species often occurs on steep rocky or scree slopes, especially granite, however, also recorded from areas of basalt and metasediment slopes and flats.
- Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter.
- Shelter by day under rock slabs, in or under logs, and under the bark of standing trees.

Brush-tailed Rock-wallaby

- Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north.
- Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night when foraging.
- Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.

Spotted-tailed Quoll

- Quolls use hollow-bearing trees, fallen logs, other animal burrows, small caves and rock outcrops as den sites.
- Use communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals.

Targeted surveys were undertaken for all species outlined above as part of the field campaign for this biodiversity assessment. Border Thick-tailed Gecko and Brush-tailed Rock Wallaby were not recorded. Spotted-tailed Quoll was recorded on a remote camera trap and a deceased individual was found. Booroolong Frog was assumed present along Wombramurra Creek, where a known population of the species occurs to the north of the project area, and surveys were undertaken outside the recommended season.

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Border Thick-tailed Gecko habitat has also been assumed to be present where suitable habitat was recorded in locations where targeted nocturnal survey was not able to be undertaken, however direct impacts to the species comprise a total of just 0.17 hectares. As such potential impacts to rocks as a result of the project are not considered likely to result in substantial additional impacts to the species.
The project is unlikely to impact upon rocky habitat supporting the population of Booroolong Frog as direct impacts will not occur to the creek or creek banks, and indirect impacts will be avoided through mitigation measures outlined in Section 8.9 of this report.
Impacts to rocky habitat that has the potential to support Brush-tailed Rock Wallaby are not expected, as the species' presence has been discounted from the subject land.
The project will permanently remove rocky habitat likely to be utilsed by Spotted-tailed Quoll, however, no den or latrine sites were recorded within the subject land during field surveys. Furthermore, rocky habitat present forms only a small portion of the similar habitat available to individuals present within the development footprint and project area. Areas of higher quality habitat, not impacted by the project, occur in the large areas of intact vegetation to the south and east of the development footprint and these areas are expected to be of higher importance to the local population of the species.
The consequences of removal of rocks associated with the project are considered negligible to Booroolong Frog, Border Thick-tailed Gecko and Brush-tailed Rock-wallaby.
Consequences of the impacts to rocky habitat for Spotted-tailed Quoll are considered likely to be minor in nature. Whilst habitat likely to be used in some capacity by the species will be impacted, no important den or latrine sites were recorded, and areas of higher quality habitat adjacent other development footprint, much more likely to support dens and latrines, will not be impacted.

Justify predictions with appropriate modelling, relevant literature and other published sources (if available), or advice from experts for impact to species associated with rocks

- As outlined above

Human-made structures or non-native vegetation

No human made structure considered likely to support threatened species will be impacted by the project. Assessment of the impacts of development on the habitat of threatened species or ecological communities associated with human made structures is therefore not required.
Non-native vegetation impacted by the project largely comprises areas of exotic grassland, with only minor occurrences of non-native trees and shrubs.
No threatened species potentially impacted by the project are associated with exotic grassland.
Assessment of the impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation is therefore not required.

Habitat connectivity

Assessment of the impacts of the proposal on connectivity of habitat of threatened entities must Describe the nature, extent and duration of short-term and long-term impacts

Areas of highest quality habitats occur to the south, east and north-east of the project area supported by large tracts of intact native vegetation. Areas to the north and west of the project area generally comprise cleared farming land with more densely vegetated areas present along steep ridgelines and gullies, less suitable for agriculture / farming practices.
The central portion of the transmission line traverses a north-south running ridgeline, forming part of the Liverpool Range, which supports what appears from aerial imagery to be intact to moderately intact vegetation to the north and south of the project area.
The eastern portion of the transmission line and the western extent of the wind farm corridor run along a north-west to south-east running ridgeline supporting patchy native (partially intact) vegetation to the north and larger tracts of intact vegetation to the south, including Crawney Pass National Park.
The central and eastern portions of the windfarm corridor occur along a ridgeline that forms the western extent of very large tracks of intact vegetation to the south and east, with areas of intact vegetation present surrounding the upper catchment of the Peel River adjacent to the development footprint to the north.

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Access road upgrades will occur along the northern end of Morrisons Gap Road where large areas of intact vegetation occur to the north and south.

The development and operation of the wind farm will result in up to 65 turbines operating over an approximate liner distance of 30 kilometres along the ridgelines as described above. This linear alignment has the potential to create an obstacle to movement through the wind farm, impacting upon habitat connectivity in an east to west, and north to south direction within different portions of the development footprint. Habitat connectivity has the potential to be most substantially impacted for those species known to fly within the range of rotor-swept height, rather than those that move under, or potentially over, the turbine blades.

It should be noted that impacts to habitat connectivity have been reduced through the removal of turbines WP1, WP19, WP23, WP27 and WP31 following turbine risk assessments undertaken following agency and public submissions. Removal of these turbines has resulted in a reduced impact to habitat connectivity in the southern and western portions of the development footprint. Removing WP19 creates a gap of over 2 kilometres between turbine WP18 and turbines WP20-22, and the removal of WP19 allows for an approximate 600 metre reduction of the intrusion into intact vegetation to the south of the development footprint, allowing more available airspace for aerial fauna around the southern extent of the wind farm corridor.

Removal of WP1 from the project design reduces potential connectivity impacts as the turbine was acting as an outlier on the south-western extent of the array, and the turbines now occur in a more linear arrangement in that location. Removal of WP19, WP23, WP27 and WP31 reduce impacts to connectivity around the southern-most part of the development footprint by reducing the incursion into intact vegetation in that location by between 400 and 500 metres at each turbine location (refer Figure 1).

Potential impacts to habitat connectivity will occur for the operational life of the wind farm, expected to be approximately 30 years, which is considered only to be in the short to medium term, following which impacts may be removed if the wind farm is decommissioned. For species that move within the height range where turbine strike is possible, and are likely to move through the operational wind farm corridor for foraging or potentially migratory movements, an associated impact of collision mortality could occur, albeit in rare circumstances. Impact risk assessment for all aerial species has been provided in Section 8.3 of this BDAR.

Landscape scale habitat connectivity is mapped on Figure 28.

Predict the consequences of impacts for the persistence of the threatened entities potentially present within the subject land, taking into consideration mobility, abundance, range and other relevant life history factors

All threatened species and ecological communities rely of habitat connectivity to some degree to maintain genetic diversity and to allow for adaption to threatening processes. Threatened species reliant on the habitat connectivity across and surrounding the development footprint have been grouped into categories based on how they utilise habitat connectivity. These include:

- Nomadic, migratory or long-range foraging birds and bats.
- Sedentary birds and bats.
- Small mammals.
- Frogs and reptiles.
- Flora and TECs.

Species with the highest potential to be impacted by changes to habitat connectivity as a result of the project include species considered nomadic, migratory and/or long-range foragers and were recorded during completed surveys. Such species include:

- Flame Robin
- Grey-headed Flying-fox
- Little Bent-winged Bat
- Little Lorikeet
- Large Bent-winged Bat
- Yellow-bellied Sheathtail-bat

These species are addressed further below in relation to how the project may impact upon habitat

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connectivity at a population scale.

Flame Robin

- Species known to breed in upland areas and in winter move to the inland slopes and plains, therefore potentially moving through the development footprint.
- However, species is likely to occur beneath or within the canopy and therefore under the turbine's rotor swept height, thus being relatively unaffected by the project.

Grey-headed Flying-fox

- Species is known to fly at higher altitudes and likely within the range of rotor swept height and be capable of travelling up to 50 kilometres from a roost to forage.
- The DAWE National Flying-fox monitoring viewer has a number of camps mapped within 50 kilometres of the development footprint including large camps at Murrurindi and Tamworth, each having recorded >50,000 individuals present in the past (2017).
- It is considered unlikely that individual flying-foxes would regularly be flying through the wind farm as these two camps are between approximately 25 kilometres (Murrunrindi) and 50 kilometres (Tamworth) from the project area, and would represent long forage efforts over commensurate landscapes providing ample forage opportunities closer to the known roosts.
- Therefore the wind farm is not expected to represent a significant barrier to movement for this species, or substantially impact upon habitat connectivity at a bioregional scale.

Little Bent-winged Bat and Large Bent-winged Bat

- Species are known to occasionally fly at higher altitudes and likely within the range of rotor swept height, and to travel large distances (100s of kilometres) for breeding migrations. Species also known to fly higher during migratory flight, potentially putting them at risk of turbine strike.
- A known non-breeding roost for both species occurs approximately 5 kilometres south of the development footprint at Timor Caves. It is expected that bats would move between this roost and the known breeding roost in Karanga-Boyd NP (approximately 250 kilometres to the south) due to its occurrence in similar topographical and climatic zones, rather than the geographically closer breeding roost at Willi Willi NP, in sub-tropical climate to the east of the dividing range in the Kempsey LGA.
- Whilst these species have been recorded foraging within the development footprint, their expected southerly breeding migration means the development is not expected to result in a substantial impact to connectivity, such that the bioregional persistence of the species is under threat.

Little Lorikeet

- Species is known to be nomadic in response to flowering eucalypts and other feed tree species.
- The species is most likely to occur in areas of intact forest, woodland or riparian vegetation, however, can also occur in paddock trees.
- The species has the potential to fly within the range of rotor swept height meaning the operational wind farm may impact upon habitat connectivity, however when observed within the development footprint the species was present at approximately 15 metres elevation. The species was not recorded flying in the range of rotor swept area during any bird surveys undertaken for the current assessment.
- As agile flyers moving as part of larger flocks, Little Lorikeets can be expected to have some capacity for avoidance of rotor blades, potentially lessening the project's impacts to habitat connectivity.
- Commensurate habitat occurs within the 50 kilometres surrounding the wind farm (where recent BioNet records of the species occur) that provides the species with habitat connectivity. As such when considered at the scale of bioregional persistence, the project is unlikely to result is significant impact to habitat connectivity for the species.

Yellow-bellied Sheathtail-bat

- Species is considered to migrate from northern parts of Australia and south in summer, which could potentially include through the operational wind farm.
- The species is considered generally to forage above the canopy and has been recorded by detectors mounted at canopy height and 60 metres on met masts during the current study. However, the species is known to fly lower over open spaces and at the forest edge (Chruchill 2008).
- Based on the above the operational wind farm may impact upon habitat connectivity for individuals flying within the range of rotor-swept height.

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- As the species is hollow-dependent for roosting and breeding, and known to generally forage over the canopy, it is considered more likely that movements may occur over vegetated areas surrounding the development footprint rather than the through the cleared areas of the wind farm potentially lessening the impacts to habitat connectivity for the species.

Potential risks to the species are further assessed in Section 8.3 of this BDAR. Bent-winged-Bat roosts and Grey-headed Flying-fox camps are is mapped on Figure 28.

The project area occurs on the boundary of three IBRA Bioregions, Nandewar, New England Tablelands, and NSW North Coast.

The project area occurs at the southern extent of the Nandewar bioregion, which extents approximately 440 kilometres north into Queensland to the west of the Great Dividing Range. The project area also occur at the southern extent of the New England Tablelands bioregion, which extents approximately 350 kilometres north to the Queensland border, along the Great Dividing Range. The project area occurs near the southern extent of the western edge of the NSW North Coast bioregion. The bioregion extents south-east approximately 150 kilometres to Newcastle, then follows the east coast approximately 420 kilometres north to Yamba, with a portion of the bioregion extending in a north-westerly direction to the Queensland border near Urbenville. Within the NSW North Coast bioregion, habitat connectivity occurs along the coastal escarpments on the eastern side of the Great Dividing Range and the area of connectivity relevant to the project is of negligible importance to the remainder of the bioregion.

The majority of habitat connectivity within the New England Tablelands bioregion occurs along the western and eastern boundaries of the bioregion, with patchy connectivity throughout the central portions. The ridgeline and adjacent vegetated slopes comprising the project area partially supports connectivity from the south into the New England Tablelands bioregion, however substantial areas of habitat connectivity (approximately 50 kilometres wide) will remain following the development.

Connectivity through the Nandewar bioregion occurs along the eastern boundary (with New England Tablelands) of the bioregion, with lower levels of connectivity along the west, from Liverpool Range through hilly country forming the boundary of the Liverpool Plains and Tamworth LGAs, north towards Mount Kaputar NP. As with the New England Tablelands bioregion, the ridgeline supporting the project area forms part of the connectivity into the Nandewar bioregion, however connectivity will remain present post development to the east and west of the wind farm (approximately 15 to 20 kilometres wide either side of the project area).

Whilst the project may have a minor effect on connectivity into the New England Tablelands and Nandewar bioregions, its linear nature and location on the edge of larger areas of intact vegetation mean connectivity will remain present around the operational wind farm through commensurate high ridgetops and vegetated upper and lower slopes.

The project will result in low level or negligible consequences relating to impacts to habitat connectivity for the suite of threatened flora species, TECs, threatened frogs, reptiles, small mammals and other aerial species not addressed above, present or potentially present within the project area, with regards to bioregional persistence of the species. The development and operation of the wind farm and transmission line corridor will not result in a barrier to connectivity for the majority of these species which are likely to preferentially utilise the adjacent areas of higher quality habitat for movement corridors, or will be capable of moving through the operational development. Furthermore, the wind farm and transmission line have largely been located in areas of existing clearing, on vegetated edges, and in more highly disturbed areas, all of which are less suitable for providing habitat connectivity to terrestrial and arboreal species.

Sedentary birds and bats are less likely to fly through the project area, between forage/roosting habitats, due to the areas of highest quality habitat generally located to the south and east. As such, these species are not expected to be substantially impacted by reduced levels of habitat connectivity.

Justify predictions of impacts with relevant literature and other published sources of information

As outlined above.

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Water bodies, water quality and hydrological processes

Assessment of the impacts of the proposal on water quality, water bodies and hydrological processes that sustain threatened entities must:

Describe the nature, extent and duration of short-term and long-term impacts

Numerous first order watercourses occur within the project area, characteristic of its ridgeline nature, with the majority flowing north and west off the ridgeline into the Namoi catchment, with the southern portion of the project area flowing to the Hunter catchment. A small portion of the eastern portion of the project area flows into the Manning catchment. There are 12 named tributaries within the development footprint, however, there are no third-order or higher watercourses impacted (ERM 2021). There are numerous farm dams within and surrounding the development footprint, some of which will be removed as a result of the project, others may be utilised for water requirements during construction.

Overland flow and run-off directed by the steep topography of the project area into gullies forming higher order streams and tributaries are the major hydrological process acting upon any potential threatened species habitat present within the development footprint. Man-made dams located along the overland-flow paths have created permanent or semi-permanent dams (pools) also providing habitat for some threatened species. Species most likely to utilise these habitat features within and proximal to the development footprint are Southern Myotis and Booroolong Frog.

As outlined in the project's Soils and Water Assessment (ERM 2021) overall potential risks to water and soils are relatively minor to moderate, with the primary constraints being steep slopes adjacent to the project footprint. This assessment is based on:

- For the most part, pad sites and access road construction occur on relatively low-moderate gradient lands high up in the respective drainage catchments.
- There is generally a very low risk of run-on or run-off of concentrated stormwater flows.
- Construction sites within the development footprint generally present a low to moderate erosion hazard considering factors such as climate, soils and landform.
- Impacts on water flows is not anticipated for the construction of the project, given the localised impacts are located upstream on the top of the ridgeline.
- Potential impacts downstream are able to be effectively managed at the source of works (i.e. velocity controls in areas with steep slopes) through the implementation of a progressive Erosion and Sediment Control Plan (ESCP).
- Additional measures are able to be effectively implemented to appropriately mitigate impacts associated with the identified sensitive locations in the adjacent National Park and waterways supporting populations of Booroolong Frog. Measures are to be included in the progressive ESCP to either:
    - Direct disturbed runoff away from the catchment area identified to contain the sensitive location.
    - Process runoff through additional sediment controls (e.g. sumps and/or sediment basins) and discharge at a low, non-erosive velocities. (ERM 2021).

Predict the consequences to the threatened entities likely to occur within the subject land

Watercourses and dams within, and adjacent to the development footprint were surveyed during the course of this assessment with results detailed in Sections 5.3 and 5.4 of this BDAR. No threatened frog species were recorded during surveys, however, Booroolong Frog has been assumed present along Wombramura Creek and is known to occur along first order tributaries of Peel River north of the development footprint. Southern Myotis has also been recorded during microbat acoustic detection surveys and is likely to utilise areas of open water, including farm dams, for foraging.

Wombramurra Creek and first order tributaries of Peel River comprise a priority management site, forming a portion of the Peel River catchment Saving Our Species Site for Booroolong Frog, with the transmission line crossing the watercourse approximately 400 meters upstream of the nearest record, and the wind farm corridor occurs approximately 2.4 kilometres upstream of the nearest record of Booroolong Frog along a tributary of the Peel River. The habitats present at the point where the transmission line crosses Wombramurra Creek, and the habitats within the wind farm corridor are all considered degraded. Only minor

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direct impacts may occur to Wombramurra Creek riparian vegetation which would be unlikely to substantially impact the population of the species, with potential minor impacts also occurring along the edges of Crawney Road (albeit outside the main riparian zone of the creek) if upgrades are required. Indirect impacts however, if not properly managed, could cause more substantial harm to the species and population. If potential impacts to soil and water movement as a result of land clearing and excavation are not adequately managed throughout the project, there is a possibility that Booroolong Frog habitat occurring further downstream within the Peel River or Wombramurra Creek could be adversely affected as a result of increased run off and sedimentation, changes in water flows, and increased pollution of the waterway. In particular, if sediment was to fill rock crevices within the river, the species would no longer be able to use this habitat for oviposition. If poorly managed, this could lead to a long-term decrease in the Peel River Booroolong Frog population, through reduction in breeding habitat. Boorloong Frog records along Wombramurra Creek are is mapped on Figure 28.

In order to minimise such impacts, a Soil and Water Management Plan (SWMP) will be prepared, outlining measures for the management and monitoring of surface water quality and hydrology during construction. The plan would also address any requirements for the management of pollutants or contaminated lands during construction so as to minimise impacts to terrestrial and aquatic habitats. The plan would include the implementation of a construction surface water quality monitoring to minimise impacts to surface water quality. An Erosion and Sediment Control Plan (ESCP) will also be prepared, outlining measures for the prevention of erosion and sedimentation during construction. If adequate soil and water management measures are employed, the indirect impact to Booroolong Frog habitat can be substantially reduced. Implementation and monitoring of the success of this plan would be a key requirement of the Biodiversity Management Plan.

Booroolong Frog is also known to occur within the Barnard River in Ben Halls Gap NP and a tributary to the Isis River in Crawney Pass NP, based on information provided by NSW NPWS during the project's submission process. The presence of the species within these waterways will also need to be considered in any Soil and Water Management Plan to be development for the project if potential run-off to these waterways is likely.

If constructing soil and water are management properly and in accordance with best practice construction environmental management then the project is not expected to result in significant of substantial impacts to Booroolong Frog.

As outline above Southern Myotis was recorded with the subject land and may utilise the existing farm dams for forage opportunities. However the presence of this type of forage habitat is not limited in the landscape and individuals present within the subject land will continue to utilize other forage opportunities following the decommissioning of dams as a result of the project. As such, significant or substantial impacts to Southern Myotis are not expected to occur as a result of impacts to waterbodies.

It is also expected that drainage design and engineering for the project will ensure overland flow patterns are maintained to a practicable level and the project will not result in substantial changes to hydrological patterns or increase erosion downstream potentially impacting downstream habitats.

Additional measures are able to be effectively implemented as part of the SWMP, ESCP and BMP to appropriately mitigate potential impacts associated with the identified sensitive location in the adjacent National Park (Sphagnum Moss Cool Temperate Rainforest). Measures are to be included in the progressive Erosion Sediment Control Plan (ESCP) to either:

- Direct disturbed runoff away from the catchment area identified to contain the sensitive location.
- Process runoff through additional sediment controls (e.g. sumps and/or sediment basins) and discharge at a low, non-erosive velocity (ERM 2021).

An updated assessment of site gradients and risk to this TEC is provided in the updated Soil and Water report including project commitments to avoid impact in the EIS (Someva 2021).

Based on the above information the project will not result in substantial or significant consequences to the bioregional persistence of threatened species or ecological communities potentially relying on hydrological processes or waterbodies present within the development footprint. Potential risk to soil and water are

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considered low and able to be successfully managed to prevent downstream impacts.
Justify predictions of impacts with appropriate modelling (if available), relevant literature and other published sources of information, or consultation with species experts.
As outlined above.
Wind farms
Assessment of the impacts of wind turbine strikes on protected animals identified as likely to be present within the subject land must:
Predict the impact on species living in, or likely to fly over, the proposed development site, including bat or bird strike and barotrauma
The likelihood of impact of birds and bats resident in or likely to fly over the project area are presented in Sections 8.3.1, 8.3.2, 8.3.4 and Appendix D of this BDAR.
Predict the rate and timing of impact per turbine per year for species likely to be affected
The predicted rates of impact for birds resident in or likely to fly over the project area are presented in Section 8.3.2 and Appendix D of this BDAR. It is not possible to make such a prediction for bats as individual bats cannot be counted, which is the data required to make such a prediction. A qualitative risk assessment has been undertaken to predict the potential impacts to microbat species and is presented in Section 8.3.1.
Predict the consequences of impacts for the persistence of populations
The consequence of impacts to local populations form a consideration as part of the qualitative risk assessment presented in Section 8.3.1. As outlined above, the project area occurs within, and on the boundary of, three separate bioregions; NSW North Coast, New England Tablelands and Nandewar, which comprise a combined are of approximately 100,000 square kilometres. Each of these bioregions supports substantial areas of habitat of lower, higher and of commensurate quality and value to that which occurs within, and immediately adjacent to, the project area, likely to be directly and indirectly impacted by the project. Whilst it is expected that impacts via blade strike and possibly barotrauma may occur, and further indirect impacts such as loss of habitat opportunities through avoidance of areas surrounding the turbine blades may occur, the scale at which these impacts may be realised is not expected to be such that the bioregional persistence of any species or populations will be subject to substantial or significant consequences. Indirect impacts associated with potential blade strike to individuals utilising the confirmed potential microbat root habitat features have been minimised through the removal of WP27 from the project design, creating a gap of over 400 metres between the habitat feature and the base of the nearest turbine, which is increased further if habitat height and rotor swept height are considered. Furthermore WP50 has been relocated approximately 130 metres to the north-east, ensuring a separation of over 300 meters from the base of the turbine and the top of the habitat feature. As outlined in Section 5.4.2 of this BDAR, there is potential for blade strike impacts for a number of cave-dwelling threatened microbat species including Eastern False Pipistrelle, Large Bent-winged Bat, Large-eared Pied Bat and Little Bent-winged Bat, which were all recorded by acoustic detectors mounted on met masts at approximately 60 metres above the ground. However, it is not expected that impacts associated with potential blade strike impacts would result in impacts substantial or significant enough to threaten the persistence of any of the these species within the bioregion, given the low level of relative activity recorded for all species at higher elevations (i.e. within the range of rotor blades), the wide ranging nature of the species, and the expected volume of commensurate habitat available in the landscape. It should be noted however that locally, repeated loss could alter populations in the short term, and the potential for this will be monitored through implementation of the BBAMP and mitigated accordingly.
Predict the cumulative impacts of the proposed development alongside existing wind farms, on species mortality, movement patterns and use of adjacent habitat
As wind farm developments increase in NSW, and Australia, bird and bat species with the potential to move over far ranging distances can be subject to impacts at multiple wind farms (Biosis, 2006). Five existing wind farms (considered to be those currently operating and/or having been approved for development) occur within approximately 200 kilometres of the project area, these include:

- Sapphire Wind Farm and White Rock Wind Farm both between Glen Innes and Inverell, approximately 200 kilometres to the north.
- Bodangora Wind Farm south-east of Dubbo approximately 200 kilometres to the south-west.
- Liverpool Range Wind Farm (yet to be constructed) approximately 120 kilometres to the south west.
- Kyoto Wind Farm (yet to be constructed) approximately 50 kilometres to the south-west.
- Additionally, Winterbourne and Doughboy Wind Farms, located on the Northern Tablelands near Armidale, as well Bowmans Wind Farm near Muswellbrook, are currently under assessment or EIS stage.

These wind farms range in size from 33 turbines at Bodangora, 42 turbines for Kyoto, 70 and 75 turbines at White Rock and Sapphire respectively, and up to 267 turbines at Liverpool Range.

Each of these wind farms are considered to potentially result in some level of mortality to wide ranging aerial species, however there would be limited overlap in species populations between four of these five wind farm due to their distal locations. Potential interactions of populations of long-range foragers and/or migrating species may occur between the Hills of Gold wind farm and the Kyoto wind farm, however large expanses of intact native vegetation and open air space occur between the two sites, meaning the likelihood of individuals and/or populations occurring at both sites is considered minimal. Based on the number of turbines operating at the five wind farms within 200 kilometres of the project area, the Hills of Gold wind farm could be expected to contribute to 13 % of potential mortality to aerial species. Detailed and adaptive management plans, such as an Operational Bird and Bat Adaptive Management Plan, will be developed for the project and provide an effective monitoring program and strategy to manage and mitigate operational issues relating to operational and cumulative issues.

As only five existing wind farms (include two yet to be built) occur within approximately 200 kilometres of the current project area cumulative impacts to movement patterns and use of adjacent habitat are expected to be minimal.

Additional assessment cumulative impacts in provided in Section 8.7 and existing wind farms proximal to the subject land are is mapped on Figure 28.

Predict the likelihood and nature of impacts on aerial species living in, or likely to fly over, the proposed development site, including barriers to migratory pathways, and breeding, feeding and resting resources

The likelihood of impact of birds and bats resident in or likely to fly over the project area are presented in Sections 8.3.1, 8.3.2, 8.3.4 and Appendix D of this BDAR, as well in the relevant prescribed impacts section above. Bent-winged Bat roosts and Grey-headed Flying-fox camps are is mapped on Figure 28.

Predict the impact of avoidance behaviour for migratory species relative to migration distances, and the availability of suitable habitat for breeding, feeding and resting over the migration route

The likelihood of impact of birds and bats, including known or potential migratory species, over the project area are presented in Sections 8.3.1, 8.3.2, 8.3.4 and Appendix D of this BDAR. No species listed as migratory under the EPBC Act were recorded during the field campaign undertaken for the current assessment that extensively targeted the avian fauna present within the subject land during repeat surveys over multiple seasons. Impacts associated with barriers to habitat connectivity are provided above, including an assessment of species recorded that could be considered somewhat migratory, such as bent-winged bats.

Justify predictions with reference to data, collision risk modelling (if available), relevant literature or other published sources including any publications by the Department

Justifications for the likelihood of impacts for birds and bats resident in or likely to fly over the project area are presented in Sections 8.3.1, 8.3.2, 8.3.4 and Appendix D of this BDAR.

Map the disturbance zone around wind turbines, and the significant landscape and habitat features within that zone, for species likely to be affected, e.g. hollow bearing trees and important habitat for migratory species

The predicted zone of disturbance around wind turbines is considered to equate to the area outside (and additional to) the rotor swept area where indirect effects of rotating turbine blades are likely to cause changes in air pressure, and/or other characteristics, that may impact upon aerial fauna which fly into this space. In the

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case of the current assessment, the rotor swept area is expected to extend up to 85 meters either side of the turbine hub, with an additional 50 meters beyond the blade tip considered as a nominal zone of disturbance. These 50 metres, where effects would dissipate away from the rotor swept area, is estimated as the maximum extent an aerial fauna species would likely be disturbed by fluctuations in the air space around rotating turbines. It is expected that smaller species would be more likely to experience disturbance from smaller changes in air pressure (etc), and therefore experience disturbance further from the blade tips, when compared to larger species likely to be more tolerant of smaller changes, and thus experiencing disturbance closer to the tips of the blades. The zone of disturbance therefore is considered to extend to a maximum of 135 metres from the turbine hub. The predicted zone of disturbance around each turbine is mapped on Figure 28.

The zone of disturbance can be considered to comprise two separate parts, those being the rotor swept area, and the area of air disturbance extending past the blade tip. Potential impacts to aerial species within the rotors swept area are largely associated with blade strike and possibly barotrauma, the risk and likelihood of which has been assessed for bird and bat species in Sections 8.3.1, 8.3.2 and Appendix D of this BDAR.

Impacts associated with the area of air disturbance, past the end of the blade tips, are less clear but are likely associated with increased avoidance behaviour and barrier effect due to alteration of forces acting on aerial species, potentially leading additional indirect habitat loss due to expected avoidance behaviour.

Within the combined zone of disturbance, equating to the rotor swept area and the additional area of air disturbance, habitat features likely to be utilised by aerial fauna include open grassy areas, paddock trees and intact vegetation supporting numerous hollows, small dams and minor watercourses. All of these features are potentially utilised for foraging, roosting and breeding habitat (for some species). Potential microbat roosting/breeding habitat near (former) WP27 and (relocated) WP50 no longer occur within the zone of disturbance from any turbines. Based on a 135 metre radius buffer around the 70 wind turbines the total area within the zone of disturbance is approximately 365 hectares, comprised of open airspace above 198 hectares of disturbed open areas of exotic grassland, and approximately 167 hectares of forest and woodland vegetation. This 365 hectares of potential airspace habitat could be considered to be a maximum area of possible forage habitat indirectly impacted for smaller aerial species such as microbats at times when the turbines are operational. Furthermore the amended design has reduced this potential impact by approximately 7% (or 26 hectares) as a result of the removal of 5 turbines from the Projects layout. Whilst this potential indirect impact to movement and potential forage habitat due to fauna avoiding areas surrounding operation wind turbines could be considered substantial when considered in isolation, it should be noted that none of the habitats present within the estimated zone of disturbance are limited in the landscape. The areas subject to disturbance comprise only a small fraction of commensurate habitats available to individuals of any local populations of species. Furthermore, as outlined above the removal and relocation of turbines has ensured that there is over 100 metres (and likely much more) between the extent of the zone of disturbance and any potential microbat cave breeding habitat, ensuring substantial areas of undisturbed airspace will occur and allow for entry/exit of these habitat features into the future.

As outlined above, the project has the potential to result in impacts to habitat connectivity for some species potentially flying through the wind farm to access habitats as part of nomadic/migratory movements or long-range foraging. However as noted, habitat connectivity is maintained surrounding the development footprint and the likelihood of regular migratory movements through the wind farm is considered unlikely.

Furthermore, the proposed configuration of the wind farm is a linear row of turbines. In the more usual scattered or 'clustered' array, an aerial fauna species has a high probability of encountering multiple turbines in a given flight. The configuration of turbines for the current project is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines, thus somewhat reducing the impacts to habitat connectivity.

The predicted zone of disturbance is illustrated on Figure 15.

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Vehicle strikes
Assessment of the impacts of vehicle strikes on threatened fauna or fauna that are part of a TEC identified as potentially occurring within the subject land must:
Predict the likelihood of vehicle strike to each relevant species, considering mobility, abundance, range and other relevant life cycle factors
Terrestrial (and terrestrial/arboreal) mammals are at highest risk of being stuck by vehicles, which for the current assessment includes Koala and Spotted-tailed Quoll. Vehicle strikes are most likely to occur when increased vehicle movements occur across the development footprint, which will be during the construction phase of the project, with mobile plant and machinery moving across the site, and turbine components are being delivered and assembled. However, as both species considered at risk of vehicle strikes are nocturnal, the potential for vehicle strikes during construction is very low to negligible. Potential for vehicle strikes is also considered very low during the operational phase of the project and would only occur when vehicles are moving across the site at night. The frequency of this is expected to be low.
Estimate vehicle strike rates with supporting data or literature, where available
Not applicable
Predict the consequences of the impacts for the persistence of the relevant species
Due to the low potential for increased vehicle strikes during the construction and operational phases of the project, as well recommended mitigation measures, there are not expected to be any significance consequences to the local of bioregional populations of Koala or Spotted-tailed Quoll as a result of the project.
Justify predictions of impacts with relevant literature and other published sources of information
Not applicable

8.5.1 Residual prescribed impacts, monitoring, adaptive monitoring and offsetting

As outlined in previous section, some aspects of the impact assessment contained in this BDAR are considered uncertain at the current time due to limited baseline data and the unknowns around the actual incidences of turbine collisions and potential barrier effect impacts. As such an adaptive management strategy has been developed and included in this BDAR, which will be further developed and expanded post approval into a BBAMP and BMP. At the current time there is considered insufficient evidence to justify the need for additional offsets for residual prescribed impacts to threatened species, and no way to quantify what these offsets might be, if deemed necessary.

Proposed methods to quantify residual prescribed impacts, potentially associated with turbine strike and the impacts of barrier effect, have been provided in Sections 8.3.4, 8.10.1 and 8.10.2. In summary, where a tangible and measureable residual impacts occur, offsets will be secured. In the case of the impacts of turbine strike, this will be measured by confirmed and extrapolated collisions based on carcass surveys. In the case of barrier effect impacts, this will be based on statistically significant changes in site/habitat utilisation, that are considered to have the potential to substantially or significantly impact the local population of threatened species. Changes in site utilisation will be monitored through ongoing utilisation surveys, with the effects of any statistically significant changes measured by assessment against the Test of Significance and Significant Impact Criteria assessment guidelines. This further level of assessment is considered warranted to determine whether changes in site utilisation patterns is in fact a negative impact to the species, or simply a shift in habitat and resource use. Further detail will be developed and finalised in the preparation of the BBAMP.

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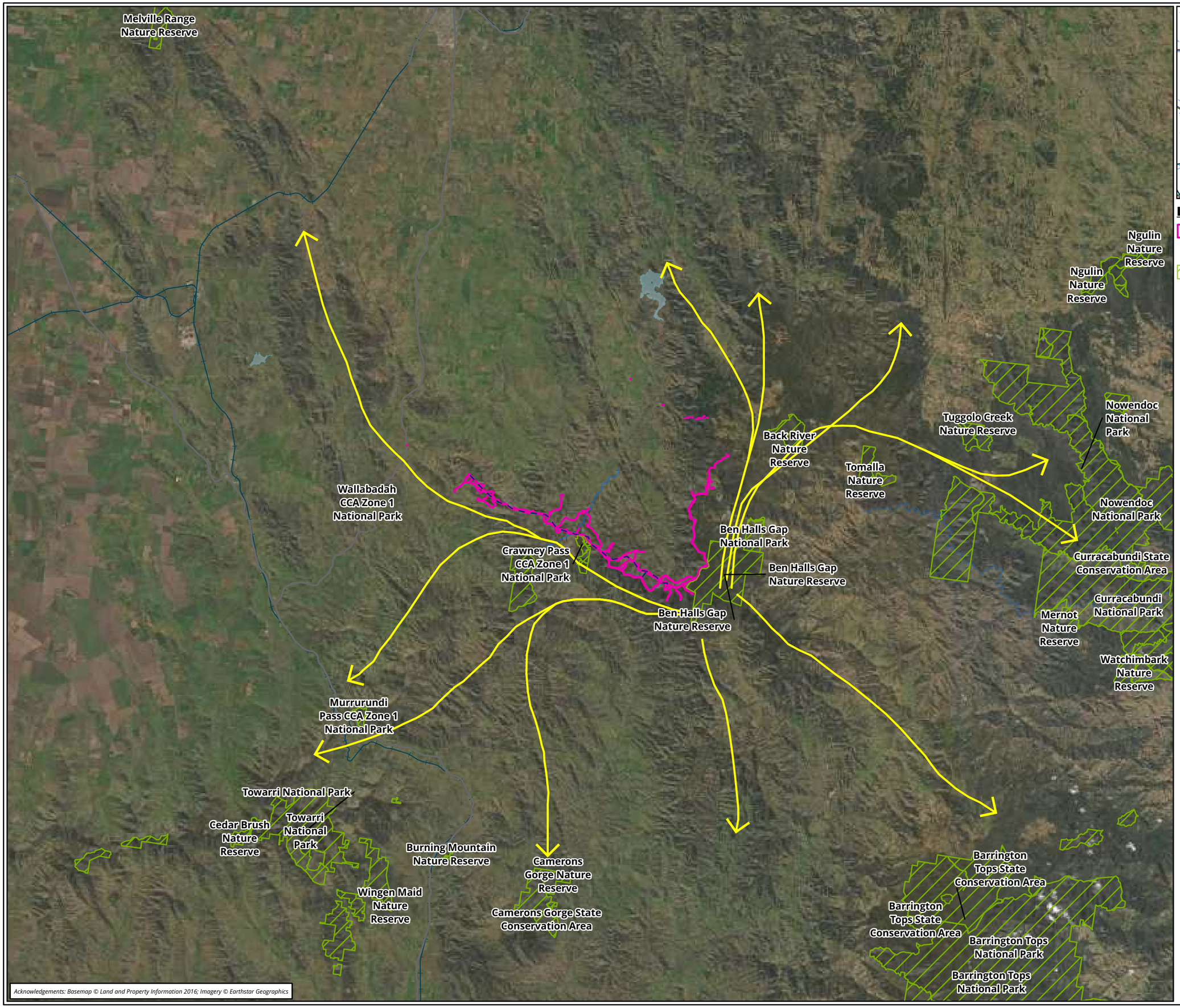

Figure 28 Prescribed impacts, Page 1: Landscape scale habitat connectivity

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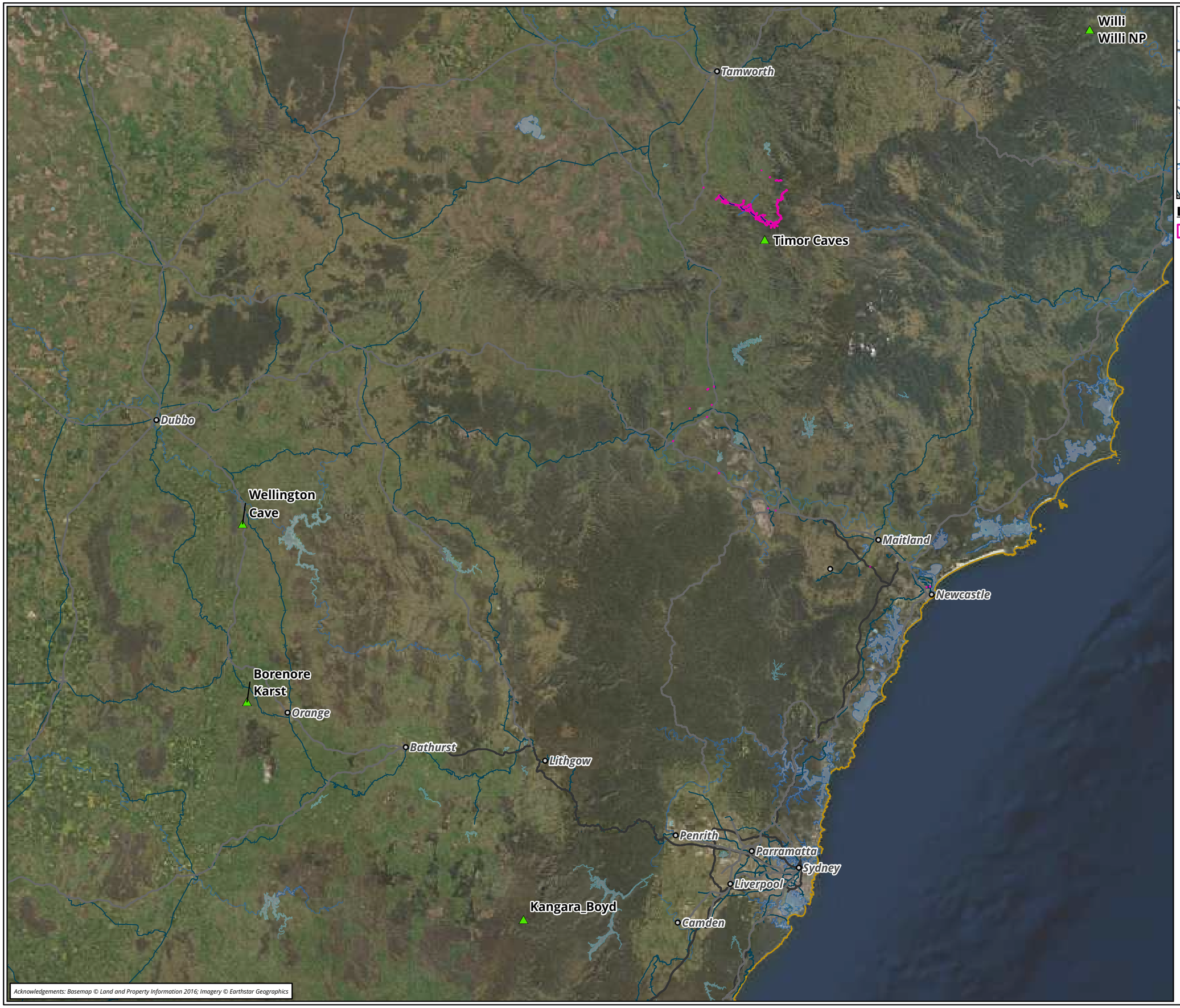
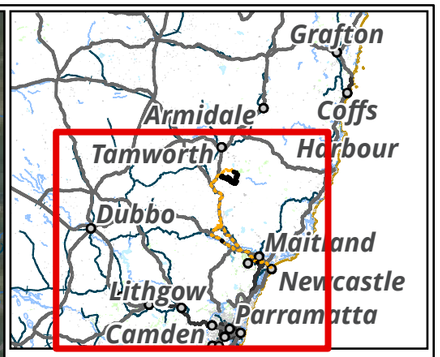
Date: 23 March 2022 ,
Prepared for: CW, Prepared by: LH, Last edited by: jtownsend
Layout: 34963_F28_PrescribedImpacts
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx





Legend

- Infrastructure footprint
- Bent-winged Bat roosts

Figure 28 Prescribed impacts, Page 2: Bent-winged Bat roosts

0 10 20 30 40

Kilometers

Scale: 1:1,350,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
Date: 23 March 2022 ,
Prepared for: CW, Prepared by: LH, Last edited by: jtownsend
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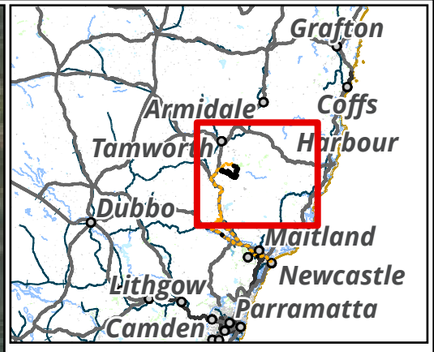

Legend

- Infrastructure footprint
- Grey-headed Flying-fox camps (EPBC viewer)

Figure 28 Prescribed impacts, Page 3: Grey-headed Flying-fox camps

0 7 14 21 28 N

Kilometers

Scale: 1:600,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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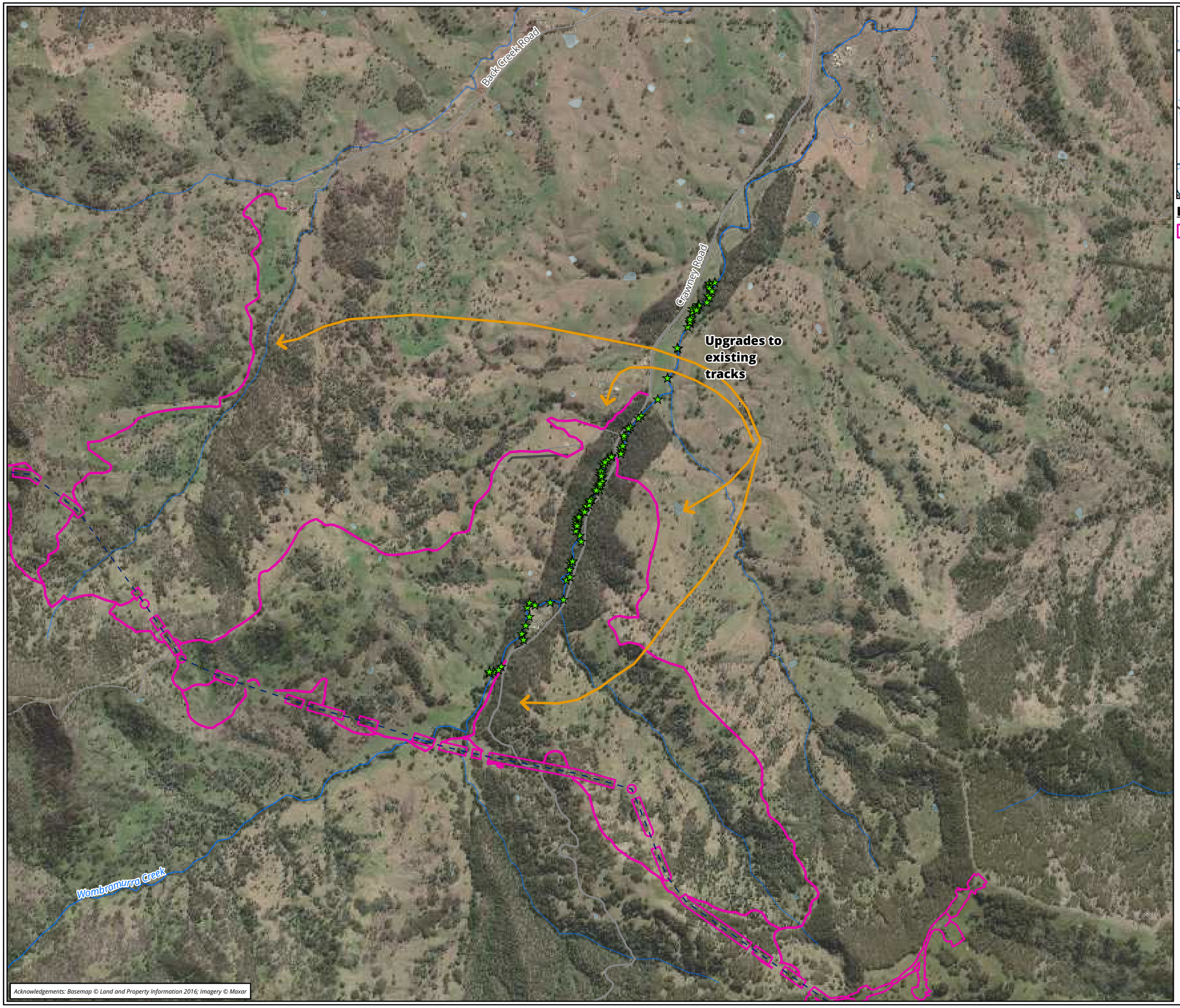

Legend

- Infrastructure footprint
- Booroolong Frog

Figure 28 Prescribed impacts, Page 4: Booroolong Frog records

0 0.25 0.5 0.75 1

Kilometers

Scale: 1:25,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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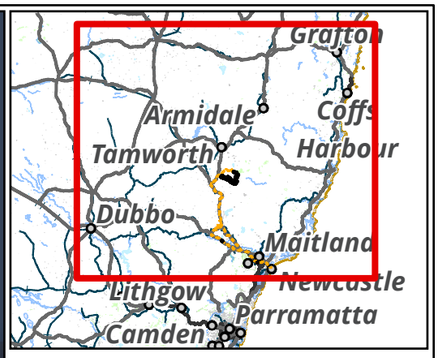
Date: 23 March 2022 ,
Prepared for: CW, Prepared by: LH, Last edited by: jtownsend
Layout: 34963_F28_PrescribedImpacts
Project: P:\34900s\34963\Mapping\34963_ArcGISPro\34963_BDAR\34963_HoG_BDAR_LH.aprx



Legend

- Infrastructure footprint
- Existing wind farm

Figure 28 Prescribed impacts, Page 5: Existing wind farms

0 10 20 30 40

Kilometers

Scale: 1:1,480,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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8.6 Serious and irreversible impacts

Threatened species and ecological communities, listed in Appendix 3 of the 'Guidance to assist a decision-maker to determine a serious and irreversible impact and/or the NSW BioNet Threatened Biodiversity Profile Database, as entities potentially subject to SAIIs will be impacted, either directly or indirectly by the project.

Those entities relevant to the Project include:

- Box Gum Woodland TEC
- Large-eared Pied Bat
- Large Bent-winged Bat
- Little Bent-winged Bat
- Eastern Cave Bat

As outlined in the above section, turbine removal and relocation have resulted in all direct and indirect impacts previously located within the BAM prescribed 100 metre breeding habitat buffers for the above listed microbat species being removed. However SAII assessments were prepared in accordance with the former BAM (OEH 2017) on the basis of this impact occurring and have been retained and updated to provide additional impact assessment information for these species, as all were recorded within the project area, and the assessments provide valuable insights into the local populations and potential impacts.

In accordance with Clause 6.7 Of the BC Regulation an impact is to be regarded as serious and irreversible if it is likely to contribute significantly to the risk of a threatened species or ecological community becoming extinct because:

a) it will cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline, or

b) it will further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size, or

c) it is an impact on the habitat of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution, or

d) the impacted species or ecological community is unlikely to respond to measures to improve its habitat and vegetation integrity and therefore its members are not replaceable.

Assessments undertaken in accordance with Section 9.1 of the BAM for the above listed potential SAII entities are included in Appendix E, with a summary provided in Table 73. Impacts to Box Gum Woodland in the context of the SAII assessment are mapped on Figure 29.

Table 73 Summary of SAII assessments

SAII entity	Summary of assessment
Box Gum Woodland	Throughout the development of the project layout, design decisions have been implemented to avoid impacts to Box Gum Woodland. This has included early biodiversity surveys, prior to development of the preferred corridor. Preliminary assessment highlighted areas of key ecological concern and allowed for avoidance of these areas during the wind farm concept design. During the wind farm layout design, workshops were held between project ecologists, civil engineers and wind modellers to further optimise layout options and ensure impacts to the areas of mapped Box Gum Woodland. Overall design refinements undertaken since the exhibited BDAR have resulted in a

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SAII entity	Summary of assessment
	reduction of impact to Box Gum Woodland CEEC from 13.3 hectares to 6.07 hectares. Approximately 41 % of the impacts to Box Gum Woodland (2.47 hectares) as a result of the project will occur on areas of DNG or that have been assessed as occurring in Low condition. The Project is not considered likely to reduce the extent of the CEEC at the national, bioregional or local scales, and as such the scale of the impact will not lead to a reduction in the geographic distribution of Box Gum Woodland across its known distribution. Furthermore indirect impacts associated with disruption or abiotic process, the loss of functionally important species, and/or exacerbation of fragmentation and isolation are considered unlikely to be substantial as a result of the Project. Further details are provided in Appendix E, and Figure 29.
Large Bent-winged Bat	Actions to avoid impacts to Large Bent-winged Bat include reduction in the numbers of turbines and changes to project layouts to avoid impacts to roosting/breeding habitat buffers, increased separation distances between turbines, and increase separation distances between blade tip and roost/forage habitats. Ongoing construction and operational phase commitments have also been made to reduce indirect impacts to bats potentially present in roost habitat, and potential blade strike impacts. Turbine removal and relocation have resulted in all direct and indirect impacts previously located within the BAM prescribed 100 metre breeding habitat buffers being removed. The local population of the species is considered to be quite large due to the presence of a known non-maternity roost at Timor Caves, approximately 5 kilometres south of the development footprint. Impacts associated with the project are considered relatively minor in the context of the species' potential forage distance, and also relatively minor to potential breeding habitat. Impacts associated with blade strike may occur, with Large Bent-winged Bat being one of the more frequently recorded bats within rotor swept height. Due to the uncertainty of these potential impacts ongoing monitoring, adaptive management, and mitigation strategies have been committed to, to minimise the likelihood and consequences of this impact. Local movement patterns may be somewhat disrupted by the operational wind farm, however bats forming the local population will generally be roosting south of the wind farm at Timor Caves, with breeding migrations are expected to be heading further south still. Further details are provided in Appendix E.
Little Bent-winged Bat	Actions to avoid impacts to Little Bent-winged Bat and associated residual impacts are generally aligned with Large Bent-winged Bat, as detailed above. This is due to the similarities in the species foraging, roosting and breeding habitats, and life-cycles. Turbine removal and relocation have resulted in all direct and indirect impacts previously located within the BAM prescribed 100 metre breeding habitat buffers being removed. Little Bent-winged Bat was recorded less frequently within rotor swept height than Large Bent-winged Bat, however the potential consequences of blade strike are considered similar, and commitments made to ensure ongoing reduction impacts to the species apply. Further details are provided in Appendix E.
Large-eared Pied Bat	Actions and commitments to avoid impacts to Large-eared Paid Bat are commensurate with those summarised above. Turbine removal and relocation have resulted in all direct

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SAII entity	Summary of assessment
	and indirect impacts previously located within the BAM prescribed 100 metre breeding habitat buffers being removed. The size of the local population of Large-eared Pied Bat is considered to be smaller than the bent-winged bat species, and the species is known to generally fly closer to the canopy, hence lower activity levels recorded at all elevations during acoustic surveys are as expected. Impacts to forage habitat are considered relatively minor based on the presence of native vegetation within an estimated 2.5 km forage distance from the development footprint. Impacts to roosting and potential breeding habitat (and 100 m buffers) have been minimised through project design, and commitments have been made to further reduce potential impacts during micro-siting of turbines. Dispersal and movement patterns are not expected to be substantially interrupted due to the linear layout of the turbines and the species' habit of flying closer to the canopy.
Eastern Cave Bat	Actions and commitments to avoid impacts to Eastern Cave Bat are commensurate with those summarised above. Turbine removal and relocation have resulted in all direct and indirect impacts previously located within the BAM prescribed 100 metre breeding habitat buffers being removed. Little is known about the biology and ecology of the species, however, the local population of Eastern Cave Bat is considered to be similar to that of Large-eared Pied Bat. Impacts to the species are also expected to be of a similar magnitude and consequence to Large-eared Pied Bat, with further details provided in Appendix E. In summary, impacts to forage habitat are considered relatively minor based on the presence of native vegetation and impacts to roosting and potential breeding habitat have been minimised through project design, and commitments have been made to further reduce potential impacts during micro-siting of turbines.

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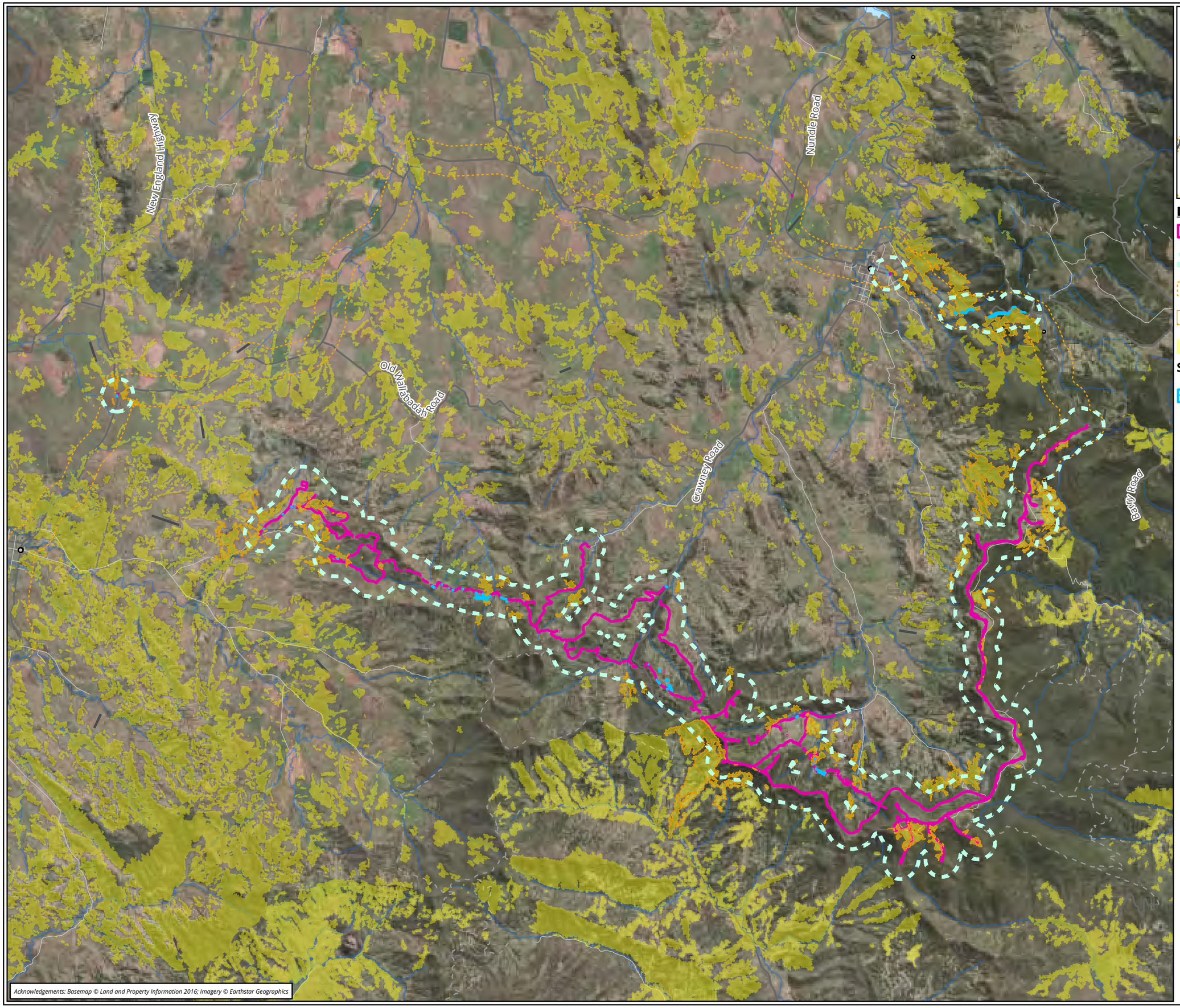

Legend

- Infrastructure footprint
- Development footprint 500m buffer
- Transport haul routes
- Box Gum Woodland within 500m of the development footprint
- Mapped BGW PCTs in the locality

Serious and irreversible impacts

- Box Gum Woodland within the development footprint

Figure 29 Serious and irreversible impacts

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:116,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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8.7 Cumulative impacts

An assessment of proposed and current wind farm projects within a 200km buffer of the project site has been carried out to provide a summary of potential cumulative impacts to biodiversity (Table 74). The summary chapters for biodiversity from each of these projects EIS or the scoping report was reviewed to gain an understanding of the main biodiversity impact and how these may contribute to cumulative impacts when considering the development of the Hills of Gold Project. The proximity of these wind farms to the subject land is mapped on Figure 28.

Table 74 Cumulative impacts from wind farms in the region

Project, description and location	Potential biodiversity impacts	Relevance to Hills of Gold
Kyoto Energy Park **47km away** **42 wind turbines, solar photovoltaic array and mini hydro plant** **EIS chapter reviewed.**	• No threatened flora. • 5.9 ha of impact to White Box-Yellow Box-Blakely's Red Gum TEC. • Seven threatened fauna species comprised of birds and microbats with lower terrestrial fauna diversity than the Hills of Gold project. • Potential Koala habitat, but no records or sign of activity during field surveys. • Wedge-tailed Eagle and Nankeen Kestrel identified in collision risk.	A test of significance under the now repealed *Threatened Species Conservation Act 1997* found that the project is unlikely to have a significant impact on threatened species and communities. An additional 5.9ha of impact to the TEC is not considered to substantially contribute to the impact assessment for impacts to this TEC for the Hills of Gold Project.
Bowmans Creek Wind Farm **59 km away** **Desktop assessment from request for SEARs**	• Nine PCTs mapped as being potentially impacted, with five of these being TECs.	The Bowmans Creek windfarm is in a different soil landscape than the Hills of Gold Project and there is no PCTs that are common to both.
Winterbourne Wind Farm **75km away** **Field assessment from request for SEARs**	• Two threatened fauna species, Scarlet Robin and Spotted-tailed Quoll. • Two TECs, New England Peppermint woodland and Box Gum woodland. • Five non-threatened raptors at risk of blade strike.	The Winterbourne windfarm is in a different soil landscape than the Hills of Gold Project and there are few PCTs that are common to both. Potential impacts to Wedge-tailed Eagle as a results of collision risk, however unlikely to be significant with a similar outcome as assessed for this Hills of Gold project
Liverpool Range Wind Farm **116km away**	• Key impacts are to Box Gum Woodland, woodland birds, forest owls and microchiropteran bats.	Assessment of collision risk for microbats determined that species unlikely to be significantly impacted by blade strike due to foraging heights within or below canopy.

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8.8 MNES Significant impact assessment

A detailed assessment against the EPBC Act *Significant Impact Guideline 1.1 – MNES* is included in this section of the BDAR. The outcomes of this assessment indicate that the project has the potential to result in a significant impact to one TEC and three threatened fauna species, summarised in Table 75.

The following sections describe the significant impact assessment for all MNES species known or considered likely to occur in the development footprint.

Table 75 Summary of MNES assessed to have a significant impact under the EPBC Act guidelines

TEC and EPBC Status	Extent and nature of significant impact
White Box Yellow Box Blakely's Red Gum Woodland Critically Endangered	The project has been assessed as resulting in the direct impact and loss of up to 6.07 ha of this TEC within the transmission line, transmission line access tracks, and transport route upgrades infrastructure areas. It should be noted that actual impacts are considered likely to be almost half of that currently assessed at Devils Elbow (2.5 ha) following detailed design of project components. The current impact footprint assesses impact over a width of between 30 to 60 metres at that location, with the expected final design only requiring a 14.5 m average total width. Measures to avoid and minimise impacts to this TEC have been considered as part of the design, particularly in the selection of the preferred transmission line route. Additional mitigation measures to avoid impacts to the TEC will be considered and implemented where practicable during future design phases and any residual impacts will be offset. The current development footprint considers a 'worst case' clearing footprint for the transmission line easement, assessing complete clearing within the easement. Depending on the height of the towers and the topography of the easement, there will be locations where the existing eucalypt forest can be retained, while still maintaining the required safety and operational clearance to the transmission lines. This presents opportunities to further minimise the extent of clearing of this TEC during detailed design. As well as minimising impacts through design, site restoration and rehabilitation will utilise a species planting list drawn from this TEC where appropriate. Any **impacts to this TEC are considered unlikely to be significant**, as it is listed as critically endangered.
Koala Vulnerable	Given the scale of native vegetation removal required for the proposed works (> 20 hectares), the presence of Koala within the development footprint, and the contiguous nature of the development footprint with surrounding National Parks and State Forests, the EPBC Act referral guidelines classifies the vegetation within the development footprint as critical to the survival of the species. The referral guidelines, which are applicable to all project types, states that the proposed works has the **potential for a significant impact** on the species, due to the removal of greater than 20 hectares of habitat. The removal of 36.44 hectares of native vegetation known to support Koala (which has been reduced by 14.32 hectares due to design revisions undertaken for the amended project) has the potential to impact the species due to the removal of habitat available to the local population. It should be noted however that, based on a conservative home range buffer of 20 kilometres (Kavanagh, Stanton, & Brassil 2007, Davies et al. 2013) (further detailed below), up to approximately 116,500 hectares of native vegetation is available to those Koala individuals most likely to utilise the habitat within and directly adjacent to the development footprint. Of this 116,500 hectares of habitat approximately 32,000 hectares (27.5 %) was

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TEC and EPBC Status	Extent and nature of significant impact
	burnt in the 2019-2020 bushfires (GEEBAM DPIE 2020), which leads to the remaining unburnt habitat becoming a more important resource to the local population. In consideration of the impacts of the 2019-2020 bushfires, the project will only impact upon approximately 0.4% of the habitat available to the local population, which includes the large areas of intact bushland to the south and east of the project footprint. The federal conservation aim for the Koala includes increased vegetation recovery in regions containing fragmented Koala populations, with the project's Biodiversity Offset Strategy aiming to contribute towards this in the local area through increased habitat connectivity, and in the overall achievement of the 'No Net Loss' standard. The current population in the area is not considered to be fragmented, and the areas of habitat impacted as part of the Project are generally small, isolated patches or areas of edge habitat adjacent to larger contiguous areas of Koala habitat. These impacts are not considered likely to result in a reduction in the size of the Koala population in the region. Measures to avoid and minimise impacts to critical Koala habitat have been considered during the design, especially as part of the design refinements for the wind farm resulting in a reduction of the proposed turbines from 97 to 65 and workshops to site infrastructure within cleared areas where practicable. Impacts to Koala habitat have been reduced by a further 27% from the 50.76 ha identified in the original BDAR, to 36.44 ha in the updated BDAR as a result of the project design changes and avoidance initiatives targeted specifically towards Koala habitat. Additional measures will be explored during detailed design phases to reinstate Koala habitat in suitable areas as part of revegetation and landscaping works for rehabilitation of areas subject to temporary impacts. Potential impacts through the construction phase of the Project will be minimised through implementation of the Biodiversity Management Plan that will target management actions specifically towards Koala with details provided in Section 8.9 below.
Large-eared Pied Bat Vulnerable	The proposed works would require the removal of 19.68 hectares of Large-eared Pied Bat habitat that likely forms foraging habitat for the species, based on a 2 km buffer on potential breeding habitat. Previously, potential breeding habitat for this species had been identified within the impact areas, associated with eucalypt forest that is within 100m of the mapped steep cliffs providing potential roosting/breeding habitat (refer to Section 5.4.2 above). However, following targeted field investigations this potential habitat was greatly refined, and project modifications undertaken to avoid this habitat with the result that no potential breeding and roosting habitat for Large-eared Pied Bat will be impacted by the Project. Based on the above, and further detailed in the significant impact criteria assessment below, this level of impact is **not considered likely to be a significant impact** to the species. This is largely due to the large areas of commensurate habitat available in the locality to this highly mobile species.
Spotted-tailed Quoll Endangered	In consideration of the significant impact criteria, the Project has been precautionarily assessed as leading to a **potentially significantly impact** on habitat of the Spotted-tailed Quoll within the development footprint and wider locality. The Spotted-tailed Quoll habitat within the development footprint is considered to be important habitat, given the Endangered EPBC Act threat status of the Spotted-tailed Quoll and the direct evidence of occupancy by the species (DAWE 2016). A total of 40.67 hectares of this habitat is proposed to be removed as part of the project, which is likely to adversely impact Spotted-tailed Quoll habitat within the locality. However, there is still approximately

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TEC and EPBC Status	Extent and nature of significant impact
	84,000ha of unburnt native vegetation present within the expected habitat range for the local population of the species that is considered to be adequate for the population to persist. Measures to avoid and minimise impacts to important Spotted-tailed Quoll habitat have been implemented where practicable during the design of the Project, especially as part of the re-design work since EIS exhibition. Impacts to high and moderate condition PCTs have been reduced by a total of 54.58 ha as a result of project amendments, and the majority of this avoided native vegetation is considered potential habitat for the species. The removal of Spotted-tailed Quoll habitat from the development footprint may contribute to the threats currently impacting the species (i.e. habitat loss). However, the project's Biodiversity Offset Strategy aiming to contribute towards improvement in the species' habitat in the local area through increased habitat connectivity, and in the overall achievement of the 'No Net Loss' standard. Potential impacts through the construction phase of the Project will be minimised through implementation of the Biodiversity Management Plan that will target management actions specifically towards Spotted-tailed Quoll with details provided in Section 8.9 below.

8.8.1 White Box-Yellow Box-Blakely's Red Gum Woodland

Box Gum Woodland CEEC is strongly associated with more fertile soils on lower elevations across the known range in Queensland, New South Wales and Victoria. Over much of its range, this TEC has been subject to extensive clearing and modification for agriculture and grazing, so it often occurs as derived native grasslands with no overstorey.

To be considered the listed CEEC under the EPBC Act, areas of this community must have a predominantly native understorey (i.e. more than 50% of the perennial vegetative ground layer must comprise native species), and be 0.1 hectare (ha) or greater in size and contain 12 or more native understorey species, (excluding grasses), including one or more identified important species. Or patches can be over 2ha or greater in size and have either natural regeneration of the overstorey species or an average of 20 or more mature trees per ha (DECC, 2010).

Based on an analysis of the plot data collected within PCTs comprising this CEEC, all sampled patched meet these criteria and therefore all patches of the following PCTs, in all condition states are conservatively considered to represent the EPBC Act listed CEEC:

- PCT 433 - White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, Brigalow Belt South Bioregion.
- PCT434 - White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion
- PCT 492 - Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion.
- PCT 599- Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion.

It is acknowledged that some areas mapped as the above listed PCTs in Low or DNG condition states may not in fact meet the EPBC Act listing requirements, however based on a lack of plot data in these lower condition patches, this updated BDAR has conservatively assumed that the mapped areas all consistute the CEEC to ensure a worst case assessment of impacts within the development footprint.

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Based on this conservative assumption, the project will impact on 6.07 hectares of Box Gum Woodland CEEC, of which approximately 40% occurs in Low or DNG condition states, with impacts to higher condition patches largely associated with transport route upgrades at Devils Elbow. It should be noted however, that actual impacts are considered likely to be lower following detailed design of project components including Devils Elbow, where the current impact footprint assesses impact over a width of between 30 to 60 metres, with the expected final design only requiring a 14.5 metre average total width.

An assessment of the potential significant of this impact is presented in Table 76 below, with a significant impact to Box Gum Woodland determined to be unlikely.

Table 76 EPBC Act significant impact assessment for Box Gum Woodland

Criteria	Assessment response
Is there a real chance or possibility that the action will reduce the extent of an ecological community	As outlined in the EPBC Act Listing Advice for the CEEC the national extent of Box Gum Woodland occurs in an arc along the western slopes and tablelands of the Great Dividing Range from Southern Queensland through NSW to central Victoria (Beadle 1981). It occurs in the Brigalow Belt South, Nandewar, New England Tableland, South Eastern Queensland, Sydney Basin, NSW North Coast, South Eastern Highlands, South East Corner, NSW South Western Slopes, Victorian Midlands and Riverina Bioregions (Environment Australia 2000). The current extent of the CEEC in NSW is estimated as approximately 250,000 hectares, comprising just 7% of its pre-1750 extent of an estimated 3,700,000 hectares. Of this current estimated extant of 250,000 hectares, approximately 9,000 hectares is estimated to occur within the Nandewar IBRA bioregion, and approximately 39,000 hectares within the NSW North Coast IBRA bioregion (Commonwealth of Australia 2006). The project will impact upon a total of 6.07 hectares of Box Gum Woodland CEEC, the majority of which occurs within the Nandewar IBRA bioregion, with approximately 0.5 hectares of impact occurring in the NSW North Coast IBRA bioregion. These impacts represent a tiny fraction of the extant of Box Gum Woodland CEEC at the National scale, and at the bioregional scale. To assess potential impacts to the CEEC at a more local scale aerial vegetation mapping (DPIE 2019, DPIE 2015) was interrogated to ascertain the extant of PCTs known to represent Box Gum Woodland (NSW BioNet) within a 5 kilometre and 10 kilometres buffer of the development footprint. A total of approximately 10,800 hectares of PCTs known to partially or entirely represent Box Gum Woodland are mapped within the 5 kilometres buffer, and approximately 29,000 hectares are mapped within the 10 kilometre buffer. If only 10% of these mapped vegetation polygons were found to actually represent the EPBC Act listed CEEC, impacts associated with the project would again only represent a small fraction (0.5% and 0.2%) of the CEEC likely to be present in the locality. Based on the above, the project is not considered likely to reduce the extent of the CEEC at the national, bioregional or local scales.
Is there a real chance or possibility that the action will fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	Box Gum Woodland occurs within the development footprint in association with the transmission line corridor, transmission line access tracks and road upgraded along Barry Road outside Nundle and at Devils elbow. Along the transmission line and its access tracks the CEEC occurs in an already highly fragmented landscape, with the impacted patches of the CEEC, and the patches mapped in the surrounding landscape largely occurring as isolated patches of vegetation in an over-cleared landscape. Some larger patches of

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Criteria	Assessment response
	potential CEEC also occur on steeper slopes in more intact vegetation where the CEEC is associated with PCT 488 Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills, however thee areas are mainly south of the development footprint and on the southern side of the ridgeline. Impacts associated with the construction and operation of the project's transmission line (and associated access tracks) will not result in fragmentation of any substantial patches of the CEEC, nor will it increase fragmentation in the landscape. Near Nundle a small isolated patch of Box Gum Woodland will be impacted by the required transport route upgrade works to allow for wind turbine components to be transported to the site. This impact will occur to a single Blakelys Red Gum tree present on the road side in low condition, and within a landscape of scattered paddock trees, and retained vegetation near creeks. This impact will not fragment or increase fragmentation of the CEEC in this location. More significant road upgrades works are required further east along Barry Road, at Devils Elbow, where the double hairpin turns must be bypassed to allow for turbine components to reach the site. Box Gum Woodland in this location exists not in its more typical grassy woodland form but on thinner rockier soils with a shrubbier understorey, as PCT 492 Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest. It does however, align well with the floristic and condition requirements for listing as the CEEC. Minor clearing of the CEEC is required at the eastern extent of the works area on road edges to widen the corners, and as such no fragmentation impacts will occur in this area. However to bypass the Devils Elbow corners clearing will occur over approximately 700 metres up the ridgeline through a patch of intact vegetation. This will result in the fragmentation of an approximately 5.5 hectare patch of vegetation to the north, that will no longer be part of the large contiguous patch of vegetation, and will be surrounded on all side by roads (approximately 10 to 15 m wide). This vegetation was mapped as PCT 541 Silvertop Stringybark - Rough-barked Apple grassy open forest during assessment of haul route impacts and is noted as having the upper stratum dominated by Silvertop Stringybark and Rough-barked Apple. It is considered likely that this vegetation supports occasional Yellow Box, moving downslope from the adjacent PCT 492 (Box Gum Woodland CEEC), but the vegetation to the north is considered unlikely to represent the CEEC. Indirect impacts to this fragmented patch of retained vegetation (PCT 541) will be managed through best practice road drainage designs, ensuring current hydrological patterns are maintained a close as possible to the system. Impacts to PCT 492 in this location occur along a ridgeline on the northern edge of a large mapped patch of the PCT, and as such fragmentation impacts are not expected to occur. It is therefore considered that the project will not fragment or increase fragmentation of Box Gum Woodland CEEC.
Is there a real chance or possibility that the action will adversely affect habitat critical to the survival of an ecological community	Habitat critical to the survival of Box Gum Woodland is on the moderate to highly fertile soils of the western slopes of NSW, which includes the sections of the transmission line corridor, albeit in generally poor condition (refer Table 27). Critical habitat for the survival of the CEEC also includes areas that contain the floristic structure and patch size requirements listed in the recovery plan for Box Gum Woodlands.

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Criteria	Assessment response
	The proposed development will impact on 6.07 hectares of this habitat, either a part of an already disturbed landscape or on the edge of a larger patch of the CEEC within intact vegetation. Based on the scale of the impact, and the tiny proportions of existing Box Gum Woodland and its habitat this equates to in the locality, the projects is not considered likely to adversely affect habitat critical to the survival of the CEEC.
Is there a real chance or possibility that the action will 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	The construction and operation of the 330kV transmission line or section of open road built to the required Australian Standards is unlikely to result in changes to any abiotic factors that are critical to the long term survival of Box Gum Woodland in areas adjacent to the development footprint. The construction of the transmission line will not require substantial earthworks that could impact on surface water or groundwater flow patterns. The current design has also allowed for several access tracks into the transmission line corridor to limit the need for substantial earthworks along the length of the alignment to enable construction. Earthworks and design of the roadway constructed to bypass Devils Elbow will ensure that existing environmental processes are not substantially altered or negatively impacted by the construction.
Is there a real chance or possibility that the action will 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	The impacts to Box Gum Woodland associated with the project are confirmed to generally low condition vegetation within a fragmented landscape associated with the transmission line and its access racks, and to high condition vegetation within larger patches of intact vegetation associated with road upgrades. Neither will result in clearing of vegetation unique to the locality, or to species locally common when compared to elsewhere in the development footprint or broader locality. As such the project is not considered likely to cause a substantial change in the species composition of an occurrence of Box Gum Woodland such that it would continue to decline.
Is there a real chance or possibility that the action will 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 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**	As outlined above impacts to Box Gum Woodland associated with the project are confirmed to generally low condition vegetation within a fragmented landscape associated with the transmission line and its access racks, and to high condition vegetation within larger patches of intact vegetation associated with road upgrades. Box Gum Woodland present along the transmission line and in the surrounding landscape largely occurs as fragmented and isolated patches in an over-cleared landscape. The construction and operation of the transmission line will not result in negative ongoing impacts to the CEEC in the landscape, nor will it increase existing pressures associated with fragmentation, isolation and edge effects. Box Gum Woodland along Barry Road mainly occurs on the edges of the extent of the CEEC, and within larger patches of intact grassy and shrub/grass woodland. The construction and operation of the new roadways may result in an increase in edge effects where the new road will occur through an existing patch of intact vegetation, however it is not expected that sources of negative impacts such as weed encroachment will increase above the levels that already existing in the landscape. The vegetation currently exists in in high condition away from the immediate roadside edges and there is no reason to expect this would change into the future.

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Criteria	Assessment response
	It cannot be said that the project is likely to cause a substantial reduction in the quality or integrity of an occurrence of an ecological community through vectors such as invasion of weeds, or the increase of chemicals or other pollutants.
Is there a real chance or possibility that the action will interfere with the recovery of an ecological community	Where the CCEC occurs along the transmission line, ongoing negative pressures are impacting upon existing patches associated with fragmentation, isolation and edge effects. Landuse in these locations is unlikely to change and as such it can be expected that the condition and overall extant of the CEEC in the locality will continue to decline. Along Barry Road the CEEC occurs within, and on the edges of, large patches of intact grassy and shrub/grass woodland, surrounding by a broader landscape similar to that along the transmission line, and other areas supporting pine forestry practices. There is limited opportunity for recovery of Box Gum Woodland in this landscape with rural pressures likely to continue preventing opportunities for regeneration or rehabilitation of Box Gum Woodland across the majority of the landscape, and steeper/hillier areas less suitable for farming also limited in their capacity to allow for an increase is extent or condition of the CEEC. The project will not result in direct or future ongoing impacts that are likely to interfere with the recovery of Box Gum Woodland, and the seeking of local offset opportunities may actually provide some scope for the CEEC to be rehabilitated in the vicinity of the project area.

8.8.2 Koala

Koala is listed as Vulnerable under the Commonwealth EPBC Act. It occurs from north-east Queensland to South Australia, including parts of NSW. A rapid decline in the number of individuals has been seen since European settlement, primarily due to a reduction in available good quality vegetation with appropriate canopy species suitable for supporting the species (DECC 2008).

The development footprint is located within the Northern Tablelands Koala Management Area (KMA), and the project will require the removal of a total of 132.43 hectares of native vegetation within the development footprint. Of this, 36.44 hectares is considered to be Koala habitat.

Potential impacts of the proposed works include removal of documented Koala feed trees within the Northern Tablelands KMA located within the development footprint, including Snow Gum, Mountain Gum, Mountain Ribbon Gum, Yellow Box and Messmate (OEH 2018).

Within 10 kilometres of the development footprint, the species has been recorded seven times (EES 2020), with an additional two individuals recorded within the development footprint during the current field assessment (consisting of a mother and joey, Biosis 2019). The closest previous records of Koala occur within Ben Halls Gap Nature Reserve, which is east of, and contiguous with, the development footprint. Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve all lie within 20 kilometres of the assessment area, and contain scattered Koala records throughout (EES 2020). For the purposes of this assessment the definition of "the population" encapsulates all contiguous areas of Koala habitat into a singular spatial unit.

Koala populations throughout Australia are currently under increased pressure due to the 2019-2020 summer bushfires that occurred across the southern and eastern states of Australia. An extent of 5.3 million ha of land representing 6.7% of NSW has been impacted by bushfires affecting over 60 threatened fauna species. DAWE have provided several resources in response to these fires including analyses of listed species habitat within fire affected areas (DAWE 2020a), as well as provisional lists of fauna that require urgent

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management intervention (DAWE 2020b). Approximately 13% of the likely and known distribution of the combined Koala population has been identified as occurring within fire affected areas, and Koala has been identified as one of the species requiring urgent management intervention. Given this context, remaining areas of high quality Koala habitat are of key importance in the conservation of the species.

A detailed assessment of impacts to Koala against the significant impact guidelines is provided in Table 77. Impacts to Koala's are considered to be potentially significant due to the loss of habitat critical to the survival of Koala.

Table 77 EPBC Act significant impact assessment for Koala

Criteria	Assessment response
Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population?	The Commonwealth Species Profile and Threats Database (SPRAT) currently states that there is a data deficiency in regard to the delineation of sub-populations throughout the listed Koala's range (DAWE 2020a). Therefore, it is currently difficult to specify important populations and such a proposition must be assessed on a case by case basis, using the information available for a particular location. The extent of a sub-population is likely to be defined by significant natural or anthropogenic barriers. The development footprint lies approximately 100 kilometres south east of Gunnedah, a known Koala hot-spot. In Gunnedah, local records of Koala were particularly high from the 1970s to the 1990s but began declining rapidly after multiple heat waves hit the area around 2009 (Gunnedah Shire Council 2015). Since then, further impacts to Koalas such as clearing of land and vehicle strikes have further contributed to the decline of the Koala population. It is likely that the Gunnedah population would be considered an 'important population' of the species. Conversely, Koala records nearby the current assessment area are much less concentrated, and little is known about the abundance, distribution or movement patterns of Koalas in the broader area. It is unlikely that Koalas inhabiting the development footprint would be considered part of an 'important population' of Koalas. Regardless, Koalas are known to breed in the locality of the development footprint (recent record of mum and joey, Biosis 2019), and the locality is likely to be used by the species. The proposed works require impacts to 36.44 hectares of native vegetation identified as potential Koala habitat, which has been reduced by 14.32 hectares due to design revisions undertaken for the amended project, these impacts will however reduce the availability of resources within the locality. Given the proposed impacts occur on the edge of an extensive reserve system (greater than 3000 hectares), it is unlikely that the overall size of the existing population will diminish as a result of the works. Impacts to Koala habitats impacted within the development footprint are also to largely fragmented patches located within a matrix of agricultural land. There are no large, intact areas of Koala habitat proposed to be impacted and the project will not cause any permanent barriers to Koala movement within or through the development footprint. Overall, it is unlikely that the proposed works will lead to a long-term decrease in the size of an important population.
Is there a real chance or a possibility that the action will reduce the area of occupancy of	Koalas occurring in and nearby the development footprint are not considered to form part of an 'important population' of Koalas. The proposed works require impacts to 36.44 hectares of native vegetation

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Criteria	Assessment response
an important population?	identified as potential Koala habitat, which has been reduced by 14.32 hectares due to design revisions undertaken for the amended project, these impacts will however reduce the availability of resources within the locality. Whilst impacts to these areas may restrict the expansion of the existing Koala population, given the proposed impacts occur on the edge of an extensive reserve system (greater than 3,000 hectares), it is unlikely that the overall size of the existing population will diminish as a result of the works. Overall, it is unlikely that the proposed works will significantly reduce the area of occupancy of an important population.
Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?	Koalas occurring in and nearby the development footprint are not considered to form part of an 'important population' of Koalas. Within the locality of the development footprint, Koala records are scattered throughout the landscape, mostly to the north and east. Koala have been recorded within the wider area surrounding the development footprint, with previous records also occurring within Ben Halls Gap Nature Reserve, Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve, all laying within 20 kilometres of the development footprint (EES 2020). To the west of the development footprint however, land is largely cleared for farming, and large gaps occur between areas of native vegetation. It is likely that the development footprint falls at the western edge of the local Koala population, with Koalas mostly inhabiting the nearby nature reserves to the east. The proposed works require removal of 36.44 hectares of potential Koala habitat (reduced by 14.32 hectares due to design revisions undertaken for the amended project), however, this habitat occurs at the western fringes of Ben Halls Gap Nature Reserve. While removal of this vegetation will reduce resources for Koala in the area, it is unlikely to fragment the local population, which most likely occurs largely east of the development footprint. Overall, it is unlikely that the proposed works will result in the fragmentation of the current existing population into two or more populations.
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	Table 4 of the EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (DoE 2014) includes a habitat assessment tool for assessing habitat critical to the survival of the Koala. Impact areas that score five or more are considered to include critical habitat for the species. The area of the proposed works returned a score of 8, and therefore constitutes habitat critical to the survival of Koala. This score was based on the following criteria: • Evidence of one or more Koalas within 2 kilometres of the edge of the impact area within the last 5 years (2 points). • Has forest, woodland or shrubland with emerging trees with two or more known koala food tree species (2 points). • Area is part of a contiguous landscape ≥ 1000 hectares (2 points). • 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 (1 point). • Uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context (1 point). The EPBC Act referral guidelines for Koala include assessment criteria under Section 7 for determining whether a proposed action including impacts to critical

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Criteria	Assessment response
	koala habitat requires an EPBC referral (see Figure 2: assessing adverse effects on habitat critical to the survival of the Koala). As the development footprint contains habitat classed as critical, and the impact to vegetation is more than 20 hectares, the guidelines state that the impact to Koala is most likely to be significant for the purposed of the EPBC Act. Given the patchy spatial arrangement of majority of the native vegetation removal, the presence of Koala within and surrounding the development footprint, the limited barriers to movement and corridors from the project, and the contiguous nature of the development footprint with surrounding National Parks and State Forests, this assessment considers the Project is unlikely to result in impacts that will actually adversely affect habitat critical to the survival of the species in the locality. Regardless, based on the guidance provided in the EPBC Act referral guidelines, the removal of Koala habitat as a result of the project is considered to have the potential result in a significant impact to the species. In addition, large-scale bushfires during the summer of 2019-2020 have reduced the availability of Koala habitat across its distribution by approximately 13 % (DAWE 2020a). Studies have shown that the home ranges of Koalas vary based on foraging resources. One study in north-western NSW found that the home ranges for male Koala's was around 12 hectares, and for female's it was around 9 hectares (Kavanagh, Stanton, & Brassil 2007). A second study in semi-arid landscape of southwest Queensland found that home range size varied significantly with the availability of water, with average home range being around 18 hectares where annual rainfall was in excess of 580 mm per annum, increasing to around 80 hectares where annual rainfall was around 450 mm per annum (Davies et al. 2013). Given the typically high annual rainfall around Hanging Rock (BOM Station 055200) which has ranged from 424.6 mm to 1452.90 mm since 2014 (BOM 2020), a conservative 20 kilometre buffer around the wind farm development footprint is likely to include the home ranges of those individuals most likely to utilise the habitat within and directly adjacent to the development footprint. Within this 20 kilometre buffer area approximately 32,000 hectares (27.5 %) of native vegetation has been burnt, with the area estimated to support a total of approximately 116,500 hectares of native vegetation. Most (approximately 26,200 hectares or 82 %) of this vegetation has been burnt to a medium or high degree of intensity, in accordance with the burnt area classes outlined in the GEEBAM (NSW Department of Planning, Industry and Environment 2020), meaning both the canopy and understorey have either been partially of completely burnt. As such, the native vegetation being removed by the Project is of potentially greater importance than prior to the 2019-2020 bushfires for the species, given it mainly represents unburnt habitat within an areas where a substantial portion of the vegetation as burnt.
Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?	Koalas occurring in and nearby the development footprint are not considered to form part of an 'important population' of Koalas. The 36.44 hectares of vegetation being removed (reduced by 14.32 hectares due to design revisions undertaken for the amended project) occurs on the fringes of native vegetation along the western side of Ben Halls Gap Nature Reserve. While Koalas are known to breed in the locality (project record of mother and joey, Biosis 2019), it is also likely that such behaviour occurs throughout the reserve system to

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Criteria	Assessment response
	the north and east of the development footprint. While the removal of vegetation as part of the proposed works will reduce habitat (including breeding habitat) for Koala in the local area, the local Koalas are not considered an important population and the abundance of habitat available within the nearby reserve system would likely continue to support the breeding and population growth of the species in this area. Overall, it is unlikely that the proposed works will disrupt the population or breeding cycle of an important population of Koala.
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The proposed works will remove 36.44 hectares of potential Koala habitat from the development footprint, reduced by 14.32 hectares due to design revisions undertaken for the amended project. This includes removal of native trees identified as feed trees for Koala within the Northern Tablelands KMA (OEH 2018). As Koala are known to utilise the development footprint, the removal of this habitat will decrease the availability of habitat for the species within the locality. In addition, large-scale bushfires during the summer of 2019-2020 have reduced the availability of Koala habitat across its distribution by approximately 13 % (DAWE 2020a). Approximately 32,000 hectares of native vegetation within a 20 kilometre buffer of the development footprint has been lost due to bushfire. This represents 27.5 % of the 116,500 hectares of native vegetation estimated to occur within this buffer. As such the native vegetation being removed by the Project is of potentially greater importance than usual for the species. However the habitat within the development footprint is located on the edges of vegetation patches, with significant tracts of more in-tact vegetation still available to Koala within the nearby reserve system to the north and east, where the main portion of the koala population is expected to exist. Additionally, protecting and enhancing native vegetation outside of approved disturbance areas and managing the remaining remnant vegetation and habitat within or surrounding the development site toward a benchmark state, would aid in the recovery of Koala habitat locally. Overall, it is unlikely that the proposed works would cause the local population of the species to decline.
Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	Invasive species such as the European Fox *Vulpes vulpes* that may predate Koala are considered established within the region. Invasive weeds species are not known to directly harm populations of Koala but do have potential to reduce quality of habitat in the adjoining bushland and therefore increase potential to harm the population of Koala. Management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include: • Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the Environmental Management Strategy (EMS) • Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. • Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. • Appropriate disposal of any weed material.
Is there a real chance or a	The proposed action will result in removal of potential habitat for Koalas within the

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Criteria	Assessment response
possibility that the action will introduce disease that may cause the species to decline?	development footprint. This impact is not likely to results in the introduction of diseases that may cause the species to decline.
Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?	There is no accepted or adopted national recovery plan for Koala. However, the approved conservation advice (Commonwealth of Australia 2012) gives priority to the following conservation actions: • Develop and implement a development planning protocol to be used in areas of koala populations to prevent loss of important habitat, Koala populations or connectivity options. • Development plans should explicitly address ways to mitigate risk of vehicle strike when development occurs adjacent to, or within, Koala habitat. • Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Identify populations of high conservation priority. • Investigate formal conservation arrangements, management agreements and covenants on private land, and for Crown and private land investigate and/or secure inclusion in reserve tenure if possible. • Manage any other known, potential or emerging threats such a Bell Miner Associated Dieback or Myrtle rust. • Develop and implement options of vegetation recovery and re-connection in regions containing fragmented Koala populations, including inland regions in which Koala populations were diminished by drought and coastal regions where development pressures have isolated Koala populations. • Develop and implement a management plan to control the adverse impacts of predation on Koalas by dogs in urban, peri-urban and rural environments. • Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions. The project cannot be said to be adverse to any of the above conservation actions, and if proposed local biodiversity offsets are secured as planned habitat in the locality surrounding the wind farm will be improved and conserved in perpetuity.

8.8.3 Large-eared Pied Bat

The Large-eared Pied Bat is a medium-sized insectivorous bat measuring a total length of approximately 100 millimetres and weighing 7–12 grams (Hoye and Dwyer 1995). The species is listed as Vulnerable under the BC Act and the EPBC Act. The species' current distribution is poorly known. Records exist from Shoalwater Bay, north of Rockhampton, Queensland, through to the vicinity of Ulladulla, NSW in the south (Hoye 2005). Despite the large range, it has been suggested that the species is far more restricted within the species' range than previously thought (DECC 2007). Much of the known distribution is within NSW. Available records suggest that the largest concentrations of populations appear to be in the sandstone escarpments of the Sydney basin and the north-west slopes (Coolah Tops, Mt Kaputar, Warrumbungle National Park and Pilliga Nature Reserve. Although the species is widely distributed, it is uncommon and patchy within this area (DERM 2011).

The species requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors which are used for foraging (TSSC 2012). Almost all records have been found within several kilometres of cliff lines or rocky terrain (Hoye 2005). Roosting has also been observed in disused mine shafts, caves, overhangs and disused Fairy Martin Hirundo ariel nests (Hoye and Dwyer 1995).

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Known breeding locations are extremely limited within NSW. Five locations are known to have been used for breeding within NSW, including:

- A mine tunnel at Copeton which was used for breeding until flooded by dam waters in 1976 (Dwyer 1966).
- A sandstone cave near Coonabarabran, NSW (Pennay 2008).
- Capture of lactating females adjacent to sandstone cliffs in Ulan, NSW (Fly by Night 2005).
- Observations of small groups of females in a disused gold mine near Barraba, NSW (DERM 2011).
- Anecdotal observations of small groups of females and young bats in the sandstone Pilliga region, NSW (DERM 2011).

The maternity site at Barraba lies approximately 150 kilometres north of the current development footprint, while the maternity site at Coonabarabran lies approximately 185 kilometres west. Post-lactating females have also been recorded approximately 16 kilometres south west of the development footprint near Murrurundi.

The structure of maternity roosts appears to be very specific (arch caves with dome roofs). Caves need to be high and deep enough to allow juvenile bats to learn to fly safely inside and have indentations in the roof. Roosting bats cluster in these indentations, presumably to allow the capture of heat. These physical characteristics are very uncommon in the landscape and their scarcity presumably poses an important limiting factor in the distribution of the Large-eared pied bat (Pennay 2008). No maternity roosts were identified within or adjacent to the development footprint or the 1,500m landscape buffer development footprint, as part of the desktop and field investigations completed for this project.

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area (EPBC Act). In relation to vulnerable threatened species, occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations.
- A population, or collection of local populations, that occurs within a particular bioregion.

To date, there have been no genetic studies undertaken on the Large-eared Pied Bat. Movement of this species between areas has not been recorded and its dispersal ability and habits are not known (DERM 2011). Thus, it is difficult to define 'populations' of the species.

The closest previous records of Large-eared Pied Bat occur approximately 16 kilometres south west of the development footprint, nearby Murrurundi (EES 2020). These sightings recorded post-lactating females, indicating that breeding of the species likely occurs within the locality. The species was also recorded in 10 different locations on an ultrasonic acoustic device within the development footprint during the current assessment, likely using vegetation within the development footprint for foraging. Further previous records of the species lie 30 kilometres north west of the development footprint, near Quirindi. As the morphology of the species suggests that individuals do not disperse over large distances like similar species (DERM 2011), for the purposes of this assessment individuals occurring within the development footprint and nearby in Murrurundi and Quirindi are considered to make up the local population.

The proposed works will likely result in the loss of 19.68 hectares of potential Large-eared Pied Bat habitat calculated in accordance with the BAM, and comprising vegetation communities that are known to be associated with the foraging requirements for this species, as well as nearby to roosting/breeding habitat features such as caves, cliffs and rocky areas. This area of potential habitat represents the total foraging habitat available to the species.

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Previously two high potential roosting/breeding habitats were identified within the development footprint, adjacent to wind turbines WP27 and WP50. Approximately 2,000 square metres (1.8 %) of native vegetation would have been removed from the 100 metre radius buffer area (totalling 108,465 square metres) surrounding the identified habitat adjacent to the WP27 turbine. Removal of vegetation was also to occur approximately 5 metres outside of the 100 metre radius buffer area (totalling 168,036 square metres) surrounding the identified habitat adjacent to WP50. However, following further changes made to the project as part of the ongoing project design, these habitats will no longer be impacted and as such there will be no direct impacts to the roosting/breeding habitats as a result of the proposed works.

It should be noted that although impacts to microbats via blunt force trauma or possibly barotrauma from wind turbines is one of the environmental risks associated with wind farms, Large-eared Pied Bat forage for small flying insects below the forest canopy (OEH 2017), and are considered unlikely to be at high risk of turbine strike due to the lower likelihood of the species foraging nearby the turbines. That being said, this species was recorded within RSH (approximately 60m above canopy height) on the rare occasion. It was previously predicted that in the vicinity of WP27, due to the size of the turbine blades, that there would be some incursion into the air space above the 100 metre radius buffer applied to the high potential roosting/breeding habitat in this area. A distance of approximately 22 metres was been calculated between foraging habitat and the tips of the WP27 turbine blades. Although considered unlikely that a collision event would occur, this turbine has since been removed and as such these risks have been successfully avoided.

A detailed assessment of impacts to Large-eared Pied Bat against the significant impact guidelines is provided in Table 78. Impacts to Large-eared Pied Bats are considered unlikely to be significant.

Table 78 EPBC Act significant impact assessment for Large-eared Pied Bat

Criteria	Assessment response
Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population?	Information about the size, distribution and interactions of Large-eared Pied Bat populations is largely unknown. No populations have been defined as 'important populations' for the species. The largest concentration of records for this species appears to be in the sandstone escarpments of the Sydney basin, and northwest slopes of NSW. Important populations are likely to occur at the edge of the species range, for example in the sandstone escarpments of Morton National Park at the southern end of its range (DERM 2011). The local population, defined from nearby records, does not occur at the edge of the species' range in NSW, however it does occur at the eastern edge of the species range in the regional area. While the species has been recorded abundantly within the Pilliga to the west of the development footprint, no records of the species occur from the development footprint east to the coast. Due to the very few known breeding locations of the species, the record of nearby post-lactating females, and the occurrence of the development footprint at the edge of the regional occurrence of individuals, it is likely that the local population of Large-eared Pied Bat is an important population. The species is known to roost in sandstone caves, and travel down to nearby fertile wooded valleys to forage. A geomorphological assessment of the development footprint and surrounding landscape found that the diverse terrain and lithology and dynamic geomorphology within the locality creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the development footprint (Environmental Geosurveys Pty Ltd 2021). However, whilst the basalt lithology present at the development footprint may support opportunities for microbat

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Criteria	Assessment response
	roosts, no substantial caves were likely to be present, and that no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another (Environmental Geosurveys Pty Ltd 2021). The proposed works are likely to result in direct impact (via removal) of approximately 19.68 hectares of Large-eared Pied Bat habitat in the form of vegetation associated with the species that occurs nearby caves, cliffs and rocky areas, representing the total foraging habitat available to the species. Two high potential roosting/breeding habitats were previously identified within the development footprint, adjacent to wind turbines WP27 and WP50. Approximately 2,000 square metres (1.8 %) of native vegetation would have been removed from the 100 metre radius buffer area (totalling 108,465 square metres) surrounding the identified habitat adjacent to the WP27 turbine. Removal of vegetation would also have occurred approximately 5 metres outside of the 100 metre radius buffer area (totalling 168,036 square metres) surrounding the identified habitat adjacent to WP50. However, due to project modifications which have resulted in the removal of these two turbines, these impacts have been successfully avoided. As such there are no direct impacts to roosting/breeding habitat (or associated buffer areas) for this species as a result of the proposed project. The likelihood of a collisions with the installed turbine infrastructure is considered unlikely due to the species' foraging and movement behaviour. However, if repeated collisions were to occur the consequences are considered to be moderate as this could lead to a reduction in the local abundance of the species in the shorter-term (up to 5 years). Due to the expected low likelihood of occurrence and the level of high quality forage habitat, and commensurate habitat present in the locality, it is considered unlikely that the Project will lead to a long-term decrease in the size of the current important population of the species.
Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?	Given the abundance of rocky escarpments and caves in the broader locality, it is likely that Large-eared Pied Bat are breeding within the area. This is supported by nearby records of post-lactating females. Whilst there are no direct impacts to the two high potential breeding/roosting habitats within the development footprint, the Project will remove 19.68 hectares of foraging habitat for the species. This removal of native vegetation will lead to a reduction in the area of occupancy of the current important population. However, vegetation within the development footprint is well connected to surrounding vegetation, with approximately 28,000 hectares of native vegetation within the 2.5 kilometre area surrounding the development footprint, which is likely to represent the maximum dispersal distance of the local population (Williams & Thomson 2018). This area includes large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests. These areas represent prime foraging habitat for the species and are all within 2.5 kilometres of various locations along the development footprint. Given the plentiful natural roosts that are also likely to be available to individuals within 2.5 kilometres of the development footprint, due to the underlying geomorphology (Environmental Geosurveys Pty Ltd 2021), these foraging habitats would be easily

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Criteria	Assessment response
	accessible to individuals within the local population. The removal of 19.68 hectares of native vegetation as part of the proposed works represents a tiny portion of the native vegetation within the foraging distance of the species and is therefore not considered to have a significant impact on the species.
Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?	The native vegetation to be removed and land proposed to be removed as part of the proposed project lies on the western edge of Ben Halls Gap Nature Reserve. Land to the west of the development footprint contains large, cleared areas with scattered remnant vegetation. The removal of 19.68 hectares of potential Large-eared Pied Bat foraging habitat from the development footprint will reduce the availability of resources in the immediate vicinity of the development footprint, it is unlikely to fragment the existing local population of Large-eared Pied Bat, as the species is mobile and would still be able to use habitat located in the Nature Reserve to the east, and on nearby farmland.
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	Habitat critical to the survival of the species is defined as (DERM 2011): • Maternity roosts. • Sandstone cliffs and fertile wooded valley habitat within close proximity of each other. The current project proposes the removal of 19.68 hectares of Large-eared Pied Bat habitat, consisting of foraging habitat. No direct impacts will occur to the identified high potential roosting/breeding habitat. As such the removal of this habitat is not considered to adversely affect habitat critical to the survival of Large-eared Pied Bat.
Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?	As above, it is likely that Large-eared Pied Bat are breeding within the broader locality surrounding the development footprint, due to the abundance of rocky escarpment and caves, and nearby records of post-lactating females. However, the impacts associated with the project are restricted to 19.68 hectares of habitat. There are no direct impacts to high potential roosting/breeding habitats for the species. As such the removal of vegetation associated with the project is unlikely to interrupt the species' breeding cycle.
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The proposed works will likely result in the removal of 19.68 hectares of potential Large-eared Pied Bat habitat in the form of wooded areas nearby sandstone cliffs. There are no direct impacts to the two high potential roosting/breeding habitats. As such it is considered unlikely that the Project would decrease the availability of habitat for the species such that the species would likely decline.
Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	There is potential for the introduction of weeds, pests or pathogens as a result of the proposed works, via movement of vehicles and plant, and increase in foot traffic. However, management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include: • Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the EMS.

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Criteria	Assessment response
	• Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. • Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. • Appropriate disposal of any weed material. • Implementation of appropriate hygiene protocols where there are potential or known pathogen risks.
Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?	The IUCN Species Survival Commission released a statement on 19 June 2020 stating that there is a credible risk of human-to-bat transmission of SARS-Cov-2, a virus currently circulating the globe and causing a pandemic of the illness Covid-19 (IUCN SSC 2020). However, introduction of this disease to Large-eared Pied Bats within the development footprint as a result of the proposed works is unlikely for the following reasons: • The project will implement measures to minimise the risk of Covid-19 spread among the workforce as required. • No contact or sharing of closed areas between humans and bats is expected as a result of the proposed works. • If further microbat trapping or survey is undertaken by an ecologist as part of the proposed project, the recommendations provided by the IUCN will be followed, including the wearing of a face mask by the ecologist, and avoidance of handling of any microbats. • The transmission of SARS-Cov-2 is considered unlikely as a result of the proposed works. One of the main disease threats threatening insectivorous microbats globally is the exotic pathogen White-nose fungus. There have been no cases of White-nose fungus recorded in Australia (DAWE 2019). As such it is unlikely that the proposed development would result in the fungus being spread to the microbats that make up the local population.
Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?	The following recovery objectives have been specified within the National recovery plan for the Large-eared Pied Bat: • Identify priority roost and maternity sites for protection. • Implement conservation and management strategies for priority sites. • Educate the community and industry to understand and participate in the conservation of the Large-eared Pied Bat. • Research the Large-eared Pied Bat to augment biological and ecological data to enable conservation management. • Determine the meta-population dynamics throughout the distribution of the Large-eared Pied Bat. One of the recovery actions stated under these objectives is the protection of known roosts and associated foraging habitats and management of threats. Approximately 19.68 hectares of potential Large-eared Pied Bat foraging habitat is proposed to be removed as part of the project. As no direct impacts will occur to potential roosting/breeding sites, the proposed works are unlikely to interfere with this recovery action, and the recovery of the species generally.

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8.8.4 Spotted-tailed Quoll

The Spotted-tailed Quoll is listed as Endangered under the EPBC Act. The Spotted-tailed Quoll is a nocturnal, cat-sized, carnivorous marsupial with reddish-brown fur and distinctive white spots over its back and tail (OEH 2019).

The species was previously widely distributed from south-east Queensland, eastern NSW, Victoria, south-east South Australia and Tasmania (Jones 2001). The subspecies' mainland range is now considered to have reduced by 50–90% (Jones 2001). However, detailed distribution records and abundance estimates are generally lacking due to the scale and intensity of surveying that is required to detect the species across its entire range (DAWE 2016).

The Spotted-tailed Quoll has a preference for mature wet forest habitat, especially in areas with rainfall 600 mm/year (McKay 2008). Unlogged forest or forest that has been less disturbed by timber harvesting is also preferable. The Spot-tailed Quoll is predominantly nocturnal and rests during the day in dens (Jones 2001). Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves (OEH 2019). Individuals also require an abundance of food, such as birds and small mammals, and large areas of relatively intact vegetation through which to forage (DAWE 2020c). This subspecies is moderately arboreal and approximately 11% of travelling is done in trees (Jones 2001). The Spotted-tailed Quoll occupy large home ranges, with females occupying 200 – 500 hectares, while males can occupy from 500 to over 4000 hectares (OEH 2019).

The Spotted-tailed Quoll has previously been recorded within and adjacent to the development footprint, including during the current assessment. In 2019 a roadkill individual was located within the Ben Halls Gap State Forest adjacent the development footprint, and another individual was recorded on a camera trap within the development footprint. Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve all lie within 20 kilometres of the development footprint and contain scattered previous Spotted-tailed Quoll records throughout (EES 2020). For the purposes of this assessment the definition of "the local population" encapsulates all contiguous areas of this Spotted-tailed Quoll habitat into a singular spatial unit.

The local population of Spotted-tailed Quolls occurring within and nearby the development footprint is not considered to be an 'important population' of the species. There are currently 10 populations within NSW that are defined as 'important populations' of the species, with the closest populations to the development footprint occurring approximately 40 kilometres south east in Barrington Tops, and 80 kilometres north east in Walcha (DAWE 2016).

Potential Spotted-Quoll habitat occurs throughout the development footprint in the form of eucalypt woodland, rocky outcrops, caves, logs and tree hollows. Approximately 40.67 hectares of Spotted-tailed Quoll habitat will be removed as part of the proposed works. This habitat is comprised of the PCTs identified in Bionet, assessed as having high and moderate condition levels.

Spotted-tailed Quoll populations throughout Australia are currently under increased pressure due to the 2019-2020 summer bushfires that occurred across the southern and eastern states of Australia. An extent of 5.3 million ha of land representing 6.7% of NSW has been impacted by bushfires affecting over 60 threatened fauna species. DAWE have provided several resources in response to these fires including analyses of listed species habitat within fire affected areas (DAWE 2020a), as well as provisional lists of fauna that require urgent management intervention (DAWE 2020b). Approximately 29 % of the known distribution for Spotted-tailed Quoll has been identified as occurring within fire affected areas, and the species was identified as requiring urgent management intervention following those fires (DAWE 2020d). Given this context, remaining areas of unburnt Spotted-tailed Quoll habitat are now of higher importance in the conservation of the species.

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A detailed assessment of impacts to Spotted-tailed Quoll against the significant impact guidelines is provided in Table 79. Impacts to Quoll's are conservatively considered likely to be significant due to the loss of habitat for the local population, classified as important habitat (DAWE 2016), and considered to be of greater importance as refuge following the loss of habitat in the local area from the 2019-2020 bushfires.

Table 79 EPBC Act significant impact assessment for Spotted-tailed Quoll

Criteria	Assessment response
Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population?	The local population of Spotted-tailed Quolls occurring within and nearby the development footprint is not considered to be an 'important population' of the species. Habitat within the development footprint is known to be used by Spotted-tailed Quoll. The removal of 40.67 hectares of potential Spotted-tailed Quoll habitat from the development footprint (reduced by approximately 40-50 hectares as a result of project design revisions), is unlikely to limit the habitat available to the local population. The species requires large home ranges, with females occupying non-overlapping ranges of approximately 200-500 hectares, and males occupying very large, overlapping home ranges from 500 to over 4,000 hectares, depending on foraging resources (EES 2020). As the impacts associated with the project generally occur on the edges of larger areas of higher quality habitats (with the adjacent reserve system comprising greater than 30,000 hectares), it is considered unlikely that the project will result in long-term decrease in the size of the local population, which will remain supported by the higher quality habitats not impacted by the project..
Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?	As above, habitat within the development footprint is known to be used by Spotted-tailed Quoll. The removal of 40.67 hectares of potential Spotted-tailed Quoll habitat from the development footprint (reduced by approximately 40-50 hectares as a result of project design revisions), is unlikely to reduce the area of occupancy of the species, which is estimated to be 2,512 km^2 (Commonwealth of Australia 2020), as they will still be able to move through and around the relatively narrow linear development footprint.
Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?	As the development footprint occurs on the western edge of Ben Halls Gap Nature Reserve, habitat in the form of eucalypt woodland and rocky outcrops is proposed to be removed mostly along the edges of remnant vegetation. Clearing in this spatial arrangement it will not cause novel fragmentation that would split the local population into two or more populations.
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	Habitat that is critical to the survival of the Spotted-tailed Quoll includes large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey (DAWE 2016). However, the threshold densities of these critical components required to support quoll populations are unknown. Consequently, it is currently not possible to define (or map) habitat critical to the survival of the Spotted-tailed Quoll. The Recovery Plan states that given the Endangered threat status of the Spotted-tailed Quoll, all habitats within its current distribution that are known to be occupied are considered important (DAWE 2016). Furthermore, due to the large bushfires that occurred across southern and eastern Australia in the summer of 2019-2020, approximately 29 % of the available habitat across Spotted-tailed Quoll's known range was lost, and the species was

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Criteria	Assessment response
	identified as requiring urgent management intervention following those fires (DAWE 2020d). Given this context, any remaining areas of Spotted-tailed Quoll habitat are now of increased importance in the conservation of the species. The species requires large home ranges, with females occupying non-overlapping ranges of approximately 200-500 hectares, and males occupying very large, overlapping home ranges from 500 to over 4,000 hectares, depending on foraging resources (EES 2020). In the Marengo State Forest in north-eastern NSW, females were reported to have non-overlapping range of up to 175 hectares, and males have an overlapping range of up to 757 hectares (Glen & Dickman 2006). A 20 kilometre buffer around the wind farm development footprint is likely to include the home ranges of all those individuals most likely to utilise the habitat within and directly adjacent to the development footprint. Within this 20 kilometre buffer area approximately 32,000 hectares (27.5 %) of native vegetation has been burnt, with the area estimated to support a total of approximately 116,500 hectares of native vegetation. Most (82 %) of this vegetation has been burnt to a medium or high degree, in accordance with the burnt area classes outlined in the GEEBAM (NSW Department of Planning, Industry and Environment 2020), meaning both the canopy and understorey have either been partially of completely burnt. In spite of the influence of the 2019-2020 bushfires, the removal of approximately 40.67 hectares of Spotted-tailed Quoll habitat as part of the Project, is not expected to be of a magnitude substantial enough to adversely affect habitat critical to the survival of a species as a whole. However, impacts to the local population are conservatively considered to be more substantial, due to the due to the higher value of unburnt habitat in the locality. Due to the large home ranges required by the species, with female home ranges generally not overlapping, and the loss of approximately 27.55% of estimated native vegetation from the 20 kilometre area surrounding the development footprint in the 2019-2020 bushfires (NSW Department of Planning, Industry and Environment 2020), the removal of 40.67 hectares of habitat is considered a moderate loss. This conclusion is conservatively made despite the reduction in impacts the project has been able to achieve, and the largely sub-optimal and edge effected nature of the habitat impacted.
Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?	Potential Spotted-tailed Quoll breeding habitat may be removed from the development footprint as part of the proposed works, including rocky outcrops, tree hollows and logs. Due to the reserve system directly adjacent the development footprint, encompassing Ben Halls Gap Nature Reserve, Hanging Rock State Forest, Nundle State Forest, and Tomalla State Forest and Nature Reserve, it is likely that adequate den sites are located within the locality such that the breeding cycle of the local population will not be interrupted by the proposed works.
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is	Approximately 40.67 hectares of Spotted-tailed Quoll habitat is proposed to be removed from the development footprint as part of the proposed works, which as been reduced by approximately 40-50 hectares as a result of project design revisions. However, records of the species are scattered throughout the locality, and encompass the nearby reserve system, including the adjacent Ben Halls Gap Nature Reserve. The proposed works would result in a reduction of habitat

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Criteria	Assessment response
likely to decline?	available to the local population, and the available habitat within 20 kilometres of the development footprint has been further reduced by approximately 25% as a result of the 2019-2020 bushfires, which is considered substantial. However there is still approximately 84,000 hectares of native vegetation present and unaffected by bushfire. It is therefore considered that there is adequate habitat available in surrounding farmland and nature reserves that the species as a whole is not likely to decline. The local population will however be placed under increased pressure as a result of the removal of areas of unburnt habitat in the locality. Protecting and enhancing native vegetation outside of approved disturbance areas and managing the remaining remnant vegetation and habitat within or surrounding the development site toward a benchmark state, may somewhat mitigate the potential impacts of the Project and aid in the recovery of Spotted-tailed Quoll habitat locally, and will be undertaken as part of the projects Biodiversity Offset Strategy (refer Section 9.1).
Is there a real chance or a possibility that the action will result in invasive species that are harmful to an endangered species becoming established in the species' habitat?	There is potential for the introduction of weeds, pests or pathogens as a result of the proposed works, via movement of vehicles and plant, and increase in foot traffic. However, management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include: • Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the EMS. • Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. • Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. • Implementation of appropriate hygiene protocols where there are potential or known pathogen risks. • Appropriate disposal of any weed material.
Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?	The proposed action will result in removal of potential habitat for Spotted-tailed Quoll within the development footprint. This impact is not likely to results in the introduction of diseases that may cause the species to decline.
Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?	The main threats to Spotted-tailed Quoll include habitat loss and fragmentation, poison baiting, predation by invasive species, deliberate killing, road mortality, poor burning regimes and climate change, among others. The National Recovery Plan for the Spotted-tailed Quoll lists the following management objectives: • Determine the distribution and status of Spotted-tailed Quoll populations throughout the range and identify key threats and implement threat abatement management practices. • Investigate key aspects of the biology and ecology of the Spotted-tailed Quoll to acquire targeted information to aid recovery. • Reduce the rate of habitat loss and fragmentation on private land. • Evaluate and manage the risk posed by silvicultural practices.

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Criteria	Assessment response
	• Determine and manage the threat posed by introduced predators (foxes, cats, wild dogs) and of predator control practices on Spotted-tailed Quoll populations. • Determine and manage the impact of fire regimes on Spotted-tailed Quoll populations. • Reduce the frequency of Spotted-tailed Quoll road mortality. • Assess the threat Cane Toads pose to Spotted-tailed Quolls and develop threat abatement actions if necessary. • Determine the likely impact of climate change on Spotted-tailed Quoll populations. • Increase community awareness of the Spotted-tailed Quoll and involvement in the Recovery Program. The proposed works would involve the removal of 40.67 hectares of potential Spotted-tailed Quoll habitat, which would contribute to the above listed threat of habitat loss for the species and is somewhat averse to the management objective 'reduce the rate of habitat loss and fragmentation on private land'. However the condition of the majority of habitat impacted is sub-optimal due to its occurrence along vegetated edges between intact vegetation and cleared farmland. Furthermore no important den or latrine sites were recorded during the field instigations, and well vegetation riparian zones, used commonly for movement through an individual's range are not well represented in the development footprint. As impacted habitats are largely considered sub-optimal, and the protection and enhancement of native vegetation outside of approved disturbance areas and management of the remaining remnant vegetation and habitat within or surrounding the development site toward a benchmark state, may aid in the recovery of Spotted-tailed Quoll habitat locally, the project cannot be said to be likely to interfere substantially with the recovery of the species.

8.8.5 Greater Glider

The Greater Glider is listed as Vulnerable under the EPBC Act. It is the largest gliding possum in Australia, with a head and body length of 35 – 46 centimetres, and a tail measuring 45 – 60 centimetres (Menkhorst & Knight 2011). The species is arboreal and nocturnal and is mostly restricted to eucalypt forests and woodlands. It is typically found in highest abundance in tall, montane and moist eucalypt forests with old trees and abundant hollows. The species favours forests with a diversity of eucalypt species, due to the seasonal variation in its preferred tree species. During the day Greater Glider shelters in tree hollows, particularly those that are in large, old trees (McKay 2008).

The Greater Glider is found throughout eastern Australia, from the Windsor Tableland in north Queensland through to central Victoria. The broad extent of occurrence is unlikely to have changed substantially since European settlement, however the area of occupancy has decreased substantially, mostly due to land clearing (Threatened Species Scientific Committee 2016). This decline is most likely continuing due to further land clearing, fragmentation, fire and forestry activities. The species is considered to be particularly sensitive to forest clearance, logging and fire, and is slow to recover following major disturbance. The species is also considered to be sensitive to fragmentation due to a low dispersal ability, previously showing low persistence in small forest fragments (Threatened Species Scientific Committee 2016).

A total of 25 Greater Gliders were recorded within the development footprint during targeted surveys in the current assessment. Previous records of the species are also scattered throughout the adjacent Ben Halls Gap Nature Reserve (EES 2020). As Greater Glider tend to have relatively small home ranges (1 – 4 ha), for the

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purposes of this assessment, those records throughout the development footprint and adjacent reserves make up the 'local population'. Nationally, there are no officially recognised 'important populations' of Greater Glider. However in NSW, there are three specific populations listed as Endangered under the BC Act (EES 2020). These are the populations of the Eurobodalla LGA, Mount Gibraltar Reserve, and Seven Mile Beach National Park which are remote from the project. It is not considered that the local population addressed in this assessment makes up an important population of the species.

Approximately 37.45 hectares of known Greater Glider habitat is proposed to be removed from the development footprint as a part of the current project. This encompasses high condition eucalypt woodland, on the wind farm and internal roads development footprint.

Greater Glider populations throughout Australia are currently under increased pressure due to the 2019-2020 summer bushfires that occurred across the southern and eastern states of Australia. DAWE have provided several resources in response to these fires including analyses of listed species habitat within fire affected areas (DAWE 2020a), as well as provisional lists of fauna that require urgent management intervention (DAWE 2020b). Approximately 29 % of the known distribution for Greater Glider has been identified as occurring within fire affected areas, and the species has been identified as requiring urgent management intervention. Given this context, any remaining areas of high quality Greater Glider habitat are now of key importance in the conservation of the species. Greater Glider is sensitive to wildfire, and it is slow to recover following major bushfire disturbances. (Lunney 1987, Threatened Species Scientific Committee 2016). Home ranges for the species are typically small, ranging from 1-4 hectares (Pope, Lindenmayer, & Cunningham 2004), and thus reoccupation of burnt sites in subsequent years is likely to be slow as a result of the species' limited dispersal capabilities (Threatened Species Scientific Committee 2016).

A detailed assessment of impacts to Greater Glider against the significant impact guidelines is provided in Table 80, with impacts considered unlikely to be significant.

Table 80 EPBC Act significant impact assessment for Greater Glider

Criteria	Assessment response
Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population?	The *Matter of NES Significant impact guidelines 1.1* (Commonwealth of Australia 2013) defines an important population as: *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 • Population that are near the limit of the species range. There is currently no national recovery plan prepared for Greater Glider(DAWE 2021). Due to the lack of a national recovery plan there are no important populations that have been formally identified for the species at the Commonwealth level. Within NSW there are three endangered populations that have been identified, the Eurobodalla LGA population, the Mount Gibraltar Reserve area population, and the Seven Mile Beach National Park population. All of these populations occur south of Sydney and are thus geographically distant from the Project. No significant populations north of Sydney are identified in the national Conservation Advice for the species (Threatened Species Scientific Committee 2016). According to the *Ben Halls Gap National Park Plan of Management* (NPWS 2002), the park contains one of the highest recorded densities of Greater Glider, due to the high nutrient levels within the eucalypt foliage, as well as the number of suitably sized hollows. The Project will not impact on any of the habitats within the Ben

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Criteria	Assessment response
	Halls Gap National Park, and most of the development in the vicinity of the park occurs on pre-disturbed, cleared areas that are currently utilised for cattle grazing along its western border. Due to the predominantly linear nature of the development, it is also unlikely to represent a significant dispersal barrier for any individuals moving into or out of the western boundary of the Ben Halls Gap Nature Reserve, beyond that which already exists in the area. Connectivity to the contiguous native vegetation to the north, east and south of the national park will not be impacted by the Project. The species is considered as "widespread and common…particularly in north-eastern NSW" (Kavanagh 2004, Threatened Species Scientific Committee 2016), with multiple records also occurring within the nearby Hanging Rock, Nundle and Tomalla State forests (EES 2020). Given the high level of connectivity between these areas it is highly like that breeding is occurring between individuals in these reserves, and that there is free movement of genes across the landscape. The population within the Ben Halls Gap National Park also does not occur at the limit of the species range. As such the local population of Greater Glider, which is considered to be those individuals that occur within the development footprint and adjacent reserves, is not considered to be an important population key to the long-term survival and recovery of the species. As such the Project is unlikely to result in a long term decrease of an important population of the species.
Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population?	The Project will result in the removal of native vegetation that is likely to be utilised by individuals that comprise the local population of Greater Glider. The local population is likely to include individuals within the development footprint as well as individuals within the large population known to reside in the Ben Halls Gap National Park (NPWS 2002). The development primarily occurs on pre-disturbed, cleared areas that are currently utilised for cattle grazing, including areas along the western border of the Ben Halls Gap National Park. The clearing of native vegetation is primarily occurred on the edges of vegetation patches, and scattered trees within these pre-disturbed areas. The development is also a predominantly linear design, which is unlikely to represent a significant dispersal barrier for any individuals moving into or out of the western boundary of the Ben Halls Gap Nature Reserve, beyond that which already exists in the area. Whilst the removal of native vegetation within the development footprint will result in localised reductions in species habitat, it is unlikely to result in a significant decrease in the area of occupancy over which the species ranges within the locality. Furthermore, given the local population does not occur at the edge of the species range, with a high occurrence of the species across the locality as represented by records in the Hanging Rock, Nundle and Tomalla State forests (EES 2020), it is not considered that the local population meets the criteria of an important population.
Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?	The local population is likely to include individuals within the development footprint as well as individuals within the large population known to reside in the Ben Halls Gap National Park (NPWS 2002). The development primarily occurs on pre-disturbed, cleared areas that are currently utilised for cattle grazing, including areas along the western border of the Ben Halls Gap National Park. The clearing of native vegetation is primarily occurred on the edges of vegetation patches, and scattered trees within these pre-disturbed areas. The development is also a

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Criteria	Assessment response
	predominantly linear design, which is unlikely to represent a significant dispersal barrier for any individuals moving into or out of the western boundary of the Ben Halls Gap Nature Reserve, beyond that which already exists in the area. Connectivity to the contiguous native vegetation to the north, east and south of the national park will not be impacted by the Project. As such it is unlikely that the Project would result in significant modification to dispersal of individuals throughout the area, such that the population would become split into two or more populations. As the local population does not occur at the edge of the species range, with a high occurrence of the species across the locality as represented by records in the Hanging Rock, Nundle and Tomalla State forests (EES 2020), it is not considered that the local population meets the criteria of an important population.
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	Habitat critical to the survival of Greater Glider includes large, mature trees with hollows (for sheltering and breeding), and large remnant vegetation patches. Greater Glider are highly sensitive to fragmentation and are generally unable to persist in small vegetation patches. In addition, large-scale bushfires during the summer of 2019-2020 have reduced the availability of Greater Glider habitat across its distribution by approximately 29 % (DAWE 2020a). As the species' is known to have a small home range, ranging from 1-4 hectares (Pope, Lindenmayer, & Cunningham 2004), a conservative 20 kilometre buffer around the wind farm development footprint is likely to include the home ranges of all of the individuals that utilise the habitat within to the development footprint, as well as those individuals adjacent to the development footprint that may infrequently disperse through the site. Within this 20 kilometres buffer area approximately 32,000 hectares (27.5 %) of native vegetation has been burnt, with the area estimated to support a total of approximately 116,500 hectares of native vegetation. Most (82 %) of this vegetation has been burnt to a medium or high degree, in accordance with the burnt area classes outlined in the GEEBAM (NSW Department of Planning, Industry and Environment 2020), meaning both the canopy and understorey have either been partially of completely burnt. As such the 35.48 hectares of native vegetation being removed by the Project is of potentially greater importance than usual for the species. The current project proposes the removal of approximately 25.54 hectares of Greater Glider habitat, encompassing eucalypt woodland known to support the species, and the associated hollow-bearing trees throughout. Due to the large number of Greater Glider recorded during the current assessment, this habitat appears to be highly suitable for the species. It is not considered likely that the removal of 37.45 hectares of known habitat for the species would adversely affect habitat critical to the survival of this species. The project footprint avoids areas of higher quality, intact and large patch size vegetation with abundant hollows, which is important habitat for this species.
Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?	The local population of Greater Glider addressed in this assessment is not considered to be an important population of the species.
Is there a real chance or a	The current project proposes the removal of approximately XXX hectares of known

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Criteria	Assessment response
possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	Greater Glider habitat, encompassing eucalypt woodland known to support the species, and the associated hollow-bearing trees throughout. Due to the large number of Greater Glider recorded during the current assessment, this habitat appears to be highly suitable for the species. In some areas this vegetation occurs in small remnant patches within cleared areas. Removal of this vegetation would make the land unusable to Greater Glider, as they are not able to persist in cleared areas and have limited dispersal ability. In addition, large-scale bushfires during the summer of 2019-2020 have reduced the availability of Greater Glider habitat across its distribution by approximately 29 % (DAWE 2020a). Approximately 32,000 hectares of native vegetation within a 20 kilometre buffer of the development footprint has been lost due to bushfire. This represents 27.5 % of the 116,500 hectares of native vegetation estimated to occur within this buffer. As such the 37.45 hectares of native vegetation known to support the species, being removed by the Project is of potentially greater importance than usual for the species. However, protecting and enhancing native vegetation outside of approved disturbance areas and managing the remaining remnant vegetation and habitat within or surrounding the development site toward a benchmark state, would aid in the recovery of Greater Glider habitat locally. Additionally, Ben Halls Gap Nature Reserve occurs directly east of the development footprint, and likely provides large areas of suitable habitat to the species. As Greater Glider require relatively small home ranges (1-4 hectares), it is considered that there is adequate habitat within the nearby reserve and retained within the development footprint to support the local population of Greater Gliders, and that the proposed works would not cause the species to decline.
Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?	Invasive weeds species are not known to directly harm populations of Greater Glider but do have potential to reduce quality of habitat in the adjoining bushland and therefore increase potential to harm the population of the species. Management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include: • Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the EMS. • Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. • Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. • Appropriate disposal of any weed material at an appropriately licensed facility.
Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?	The proposed action is not likely to results in the introduction of diseases that may cause the species to decline.
Is there a real chance or a possibility that the action will interfere substantially with the	The national conservation advice for Greater Glider lists the primary conservation objectives for the species as: • Manage threats to secure or increase overall population size.

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Criteria	Assessment response
recovery of the species?	• Maintain viable populations at all known localities. While the proposed removal of 37.45 hectares of Greater Glider habitat will not contribute to the recovery of the species, it is not considered likely to substantially interfere with the recovery of the species for the following reasons: • Ben Halls Gap Nature Reserve occurs directly east of the development footprint, and likely contains large areas of high quality habitat for the species. This habitat is considered adequate such that the loss of 37.45 hectares of habitat within the development footprint would not reduce the local population size or decrease the viability of the local population. There is also large areas of suitable Greater Glider habitat retained within the development footprint. • As part of the project, preclearance assessments would be undertaken and clearing of hollow-bearing trees would be supervised by an ecologist, and any Greater Gliders utilising the habitat being removed from the development footprint would be captured and relocated. Due to the large areas of suitable habitat nearby (i.e. within the reserve system), it is likely that displaced individuals would be successfully relocated, assuring that the local population would not decrease in numbers as a result of the proposed works.

8.8.6 Booroolong Frog

The Booroolong Frog is listed as Endangered under the EPBC Act. The species is an obligate river-breeding frog that was historically found along streams on the western fall of the Great Dividing Range in New South Wales between 200 and 1300 metres above sea level (DAWE 2020d). Several populations were also found along eastern flowing streams in the northern half of the species former range. This species underwent a dramatic decline during the mid-1980s, and the results of recent surveys suggest that declines have occurred throughout its former known range, particularly on the New England Tablelands (OEH 2012). The factors identified as contributing to the historic and continued decline of the Booroolong Frog include disease (Chytridiomycosis) caused by infection with the Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*), habitat degradation, altered stream flows, and stream drying associated with recent severe droughts. The introduction of exotic predatory fish is also likely to have impacted on the Booroolong Frog in the wild, and this impact may be continuing.

The Booroolong Frog lives along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. The species shelter under rocks or amongst vegetation near the ground on the stream edge. Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools (Hunter 2007).

Based on habitat connectivity, 28 local populations are currently known across the range of the Booroolong Frog (OEH 2012). For this assessment, the closest population occurs along the Peel River within the Namoi Catchment, with the river occurring less than 500 metres from the development footprint. First order streams connected to the Peel River occur within the development footprint in parts. The closest record of Booroolong Frog to the development footprint occurs approximately 400 metres to the north of the transmission line along Wombramurra Creek, and 2.4 kilometres north west, along the Peel River, with abundant records along the both watercourses heading further north west (EES 2020). The Peel River is currently considered a Key Management Site for conservation of the Booroolong Frog as part of the Saving Our Species program run by the NSW Government (OEH 2020). The Peel River population is considered to be the local population for the purposes of this assessment.

As part of the proposed works, approximately 0.64 hectares of Booroolong Frog habitat will be directly removed in the form of riparian vegetation alongside creeklines, this has been reduced by 0.95 hectares as a

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result of the project's design revisions. However, due to the location of the development footprint upstream and in close to proximity to the Peel River, the proposed works have some potential to have further indirect impacts to Booroolong Frog habitat as a result of changes in water flows, and increased run off and sedimentation as a result of land clearing and excavation.

In order to minimise such impacts, a Soil and Water Management Plan will be prepared, outlining measures for the management and monitoring of surface water quality and hydrology during construction. The plan would also address any requirements for the management of potential acid sulphate soils or contaminated lands during construction so as to minimise impacts to terrestrial and aquatic habitats. The plan would include the implementation of a construction surface water quality monitoring to minimise impacts to surface water quality. An Erosion and Sediment Control Plan will also be prepared, outlining measures for the prevention of erosion and sedimentation during construction. If adequate soil and water management measures are employed, any indirect impacts to Booroolong Frog habitat will be substantially reduced.

A detailed assessment of impacts to Booroolong Frog against the significant impact guidelines is provided in Table 81, with impacts considered unlikely to be significant providing best practice construction environmental management measures are employed to prevent pollution of adjacent / downstream habitats.

Table 81 EPBC Act significant impact assessment for Booroolong Frog

Criteria	Assessment response
Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population?	The direct removal of 0.64 hectares of Booroolong Frog habitat at the upper reaches of first order streams connected to the Peel River is not considered likely to cause a decrease in the size of the Peel River population. The closest record of Booroolong Frog to the development footprint occurs between 400 metres and 2.4 kilometres downstream, and Booroolong Frog were not recorded within the development footprint during the current assessment, suggesting that habitat within the development footprint is marginal. However, targeted surveys for Booroolong Frog were not able to discount the presence of the species from the along the transmission line, as surveys were undertaken outside of the recommended survey period. However, if potential impacts to soil and water movement as a result of land clearing and excavation are not adequately managed throughout the project, there is a possibility that Booroolong Frog habitat occurring further downstream within the Peel River could be adversely affected as a result of increased run off and sedimentation, changes in water flows, and increased pollution of the waterway. In particular, if sediment was to fill rock crevices within the river, the species would no longer be able to use this habitat for oviposition. If poorly managed, this could lead to a long-term decrease in the Peel River Booroolong Frog population, through reduction in breeding habitat.
Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?	As above, the direct removal of 0.64 hectares of Booroolong Frog habitat at the upper reaches of first order streams connected to the Peel River is not considered likely to cause a reduction in occupancy of the Peel River population, as the closest record of Booroolong Frog to the development footprint occurs between 400 meters and 2.4 kilometres downstream, and Booroolong Frog were not recorded within the development footprint during the current assessment. This suggests that habitat within the development footprint is marginal. It should be noted that targeted surveys for Booroolong Frog were not able to discount the presence of the species from the transmission line, as surveys were undertaken outside of the recommended survey period.

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Criteria	Assessment response
	However, if potential impacts to soil and water movement as a result of land clearing and excavation are not adequately managed throughout the project (in line with legal requirements to avoid water pollution), there is a possibility that Booroolong Frog habitat occurring further downstream within the Peel River could be adversely affected as a result of increased run off and sedimentation, changes in water flows, and increased pollution of the waterway which could lead to a reduction in the area of occupancy of the Peel River Booroolong Frog population, through reduction in available habitat.
Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?	The development footprint is located between 400 meters and 2.4 kilometres south east of the nearest previous record of Booroolong Frog, with all previous records in the locality occurring downstream to the north west. As the development footprint occurs at the outer edge of the local population's range, it is unlikely that loss of habitat in this area would lead to the fragmentation of the Peel River Booroolong Frog population.
Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?	Habitat critical to the survival of the Booroolong Frog is defined as rocky sections of permanent streams occupied by the species. Any action that reduces stream permanency (e.g. pumping water) or results in loss of rock crevices (e.g. smothering by weeds or sedimentation), is likely to threaten the persistence of local populations of this species. As above, the direct removal of 0.64 hectares of Booroolong Frog habitat at the upper reaches of first order streams connected to the Peel River is not considered likely to adversely affect habitat critical to the survival of the species, as the closest record of Booroolong Frog to the development footprint occurs between 400 meters and 2.4 kilometres downstream, and Booroolong Frog were not recorded within the development footprint during the current assessment. This suggests that habitat within the development footprint is marginal. It should be noted that targeted surveys for Booroolong Frog were not able to discount the presence of the species from the transmission line, as surveys were undertaken outside of the recommended survey period. However, if potential impacts to soil and water movement as a result of land clearing and excavation are not adequately managed throughout the project, there is a possibility that Booroolong Frog habitat occurring further downstream within the Peel River could be adversely affected as a result of increased run off and sedimentation, changes in water flows, and increased pollution of the waterway. If water flow was to be affected within the Peel River such that previous areas of habitat no longer contained permanent water, or sedimentation occurred to the extent that rock crevices were filled and unable to be used for oviposition, this would be considered an adverse effect on habitat critical to the survival of the species.
Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?	As above, the direct removal of 0.64 hectares of Booroolong Frog habitat at the upper reaches of first order streams connected to the Peel River is not considered likely to disrupt the breeding cycle of the species, as the closest record of Booroolong Frog to the development footprint occurs between 400 meters and 2.4 kilometres downstream, and Booroolong Frog were not recorded within the development footprint during the current assessment. This suggests that habitat within the development footprint is marginal. It should be noted that targeted

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Criteria	Assessment response
	surveys for Booroolong Frog were not able to discount the presence of the species from the transmission line, as surveys were undertaken outside of the recommended survey period. Booroolong Frogs require rock crevices in shallow slow-medium flowing permanent streams to breed (OEH 2012). If potential impacts to soil and water movement as a result of land clearing and excavation are not adequately managed throughout the project however, there is a possibility that Booroolong Frog habitat occurring further downstream within the Peel River could be adversely affected as a result of increased run off and sedimentation, changes in water flows, and increased pollution of the waterway. If water flow was to be affected within the Peel River such that previous areas of habitat no longer contained permanent water, or sedimentation occurred to the extent that rock crevices were filled and unable to be used for oviposition, this could likely disrupt the breeding cycle of the Peel River population.
Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?	The Booroolong Frog has been previously recorded along 18 kilometres of the Peel River. The direct removal of 0.64 hectares of Booroolong Frog habitat at the upper reaches of first order streams connected to the Peel River, 400 metres to 2.4 kilometres from the closest record, is not considered likely to decrease the availability of habitat for the species such that the species is likely to decline. However, if potential impacts to soil and water movement as a result of land clearing and excavation are not adequately managed throughout the project, there is a possibility that Booroolong Frog habitat occurring further downstream within the Peel River could be adversely affected as a result of increased run off and sedimentation, changes in water flows, and increased pollution of the waterway. The Peel River Booroolong Frog population is one of only 28 known populations. If water flow was to be affected within the Peel River such that previous areas of habitat no longer contained permanent water, or sedimentation occurred to the extent that rock crevices were filled and unable to be used for oviposition, this could likely decrease the extent of the species habitat such that the species could decline.
Is there a real chance or a possibility that the action will result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat?	There is potential for the introduction of weeds, pests or pathogens as a result of the proposed works, via movement of vehicles and plant, and increase in foot traffic. However, management measures would be prepared, implemented and audited to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include: Completion of a site weed assessment and development of a Weed Management Plan. The Weed Management Plan would sit as a sub-plan to the CEMP. Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols. Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. Disposal of any weed material at an appropriately licensed facility. Implementation of appropriate hygiene protocols where there are potential or known pathogen risks.

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Criteria	Assessment response
Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?	Pathogens, including the amphibian Chytrid Fungus *Batrachochytrium dendrobatidis*, have the potential to be introduced to the site during construction. The timing and rapid nature of the Booroolong Frogs' decline from the New England Tablelands, which coincided with the disappearance of several other frog species in this region, was likely due to an outbreak of Chytrid Fungus (Mahony 1999). Declines have been recorded from higher altitude sites, where habitat remains intact, compared to persistence at lower altitudes, which is consistent with other Chytrid Fungus induced declines. Sick and dead infected Booroolong Frogs have been observed in the wild on several occasions, and healthy frogs have tested positive for infection. It is currently unclear as to whether Chytrid Fungus is present within the Peel River. However, extensive preventative measures should be undertaken during the construction phase to ensure that the disease is not introduced into the development footprint or the river system. This will be addressed in a project Biodiversity Management Plan.
Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?	The National Recovery Plan for Booroolong Frog *Litoria booroolongensis* (NSW OEH 2011b) identifies the following recovery actions: • Complete systematic surveys. • Determine the taxonomic status of northern and southern populations. • Identify genetic sub-division across the species range. • Continue and expand riparian protection and restoration. • Regulate the establishment of softwood plantations. • Enforce legislation protecting streams and water flow. • Reduce the transmission of potentially harmful pathogens. • Determine current impacts and prevent impacts from introduced predatory fish. • Implement an effective monitoring program. • Model the influence of predicted climate change. • Develop efficient reintroduction techniques. • Assess the capacity to use assisted colonisation. • Determine impact of herbicides. • Determine the current impact of Chytridiomycosis. • Determine the influence of reduced water quality. • Increase public awareness and provide specific education and training. • Establish a recovery team. As 0.64 hectares of Booroolong Frog habitat in the form of riparian vegetation is to be removed as a part of the proposed works, the only recovery action that may be interfered with as a result of the project is the continued expansion of riparian protection and restoration. However, removal of 0.64 hectares of habitat at the southern edge of the local species population is not considered to be a substantial interference to the recovery of the species.

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8.9 Mitigating and managing impacts

Table 82 identifies proposed measures to further mitigate and manage unavoidable impacts to biodiversity, following all efforts to avoid and minimise undertaken to date.

Table 82 Proposed mitigation measures

ID	Impact	Project component	Mitigation measures	Timing	Responsibility
B1	General	Entire development footprint	An Environmental Management Strategy (EMS) will be prepared and implemented, including industry standard measures for the management of soil, surface water and pollutants, weeds, pests and pathogens, as well as site-specific measures and relevant sub-management plans. Relevant sub-plans specific to the management of biodiversity are a Biodiversity Management Plan, Weed Management Plan and Bird and Bat Adaptive Management Plan.	Pre-construction/ construction	Contractor
B2		Entire development footprint	All site workers would be trained to ensure awareness of requirements of the EMS (**B1**), relevant sub-plans and statutory responsibilities. Site-specific training would be provided when specific work activities were taking place near areas of identified biodiversity value that are to be protected.	Construction	Contractor
B3	Clearing of native vegetation, threatened ecological communities and habitat for threatened flora and fauna	Entire development footprint	Prepare and implement a biodiversity offset strategy, in accordance with the requirements of the BC Act and the EPBC Act Offsets Policy.	Pre-construction	Proponent
B4	Direct impacts to native vegetation	Entire development footprint	Opportunities to further minimise impacts to native vegetation will continue to be explored during the detailed design. This would include measures to minimise the construction footprint and clearing requirements with a particular focus on the protection of hollow bearing trees and fauna movement corridors.	Pre-construction	Proponent

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
B5	Impacts to native vegetation, threatened ecological communities and habitat for threatened species	Entire development footprint	Opportunities to further minimise impacts to native vegetation will continue to be explored during the detailed design. This would include measures to minimise the construction footprint and clearing requirements with a particular focus on the protection of hollow bearing trees and fauna movement corridors. Upon final design and an understanding of detailed impact, a Biodiversity Management Plan would be prepared and implemented. The Biodiversity Management Plan will address terrestrial and aquatic matters by including: • Plans for the development footprint and adjoining area showing updated and current extents of native vegetation, flora and fauna habitat, threatened species and threatened ecological communities and measures to minimise impacts to these features. • Plans showing areas to be cleared and areas to be protected, including exclusion zones and protected habitat features, and areas for native vegetation rehabilitation or re-establishment. This will be key to minimising impacts to Koala and Spotted-tailed Quoll. • Mapping and identification of individual tree hollows and termite mounds and measures to minimise impacts to these features. • Protocols for communicating biodiversity features to the design team during any turbine micrositing and design refinements to minimise and avoid impacts. • Pre-clearing protocols, including pre-clearing inspections, establishment of exclusion zones and on-ground identification of specific habitat features to be retained and/ or relocated. • Vegetation clearing protocols, including staged habitat removal (including of wombats, Koala, and other fauna) and any specified seasonal limits on clearing activities. • Maintaining areas of habitat connectivity for as long as is practicable through or around the construction area. • Maintaining isolated paddock trees within the development footprint where possible to provide refuge to locally occurring fauna species (incl. Koala).	Pre-construction/ construction / post-construction	Contractor

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
			• Protocols for the salvage and relocation of woody debris, tree hollows and bush rock. • Requirements for temporary deterrent fencing, signage and/or requirements to modify driver behaviour and regular visual inspections to minimise the risk of fauna injury / mortality (particularly Koala and Spotted Tailed Quoll) due to vehicle strike or entrapment in deep excavations, with details to be developed during the preparation of the BMP. • Opportunity for egress to any species that may become trapped in any open excavation in the form of graded exits or tools to support climbing out. • Fauna handling and unexpected threatened species finds procedures. • Procedures detailing the management of pathogens such as chytrid fungus. • Rehabilitation, revegetation, reuse of soils and other habitat management actions. • Limit construction and operational traffic speed limits to minimise the potential for vehicle strike, and include sufficient signage on potential presence of threatened fauna species. • Ensure construction and operation personnel are educated on the presence of fauna such as Koala and Spotted-tailed Quoll in the locality, how to manage potential interactions, and to be aware of the potential for vehicle strikes when driving through the sites (particularly after dark). • Weed, pest and pathogen management requirements. • Monitoring during construction and post-construction. • Adaptive management measures to be applied if monitoring indicates unexpected adverse impacts. Operational measures to minimise the ongoing impact of the project to threatened fauna will be implemented as part of an operational component of the Biodiversity Management Plan, and will include: • Revegetation with Koala feed tree species where appropriate. • Design of operational fencing layout to ensure fauna (incl Koala and Spotted-tailed Quoll) can continue to move through the		

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
			landscape, and if they enter the wind farm are able to self-relocate back into surrounding landscape by providing egress opportunities. Ensure fauna are prevented from accessing higher traffic areas or other potentially hazardous area, and are funnelled towards areas of potential habitat rather than towards the operational wind farm, or into dead-ends and bottle-necks. • Installation of glider poles for glider species in areas where the width of the transmission line easement exceeds minimum requirements for species movement. • Establishment of Biodiversity Stewardship sites on neighbouring properties.		
B6	Impacts to threatened flora	Entire development footprint	A pre-clearing survey is to be carried out to confirm the presence/absence of threatened flora within lands that have not been surveyed within and adjacent to the development footprint. As a part of the survey, the size and extent of confirmed threatened flora populations must be determined. The results of the survey are to provide the updated baseline mapping of the vegetation communities and key fauna habitat on site for inclusion in the Biodiversity Management Plan (B5) and inform specific measures for the protection and management of threatened flora. This is to include at a minimum, specific requirements for the clearing process, any proposed translocation opportunities (for native fauna such as wombats) and associated contingency measures.	Pre-construction	Proponent
B7	Impacts to threatened fauna and karst, caves, crevices, cliffs and other geological feature of significance	Entire development footprint	As a part of the Biodiversity Management Plan, opportunities for the salvage and re-use of important habitat features, including tree-hollows and bush rock, are to be identified. The plan is to include detailed procedures for the implementation of these activities.	Pre-construction and construction	Contractor
B8		Entire development footprint	Opportunities to further minimise any impacts to fauna habitat are to be fully explored through detailed design phase including any strategies for habitat restoration augmentation post-work. Habitat avoidance should prioritise the retention of karst and caves offering potential habitat for threatened fauna.	Pre-construction	Proponent

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
B9	Impacts to National Park estate	Wind farm corridor	An appropriate buffer will be maintained to National Park estate where practicable. Implementing vegetated buffers between the access tracks and wind turbine pads and the National Park estate is to be considered during detailed design. The selection of areas of buffer plantings and species to be planted will be carried out in consultation with the Area Manager, Barrington Tops National Parks and Wildlife Service. The Erosion and Sediment Control Plan will include specific actions to identify sensitive receptors associated with the National Park estate, including waterways and the adjacent Sphagnum Moss TEC The bushfire strategy developed for the development will include measures to minimise risk of bushfire to the Sphagnum Moss TEC and includes • Increase the accessibility of the ridgeline to fire fighters and improve strategic fire advantages that already exist. • Access to water will be maintained such that existing water resources will remain available at all times to support firefighting activities. • Extension of the strategic fire zone from NHPNR • Upgrades to the access road network to RFS fire trail standards • Increased water storage	Pre-construction	Proponent
B10	Edge effects and impacts to habitat viability	Entire development footprint	Restore and rehabilitate all areas within the temporary development footprint. Priority should be given to movement corridors for fauna, significant habitats and threatened ecological communities.	Post-construction	Contractor
B11	Disturbance from weeds, pests and pathogens	Entire development footprint	Management measures would be prepared and implemented to avoid and minimise the environmental risks associated with weeds, pests and pathogens. As a minimum, these would include: • Completion of a site weed assessment and development of a Weed Management Plan, as a sub-plan to the EMS. • Implementation of appropriate weed control and weed disposal in accordance with Biosecurity protocols.	Construction and operation	Contractor and Proponent

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
			• Any soil or other materials imported to the site for use in restoration or rehabilitation would be certified free from weeds and pathogens or obtained from sources that demonstrate best practice management to minimise weed and pathogen risks. • Appropriate disposal of any weed material. • Implementation of appropriate hygiene protocols where there are potential or known pathogen risks including procedures detailing the management of pathogens such as chytrid fungus. • Commitment to ongoing consultation and participation with NPWS and LLS on their annual vertebrate pest baiting programs including a financial contribution capped at $5k per annum to cover any additional costs of aerial baiting programs as a result of rotary aircraft (as opposed to fixed wing) being required to improve safe operating practice. • Encouraging landowners adjoining the BHGNR to coordinate baiting programs to improve the effectiveness of ground-based strategies.		
B12	Habitat disturbance from light	Entire development footprint	Proposal design and construction to minimise light impacts as much as possible through the use of sensor lighting and/ or directional lighting for more heavily utilised parts of the site.	Pre-construction and construction	Contractor/ Proponent
B13	Impacts of wind turbine strikes on protected animals	Wind farm corridor	Operational management measures specific to the wind turbines will be implemented. These are described in Section 8.9.1 of this BDAR. Bird and bat activity within the site is generally concentrated around areas of vegetation. A minimum safe distance of 30m will be maintained from the turbine blade tip to the adjacent tree canopy to minimise any risk of bird or bat strike.	Pre-construction, post-construction	Proponent
B14		Wind farm corridor	Prepare and implement, an operational Biodiversity Management Plan, as part of the project EMS, detailing ongoing measures for the protection and management of flora and fauna during the operational phase of the proposal. The plan is to identify at a minimum: • Target species, important habitats and ecological features to be monitored and managed within the site.	Post-construction	Proponent

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
			• Specific management measures to be implemented during operations including a proposed schedule for implementation, including carrying out revegetation works with native species within the development footprint, including up to 90% of the transmission line corridor, and up to 50% of the transport route upgrades. • Requirements for the monitoring of target species, important habitats and ecological features within the site and processes to be implemented to ensure an adaptive management approach. • Specific requirements for the monitoring and management of bird and bat mortality from blade strike including any considerations for the timing of species seasonal movements and/ or breeding periods. • Performance objectives and proposed contingency measures. • Roles, responsibilities and reporting requirements.		
B15		Wind farm	Prepare and implement a Bird and Bat Adaptive Management Plan (BBAMP), as a sub-plan to the EMS. The BBMP will include: • A description of measures to be implemented on the wind farm site for minimising bird and bat strike. • Suitable measures must be identified for the minimisation and management bird and bat strike risks during operation. • Trigger levels for further investigation and mitigation measures to be implemented. • An adaptive management plan to be implemented if the monitoring determines threatened or at risk species are subject to adverse impacts. • A detailed monitoring and reporting plan to assess the potential impacts and effectiveness of design and operational measures to mitigate bird and bat strike. For example, the plan may contain the following suggested structure: **1 Introduction** 1.1 Background 1.2 Statutory requirements of BBMP 1.3 BBMP Objectives	Pre-operation	Proponent

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
			1.4 Consultation 1.5 Site description **2 Baseline bird and bat information** 2.1 Bird survey methodology 2.2 Bat survey methodology 2.3 Results **3 Risk assessment** 3.1 Species and groups of concern 3.2 Risk assessment methodology 3.3 Risk assessment results 3.4 Conclusions of risk assessment **4 Operational phase surveys** 4.1 Monitoring 'at risk' groups 4.2 Bird utilisation surveys 4.3 Bat surveys 4.4 Carcass searches 4.4.1 Turbine selection 4.4.2 Search protocol 4.4.3 Scavenger rates and trials 4.4.4 Detectability (Observer) trials 4.4.5 Incidental carcass protocol 4.4.6 Analysis of results and mortality estimation 4.5 Personnel involved 4.6 Injured bird and bat protocol 4.7 Reporting and review **5 Mitigation measures to reduce risk** **6 Trigger – Action – Response Plan**		
B16	Impacts to water quality and hydrology and threatened species associated with waterbodies	Entire development footprint	The Biodiversity Management Plan will include measures for the management and monitoring of surface water quality and hydrology during construction, as applicable to the protection of biodiversity values. The plan would also address any requirements for the management of potential acid sulphate soils or contaminated lands	Construction and operation	Contractor/ Proponent

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
			during construction so as to minimise impacts to terrestrial and aquatic habitats. A Soil and Water Management Plan will be prepared, outlining measures for the management and monitoring of surface water quality and hydrology during construction. The plan would also address any requirements for the management of pollutants or contaminated lands during construction so as to minimise impacts to terrestrial and aquatic habitats. The plan would include the implementation of a construction surface water quality monitoring to minimise impacts to surface water quality. An Erosion and Sediment Control Plan will also be prepared, outlining measures for the prevention of erosion and sedimentation during construction. A targeted focus of this sub-plan will be to prevent indirect impacts to waterways potentially supporting Booroolong Frog surrounding the development footprint, waterways that traverse the National Park estate and the location of the Sphagnum Moss TEC in Ben Halls Gap Nature Reserve. The Soil and Water Management Plan will include procedures detailing the management of pathogens such as chytrid fungus.		
B17		Entire development footprint	Prepare and implement an Erosion and Sediment Control Plan, as a sub-plan within the EMS, outlining measures for the prevention of erosion and sedimentation during construction.		
B18	Impacts to aquatic habitats and fish passage	Access/ transport routes	Proposed waterway crossings associated with access / transport routes are to minimise impacts to aquatic habitat and address Fisheries requirements for maintaining fish passage.	Pre-construction and construction	Contractor/ Proponent
B19	Fauna injury / mortality	Entire development footprint	The Biodiversity Management Plan will include the following to minimise and manage any risk of fauna injury mortality during construction: • Strategies for fauna management during construction including any identification roles, responsibilities and contingency measures such as temporary stop works and engagement of fauna specialist.	Construction	Contractor

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
			• Requirements for temporary deterrent fencing, signage and/or requirements to modify driver behaviour and regular visual inspections to minimise the risk of fauna injury / mortality (particularly Koala and Spotted Tailed Quoll) due to vehicle strike or entrapment in deep excavations, with details to be developed during the preparation of the BMP. • Opportunity for egress to any species that may become trapped in any open excavation in the form of graded exits or tools to support climbing out. • Pre-clearing protocols, including pre-clearing inspections, establishment of exclusion zones and on-ground identification of specific habitat features to be retained and/ or relocated. - For example, occupation surveys for wombat burrows, application of exclusion measures / deterrents prior to vegetation clearing / earthworks, works undertaken in presence of spotter / catcher. • Protocols for fauna handling and management of adverse incidents. • Fauna monitoring and management protocol including identification and reporting of fauna mortalities to the relevant Biodiversity Conservation Division office.		
B20	Impacts to habitat connectivity	Entire development footprint	The following opportunities will be fully explored as a part of the detailed design: • Opportunities to further minimise the disturbance footprint and clearing within important movement corridors for fauna. • Opportunities for post-works restoration of habitat connectivity within important movement corridors for fauna. • Areas subject to temporary disturbance will be rehabilitated using a native species planting schedule as much as practical considering any operational and safety constraints. • The total area exposed and cleared at any one time will be minimised and planned to allow for fauna movement during construction and periods of temporary disturbance	Pre-construction	Proponent
B21	Impacts to habitat	Transmission line	The following measures will be implemented post-construction to	Post-construction	Proponent

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ID	Impact	Project component	Mitigation measures	Timing	Responsibility
	connectivity		minimise impacts to flora and fauna within the transmission line easement: • Promotion of the growth of vegetation under the transmission line to the maximum allowable height to maintain habitat connectivity for fauna. • Management of understorey vegetation in easements should be managed to maintain composition and quality and to prevent weed invasion. • Installation of glider poles for glider species in areas where the width of the transmission line easement exceeds minimum requirements for species movement. • Establishment of Biodiversity Stewardship sites on neighbouring properties.		
B22	Effectiveness of mitigation and management measures	Entire development footprint	Consistent with any specific requirements of the approved Biodiversity Management Plan (**B1**), a monitoring program would be implemented during construction to assess the effectiveness of mitigation and management measures implemented, to identify any unexpected impacts and appropriate contingency measures necessary for the protection of biodiversity. A register of inspections will be established.	Construction and post-construction	Contractor/ Proponent

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8.10 Adaptive management strategy

Construction and operational management plans will all contain an adaptive management component. Adaptive management strategies will be receptive to any new and relevant data that may arise through ongoing assessment and monitoring and is key to the successful implementation of crucial objectives yet also allow flexibility to changing dynamics and ongoing feedback and results. This includes measures to monitor predicted and uncertain impacts which will trigger adaptive management actions and allow for effective and quick responses.

An overall Environmental Management Strategy (EMS) would be developed with site specific sub management plans that will entail an adaptive management strategy component. Those sub management plans in relation to biodiversity include but are not limited to a Biodiversity Management Plan (BMP) and a Bird and Bat Adaptive Management Plan (BBAMP)

8.10.1 Biodiversity Management Plan (BMP)

A BMP would be implemented demonstrating adaptive management strategies to ensure key milestones are achieved including the following project commitments:

- Protecting vegetation and fauna habitat outside the approved disturbance areas and managing the remaining remnant vegetation and fauna habitat within or surrounding the development site toward a benchmark state, minimising indirect impacts, especially to Koala and Spotted-tailed Quoll.
- Fauna monitoring and management protocol including identification and reporting of fauna mortalities to the relevant Biodiversity Conservation Division office.
- Collection of detailed baseline weed data and ensuring no increase of key emerging weeds or invasive pests.
- Commit to ongoing consultation with NPWS on vertebrate pest control baiting programs, including but not limited to;
    - A financial contribution capped at $5k per annum to cover any additional costs of aerial baiting programs as a result of rotary aircraft (as opposed to fixed wing) being required to improve safe operating practice.
    - Encouraging landowners adjoining the Ben Halls Gap Nature Reserve to coordinate baiting programs to improve the effectiveness of ground-based strategies.
    - Engage with NPWS annually on their baiting programs and ensure coordination between NPWS and the Proponent.
- Mapping and identification of individual tree hollows and termite mounds and measures to minimise impacts to these features.
- Pre-clearing protocols, including pre-clearing inspections, establishment of exclusion zones and on-ground identification of specific habitat features to be retained and/ or relocated.
    - For example, occupation surveys for wombat burrows, application of exclusion measures / deterrents prior to vegetation clearing / earthworks, works undertaken in presence of spotter / catcher.
- Monitoring of soil and water controls to prevent indirect impacts associated with water pollution to all waterways potentially supporting populations of Booroolong Frog.
- Clear performance targets and monitoring criteria.

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- Corrective actions.
- Timing and responsibilities.

A recommended outline of the BMP is provided below with further details demonstrated within the mitigation measures listed in Table 82.

- Introduction
  - Background
  - Management scope and objectives
- Planning requirements
- Construction and operational activities
- Habitat management
  - Flora and fauna values
  - Soils
  - Weeds and pests (i.e. key emerging weeds and priority weeds)
  - Baseline data
- Environmental mitigation measure
- Site specifics
  - Inductions
  - Erosion /sediment control
  - Retained vegetation and rehabilitation works
- Adaptive management
  - Performance criteria, triggers, and responses
- Compliance management
- Review and Improvement

Additional mitigation measures for turbines proximal to microbat roosting/breeding habitat

- Disturbance to roosting microbats as a result of ground vibration during breeding season (November to February) or winter torpor season (May to September) will be avoided and minimised as far as practicable.
  - As part of baseline monitoring undertaken for the development of the BBAMP and BMP, and prior to any construction requiring earthworks, monitoring will be undertaken of geological features considered to potentially provide microbat roosting habitat at 'fly-out' times to determine if/where further mitigation may be warranted.
  - If construction works likely to result in ground vibration cannot practicably be avoided during the above listed higher risk periods, then monitoring of the presence of microbats within the habitat feature(s) (e.g. near WP50, refer Figure 15) will be undertaken prior to any vibration-causing construction activities where required works coincide with breeding/torpor periods. If microbats are confirmed present prior to construction works commencing (during these

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periods), monitoring will continue during and post-construction, and suitable impact mitigation measures will be investigated such as:

- Investigation into a suitable maximum vibration level to prevent disturbance to roosting microbats
- Assessment of what activities or plant may cause this maximum vibration level to be triggered; and
- At what distance (setbacks) unacceptable levels of vibration may be experience at the habitat location.

Further details will be developed in the preparation of the BMP.

Additional commitments regarding the determination of threatened owl breeding habitat

- The presence of breeding habitat for threatened owl species (as relevant to the project, see Section 5.2) will be confirmed during the preparation of the BMP and BBAMP via implementing the following:
  - Mapping of tree hollows suitable to support breeding habitat for the target owl species (as described in the TBDC) within 100 m of the development footprint.
  - Supplementary targeted surveys for breeding owls, in accordance with relevant guidelines, to reach the 90% probability requirement outlined in the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities Working Draft November 2004 (DEC 2004) to confirm species presence.
  - Development of an unexpected finds procedure that triggers additional species specific offsets if owl breeding habitat is confirmed, and impacted by the project.

8.10.2 Bird and Bat Adaptive Management Plan (BBAMP)

Framework and objectives

The overall objectives of the BBAMP are to provide an effective monitoring program and strategy to manage and mitigate operational issues relating to bird and bat impacts for the wind farm, to monitor and assess for impacts considered uncertain at the time of approval, and prescribe additional compensatory measures for residual prescribed impacts, if required. Additionally, the framework aims to provide certainty to the consent authority and stakeholders prior to approval that measures for minimising biodiversity impacts during operation have been clearly defined that address potential prescribed impacts that cannot be quantified prior to approval.

Guided by the collision risk assessment and turbine risk assessment, and importantly, additional baseline data to be collected from within the subject land, a detailed BBAMP would be developed prior to operation of the wind farm, in conjunction with relevant stakeholders, to confirm adaptive management measures around the potential for collision mortality, barrier effects and behavioural displacement of resident, nomadic and migratory bird and bat species.

A detailed BBAMP will be developed in consultation with DPIE and BCS prior to commissioning of any turbines, however a framework of the key elements of the BBAMP is provided below, with some known specifics detailed within the mitigation measures listed in Section 8.9.

Baseline information

The BBAMP would include baseline data on threatened bird and bat species as well as any non-threatened species considered at moderate or greater risk of collision impacts ('at-risk' species) from the development.

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One of the key objectives for the collection of detailed baseline data is to gather adequate replicable information on the existing bird and bat species abundance and activity (site utilisation) prior to commencement of operation of the wind farm. This would include the setup of impact zones and control zones that would be monitored pre commissioning of turbines, during construction and during operation for an agreed period of time. The data collected would be utilised to detect changes in the species use of the site (including changes in activity patterns such as avoidance) post-commissioning and during operation of the wind farm, and allow for stringent mitigation measures to be implemented as, and when, they are required.

Investigations of the site utilisation patterns of bird and bat species at the Hills of Gold Wind Farm have been established as a Before-After-Control-Impact (BACI) assessment design. It is important that bird and bat surveys continue once the wind farm becomes operational and that the survey methods used prior to construction are replicated such that results from before and after operation are appropriately comparable. Ideally, baseline data would cover at least four peak seasons (2x spring and 2x summer/autumn) and one off-peak season (winter) within a 24 month period and prior to turbine commissioning. Currently, bird utilisation data has been collected over 3 seasons, across a 7 month period from 2019 to 2020, with bat activity data collected over a four month period during later summer and into autumn in 2020, as part of the development of this BDAR. Wherever possible, and appropriate, this data would be used as part of the baseline data to be collected for development of the BBAMP.

The final locations of all bird utilisation survey points are yet to be determined, but will include a minimum of 7 impact survey points representative and randomised across all associated turbine risks, with a minimum of 3 points associated with moderate risk turbines and the turbine cluster adjacent to Ben Halls Gap National Park (10 in total), with a further 2 control sites located between 500 to 1500m (with at least one potentially within the National Park) from the development (and operational) footprint. Options to include control sites within Ben Halls Gap Nature Reserve and/or locally established Biodiversity Stewardship Sites will be investigated during development of the BBAMP.

Bat utilisation surveys will include a minimum of 10 ultrasonic detectors, replicating existing survey locations in the northern, central and western zones of the development corridor, installed over 4 consecutive nights. Additionally, a further 2 control sites located between 500 to 1500m from the development (and operational) footprint would be installed. Detectors would be set up at varying heights, including at canopy and within Rotor Swept Area (RSA).

Following the completion of baseline data collection surveys, adaptive management triggers will be finalised for the initial implementation phase of the operational BBAMP. As part of the adaptive management strategy, a mechanism for review of trigger levels will be included that will allow for consideration of ongoing data collected at the site.

Following the collection of baseline data and following commissioning of all turbines, ongoing monitoring would mirror the baseline surveys, within spring and summer/autumn, when activity of both birds and bats are likely to be at their highest, for three years following commissioning of the wind farm.

Trigger-level and unacceptable impacts for further investigation and adaptive management

Guiding principles for the wind farm in relation to the BBAMP is to operate without any significant impact on the viability of the local and/or overall population of any species of birds or bats. In order to effectively measure impacts to any at-risk populations or species during the operation phase of the development, the development of alerts, trigger levels and adaptive mitigation response to a potential event is required.

Triggers for responsive management actions will apply where the number of collisions per annum represents a low, but uncertain potential to result in a negative effect on the local population of a species. This is a precautionary objective, as it will be implemented at levels substantially below numbers of collision mortality

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events that are considered likely to represent a significant impact on the viability of the overall population of any species.

At a minimum, and pending results of detailed baseline data, the following definitions (Table 83) are considered a trigger-level alert and if realised would warrant an increased focus on areas of concern if they were to occur.

Table 83 General investigation and monitoring triggers for Bird and Bat strike

Tier	Type	Trigger	Mitigation
Tier 1 alert	Threatened species	• Where any carcass; feather spot; or injured individual (likely caused as a result of turbine collision) is found under or close to (<120m from) a wind turbine or turbine cluster (adjacent to Ben Halls Gap National Park) during any single mortality search or incidentally by wind farm personnel.	Tier 1 mitigation instigated
	Non threatened 'at-risk' species	• Where more than two carcasses; feather spots; or injured individuals (likely caused as a result of turbine collision) of a single species are found under or close to (<120m from) a wind turbine or turbine cluster (adjacent to Ben Halls Gap National Park) during any single mortality search or incidentally by wind farm personnel.	
	Low risk species	• Where more than two carcasses; feather spots; or injured individuals (likely caused as a result of turbine collision) of a single species are found under or close to (<120m from) a wind turbine during any single mortality search or incidentally by wind farm personnel.	

Pending results of detailed baseline data, the following definitions (Table 84) are considered an unacceptable impact and require detailed investigation and stringent temporary or permanent mitigation should they occur, pending results of the investigation;

Table 84 General investigation and monitoring triggers for bird and bat strike

Tier	Type	Trigger	Mitigation
Tier 2 impact	Non threatened 'at-risk' species	• Where population* numbers are known; – Any impact that is likely to reduce the total species' population by more than 1% over a two year period; or • Where population numbers are not known; – More than four carcasses of one non-threatened at risk species (moderate or greater) identified in the tables in BDAR Sections 8.3.1 and 8.3.2 are found under or close to (<120m from) a wind	Tier 2 and 3 mitigation instigated

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Tier	Type	Trigger	Mitigation
		turbine within a two month cycle** or during incidental searches.	
Tier 3 impact	Threatened species	• Where population* numbers are known; – Any impact that is likely to reduce the total species' population by more than 1% over a five year period; or • Where population numbers are not known; – Any impact where more than three carcasses, feather spots; or injured individuals (likely caused as a result of turbine collision) of a single species are found under or close to (<120m from) a wind turbine within a two month cycle** or during incidental searches.	

*'Population' relevant to the operation of the wind farm will be determined (where possible) in consultation with BCS via a detailed monitoring plan, and based on baseline and ongoing utilisation survey data and dependent on species by species basis.

**A two month cycle is the search of all turbines split across a two month period i.e. 35 turbines in one month, the remaining 30 the following month.

A detailed decision framework will be included for triggers and mitigation (in conjunction with the below mitigation framework) associated with both the threatened and non-threatened at-risk species during the development of the BBAMP, finalised prior to commissioning of turbines.

Monitor and report on the effectiveness of impacts and trigger levels

Purpose-trained dogs have been shown to be highly efficient at detecting carcasses (Mathews *et al.* 2013) and have been used for this purpose at a number of wind farms in in Australia. Using purpose-trained dogs obviates the need for formal transects to be established in the search zones as dogs use scent to detect carcasses and are permitted to roam to do so. Every dog will be fitted with a GPS tracking device while undertaking searches. GPS tracks will be downloaded and maintained for future reference and used for analyses of search effort and coverage. GIS maps showing routes taken by dogs will be made available to DPIE on request. The use of trained dogs is the preferred method for searches and will be used, provided appropriately trained dogs and handlers are available. Dog handler(s) must have demonstrated capacity to identify bird and bat species of NSW.

However, if the use of dogs is not practicable or are unavailable for the Hills of Gold Wind Farm site the alternative is to engage suitably trained ecologists or environmental officers. Observers will search by walking transects through the search zones, generally a 120 metre radius, and a repeated 60 metre pulse search. Searches will be undertaken by persons with demonstrated capacity to identify bird and bat species of NSW and relevant to the subject land. Transects will be spaced 6 metres apart, or as near to 6 metres as is practical, and observers will thus search the ground for 3 metres either side of each transect. Each observer will carry a hand-held GPS unit and record transects they walk. GPS tracks will be downloaded and maintained for future reference and used for analyses of search effort and coverage. GIS maps showing transects walked will be made available to DPIE on request.

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It is proposed carcass searches be undertaken in accordance to the schedule in Table 85, pending adaptive management, triggers and introduction or amendments to mitigation measures.

Table 85 Monitoring requirements for carcass searches

Turbines	Monitoring schedule
All	• Monthly for the first six months following commissioning of turbines, however must include the first spring/summer season following commissioning of turbines, and therefore may be extended in duration, including follow up pulse searches*.
Low risk	• Over a two month cycle**, from six months to three years following commissioning of relevant turbines, monthly searches in a randomised order including: – 120m search area around relevant turbines, with a follow up 60m pulse search from October to March (6 in total). – 120m search area around relevant turbines, with no pulse searches required from April to September (6 in total). • From three years following commissioning of relevant turbines, sampling frequency thereafter will be informed by a series of scavenger surveys and adaptive management.
Moderate and High risk	• Over a two month cycle**, from six months to five years following commissioning of relevant turbines, monthly searches in a randomised order including: – 120m search area around relevant turbines, with 60m pulse searches throughout. • From five years following commissioning of relevant turbines, sampling frequency thereafter will be informed by a series of scavenger surveys and adaptive management.

*A 'pulse search' is a secondary search undertaken from three to seven days following the primary search to detect additional mortality of bats and birds.

**A two month cycle is the search of all turbines split across a two month period i.e. 35 turbines in one month, the remaining 30 the following month.

It is likely (but uncertain at present) that carcasses of bats and small birds will be scavenged quickly within the subject land. Carcass persistence trials will be undertaken during the course of the operational monitoring, and prior to its commencement, particularly to inform analyses required to extrapolate from numbers of carcasses detected to estimate total number of collisions. In order for the search regime to accommodate the likelihood of rapid scavenging, a relatively short period between initial searches is important. Trials to determine persistence time of carcasses are required to derive correction factors necessary to estimate total fatalities from the results of the carcass searches. Two persistence trials will be undertaken in each year of the monitoring regime (minimum of three years), one in each of spring and summer/autumn.

Further details on carcass searches/monitoring, persistence trials, incidental finds and data analysis will be included in the detailed BBAMP.

Operational mitigation measures.

It is not feasible to foresee what potential factors might lead to an unexpectedly high level of collisions by any species, and therefore appropriate mitigation measures can be prepared only if a cause, or causes, of ecologically significant impacts on the relevant species is known. Additionally, flexibility in mitigation shall be

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designed to encourage innovative and new technologies be implemented over the operational life of the wind farm where appropriate.

If a cause is not readily apparent, then investigation of the reason(s) for the impact must be undertaken prior to proposal of a mitigation strategy. Advice from DPIE will be sought with regard to design and implementation of any such investigations and of an ultimate mitigation strategy, if required. DPIE will be notified within two working days of determination by Engie or the contracted qualified ecologist that a trigger level or unacceptable impact for any species of concern is detected.

The BBAMP will detail considerations of mitigation measures to reduce the number of tier 1, tier 2 and tier 3 impacts. Broadly, these will include general mitigation measures and specific trigger related mitigation, including but not limited to, those demonstrated in Table 86 below.

Table 86 Consideration of likely required mitigation measures

Type	Mitigation considerations and response
General	• Ongoing reassessment of species risk levels and thus relevant trigger-levels. • Review of the monitoring program every two years. • Incorporate any operation mitigation measures developed during the preparation of the BMP relating to monitoring of relevant geological features at 'fly-out' times to determine if/where further mitigation may be warranted. • Encourage habitat use offsite through establishment of BSAs and associated habitat restoration in the area proximal (>200m) to the wind farm and likely to be utilised by the local population of birds and bats. • Minimising availability of raptor perches on infrastructure within close proximity to turbines and overhead powerlines. • Prompt animal carcass removal within the 200m of a turbine (within 24 hrs of discovery) to minimise raptor scavenging opportunities and reviewed annually. • Participation on local (site based) and co-ordinated (LLS and NPWS) feral animal control programs, i.e. rabbits, wild dogs and foxes, and in line with carcass removal protocols. • Investigation of potential deterrents or evolving technologies, such as: – Avoiding or limiting the use of artificial lighting (synchronising flashing red light if required) on turbines and other infrastructure within close proximity to turbines. – Consider novel deterrent techniques related to blade visibility. – Ultrasonic technologies. – Consideration of radar (or optical sensor) or live camera technologies for automatic, reactive and temporary curtailment of turbines for moderate risk turbines, turbine cluster (WP 28-43) or as required (Tier 1 and Tier 2 alerts) adjacent to Ben Halls Gap Nature Reserve. – Use of 'acoustic lighthouse' to deter avian activity by broadcasting, for example, audible frequencies of 4 – 6 kHz in front of turbine towers to encourage avoidance behaviour (as detailed in Boycott et al 2021).

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Type	Mitigation considerations and response
	• Annual reporting to include triggers relating to the re-assessment of the mitigation strategy to be implemented over the following year of operation where tier 1 and/or tier 2 and 3 triggers have occurred. – Additional triggers will be developed that consider the actual/extrapolated impacts to bird and bat species calculated across the preceding year, and include associated mitigation measures and potential additional offsets for the following year of operation.
Tier 1 Alert mitigation and response	Initiate rapid assessment framework for tier 1 alerts within the BBAMP to identify the most effective mitigation measures to be implemented, including but not limited to: • Increased monitoring of a relevant turbine(s) for a seven day period following a tier 1 alert to determine a one off event, or a potential ongoing event. • Use of 'acoustic lighthouse' to deter avian activity by broadcasting, for example, audible frequencies of 4 – 6 kHz in front of turbine towers to encourage avoidance behaviour. • Consideration of mobile radar installation for a minimum 7 day period for automatic, reactive and temporary curtailment of turbines relating to a tier 1 alert for medium to large threatened and non-threatened at risk bird species. • In the case of at risk species or threatened species nesting within 200m of a turbine, the nesting event will be allowed to occur, with increased monitoring, potential for temporary curtailment in line with tier 2 and tier 3 recommendations until removal of the nest following the breeding event can be undertaken. Any mitigation is to be consistent with project approval conditions.
Tier 2 and 3 mitigation and response	Initiate rapid assessment framework for tier 2 and tier 3 triggers within the BBAMP to identify the most effective mitigation measures to be implemented. • Cease operation temporarily of a turbine(s) relevant to a trigger event during the rapid investigation. • Increased daily carcass searches for 14 days following discovery of a tier 2 or tier 3 trigger, to be undertaken within the subsequent four weeks of the trigger event by suitable trained ecologist, environmental advisor and/or detector dog services. Pending an investigation into tier 2 and tier 3 impacts being detected, the following may be required in consultation with the Proponent, suitably qualified ecologists, wind farm subject matter experts and DPIE; • Temporary turbine shut down during periods of low visibility. • Low wind speed turbine curtailment, that being blades remain feathered and do not rotate during periods of the day and/or night when wind speeds are below either those at which turbines generate electricity, or can be shown to be conducive to higher levels of microbat activity, likely to be 0 to 4 meters per second, on a temporary or permanent basis. • Seasonal curtailment of individual turbines, for example at night during microbat breeding season i.e. between November and March.

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Mitigation measures such as low speed curtailment or seasonal curtailment may be implemented on a temporary basis for an agreed period pending results of investigation and consultation, however may become a permanent measure should multiple unacceptable impacts occur in relation to a turbine. There is potential for deterrent techniques to be used in place of having to shut down or curtail turbines, if such technologies are found to be effective.

Residual prescribed impacts and compensatory measures

Following implementation of required mitigation, additional offset requirements for prescribed impacts may be required to offset residual impacts in accordance with the BAM. This may be achieved via the retiring of credits or payment to the BCT. The amount of credits required to be offset would be calculated by the number of actual and modelled impacts, accounting for scavenger impacts, to individual species in a given year, multiplied by the biodiversity risk weighting (BRW) for the relevant species. This method is commensurate with the Equation 3 (Section 10.1.3) of the BAM for calculating species credit requirements for flora species assessed by a count of the number of individuals, which is aligned with the calculation of offsets required for impacts to individual bird and bat strikes. This method also captures the relevance of a current threatened listing for a species, and is in accordance with the expectations of BAM implementation for prescribed impacts (Section 8.6 of the BAM).

Where an unacceptable impact to a non-threatened 'at risk' species be encountered or estimated, following mitigation, then a like for like risk weighting may be applied from a similar threatened species i.e. – Wedge-tailed Eagle to Little Eagle, following consultation with BCS. Any credit generation required to offset residual prescribed impacts would be calculated during the annual reporting, which will also demonstrate that credits required for the preceding 12 months have been retired under the BOS.

Compliance management and summary

Table 87 demonstrates the key objectives and criteria for effective management of the Bird and Bat operational risks at the Hills of Gold Wind Farm, and will be the crucial in the detailed development of the BBAMP.

Table 87 Overview of commitments in relation to operational prescribed impact on Bird and Bats

Task	When	Responsibility	Criteria and commitment
Baseline surveys	Prior to turbine commissioning	Proponent Ecology contractor	At a minimum 2 spring surveys, 2 summer/autumn survey and 1 winter survey within a 24 month period prior to turbine commissioning for birds and bats.
Operational surveys	Minimum of 3 years post commissioning of all turbines	Proponent Ecology contractor	At a minimum, undertaken in spring and summer/autumn when activity of both birds and bats are likely to be at their highest.
Triggers	Operational phase, as required	Proponent Ecology contractor	Investigation and review of alerts, triggers and unacceptable impacts. Instigate appropriate mitigation measures in consultation with subject matter experts

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Task	When	Responsibility	Criteria and commitment
			and DPIE as a result of tier 2 or tier 3 impacts.
Scavenger searches	Minimum of 3 years post commissioning of all turbine	Proponent Ecology contractor	Three persistence trials undertaken in spring and summer autumn (6 in total).
Prescribed impact mitigation	Operational phase, as required	Proponent	Adaptive mitigation for tier 1 alerts. Adaptive mitigation for tier 2 and 3 triggers. Turbine curtailment or shutdown procedure based on tier 2 and 3 triggers.
Offsetting – Prescribed Impacts	Operational phase, as required	Proponent	Following appropriate mitigation, offset residual prescribed impacts. Report and retire credits annually if required.
Reporting	Operational phase, annually	Proponent	All monitoring data will be shared with DPIE, EES and DAWE annually and made publicly available on the project's website. Annual reports to identify if any triggers for action have been met. Reports will also incorporate monitoring results and establish if any adaptive actions should be made for management in the following year/s.

DPIE, EES and DAWE will be promptly notified following determination by the Proponent or the contracted qualified ecologist that an unacceptable trigger level for any species of concern is detected. All monitoring data will be shared with DPIE and EES annually.

Monitoring and adaptive management triggers for barrier effect impacts

Whilst the focus of the above section is on mitigation of the impacts associated with collision risk, it is acknowledged that there remains some potential for impacts associated with barrier effects for threatened and/or at-risk species. Following completion of baseline monitoring, and during operational monitoring, if there is a noted discernible statistical reduction or anomaly in abundance of an at-risk or threatened species, additional investigations into possible causes would occur. If it is determined that the operational wind farm was a key factor, additional assessments against key relevant Test of Significance criteria or Significant Impact Criteria would be used to quantify or measure the level of impact. If these assessments determined that an event resulting from barrier effects warranted additional mitigation, compensatory measures or species specific offsetting, these would be employed. This detail and decision framework will be provided within the BBAMP.

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9 Impact summary and biodiversity credit report

For residual impacts that cannot be avoided or fully mitigated, offsets will be required by the BOS to ensure no net loss to biodiversity. In accordance with Section 6.3 of the BC Act, the following values are subject to assessment and offset under the BOS:

- Impacts of the clearing of native vegetation and the loss of habitat.
- Impacts that are prescribed by the regulations.

A summary of relevant impacts associated with the proposal which trigger an offsets requirement is presented in Table 88.

Table 88 Summary of proposal impacts subject to assessment and offset under the BOS

Relevant matter	Details	Direct impacts (area/ count)
Native vegetation communities and ecosystem credit species habitats.	Direct loss of native vegetation communities associated with site clearing	132.43 ha
Threatened ecological communities	Direct loss of Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	23.36 ha
	Direct loss of White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	6.07 ha
Habitat for threatened fauna species – species credit species	Large-eared Pied Bat*	19.68 ha foraging habitat
	Eastern Cave Bat*	19.68 ha foraging habitat
	Southern Myotis	3.97 ha
	Eastern Pygmy-possum	18.14 ha
	Koala	36.44 ha
	Squirrel Glider	16.06 ha
	Booroolong Frog	0.64 ha
	Border Thick-tailed Gecko	0.17 ha
	Powerful Owl	1.99 ha
	Sooty Owl	1.99 ha
	Barking Owl	1.99 ha
	Masked Owl	0.99 ha
Habitat for threatened fauna species – ecosystem credit species	State and Commonwealth listed threatened fauna species known or predicted to occur	132.43 ha

* Dual credit species

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The BAM Calculator offset credit summary reports are included in Appendix G and summarised below in Table 89.

These offset credits have been calculated using the amended design footprint developed following the original BDAR. The assessment presented in this updated BDAR is appropriately conservative and precautionary and is based on worst-case footprint that will be refined and reduced during future detailed design phases. The calculation of credits has also assumed benchmark vegetation integrity scores when the required number of field-verified BAM plots were not achieved. This method, while being highly conservative, has likely over-estimated several of the credit calculations which are influenced by vegetation integrity score data.

During the detailed design phase of the Project, further refinements to the development footprint will be undertaken that will determine the Project's final impacts. Once the development footprint has been finalised, the BAM-Calculator will be updated at assess this final impact footprint, as well as to include any additional BAM plots collected to more accurately determine the range of vegetation integrity scores within the subject land, and the Project's offset liability will be re-calculated. Undertaking this final update and re-assessing the Project's offset liability will ensure there is a strong incentive for continued impact avoidance and minimisation post project approval.

A Biodiversity Offset Strategy has been prepared and includes commencement of investigations on a number of properties adjacent to the project area where Biodiversity Stewardship Sites can be established. These properties are on similar elevated ridgelines, with similar PCTs and fauna habitats, also being subject to historical impacts associated with farming. More information is provided in Section 9.1 below.

Table 89 Biodiversity offsets required to address residual impacts

Relevant matter	Associated TEC	IBRA Region/Sub region	Direct impacts (ha)	Credits required
Ecosystem credits				
PCT 433: White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	Nandewar-Peel	0.02	2
PCT 486 - River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range	-	Nandewar-Peel	1.53	57
		NSW NC-Tomalla	0.59	22
PCT 490- Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion	-	Nandewar-Peel	1.84	68
PCT 492: Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	Nandewar-Peel	4.09	207
		NSW NC-Tomalla	0.53	18

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Relevant matter	Associated TEC	IBRA Region/Sub region	Direct impacts (ha)	Credits required
Belt South Bioregion				
PCT 507: Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion	-	NSW NC-Tomalla	0.09	3
PCT 526 - Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion	-	NET- Walcha	1.12	49
PCT 540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	-	Nandewar-Peel	19.6	688
	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	NET- Walcha	1.41	56
	-	NSW NC-Tomalla	19.6	652
PCT 541 - Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	-	Nandewar-Peel	7.7	247
		NSW NC-Tomalla	3.7	122
PCT 586 - Snow Grass - Swamp Foxtail tussock grassland sedgeland of cold air drainage valleys of the New England Tableland Bioregion	-	NET- Walcha	2.56	53
PCT 599 - Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion	White Box Yellow Box Blakely's Red Gum Woodland and derived native grassland	Nandewar-Peel	1.43	89
PCT 931 - Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion	-	NET- Walcha	2.72	66
		NSW NC-Tomalla	0.47	11
PCT 934 - Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New	-	NET- Walcha	19.33	300
		NSW NC-Tomalla	3.64	155

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Relevant matter	Associated TEC	IBRA Region/Sub region	Direct impacts (ha)	Credits required
England Tableland Bioregion				
PCT 954 - Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion	-	NSW NC-Tomalla	1.23	54
PCT 1194 - Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	NET- Walcha	18.2	479
	-	NSW NC-Tomalla	21.3	554
PCT 1604 - Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	-	Sydney - Hunter	0.02	1
PCT 1691 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	-	Sydney - Hunter	0.04	2
Total				**3,955**
Species credits				
Large-eared Pied Bat	-	Nandewar-Peel NET- Walcha	19.68	625
Eastern Cave Bat	-	Nandewar-Peel NET- Walcha	19.68	625
Southern Myotis	-	NET- Walcha NSW NC-Tomalla	3.97	89
Koala	-	Nandewar-Peel NET- Walcha NSW NC-Tomalla	36.44	1225
Eastern Pygmy-possum	-	Nandewar-Peel NET- Walcha	18.14	655

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Relevant matter	Associated TEC	IBRA Region/Sub region	Direct impacts (ha)	Credits required
		NSW NC-Tomalla		
Squirrel Glider	-	Nandewar-Peel NET- Walcha NSW NC-Tomalla	16.06	544
Booroolong Frog	-	Nandewar-Peel	0.64	33
Border Thick-tailed Gecko	-	Nandewar-Peel	0.17	8
Powerful Owl	-	NSW NC-Tomalla	1.99	77
Sooty Owl	-	NSW NC-Tomalla	1.99	114
Barking Owl	-	NSW NC-Tomalla	1.99	77
Masked Owl	-	NSW NC-Tomalla	0.99	39
Total				**4111**

BAM-C notes

- BAM-C was originally established under a single case in the Nandewar IBRA Bioregion and Peel IBRA subregion. This has subsequently been split into three cases, one for each IBRA bioregion / sub-region combination.
- A Separate BOAMs parents case (00031734) had to be opened for the NSW North Coast / Tomalla and New England Tablelands / Walcha Plateau BAM-C assessments, as the original parent case (00020779) would not allow the entry of PCTs from out of the IBRA sub-region specifically PCT 492 in NSW North Coast / Tomalla and PCT 526 in New England Tablelands / Walcha Plateau.
- Relevant Mitchell (NSW) Landscapes were entered for each BAM-C case.
- Percentage native vegetation within the assessment area has not been split by IBRA, and has been entered as 51% for all cases.
- PCT 1194 and PCT 540 Mountain Gum Ribbon Gum TEC vegetation zone area are larger in BAM-C submitted with the Amended BDAR as the entire 'patch' area was entered where that patch was contiguous with the NSW New England Tablelands IBRA bioregion. As the BAM-C cases are now split by IBRA, the entries are split by the IBRA region line, and entered into the BAM-C as such. However the BDAR still assess the TEC as previous (i.e. based on the contiguous patches).

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- Where a candidate threatened species habitat polygon did not occur within an IBRA region/sub-region, that species was maintained as a Candidate in each BAM-C but noted as 'No (Surveyed)' in the Habitat Survey tab (Tab 6).
- BAM plot data was entered consistently across the three BAM-C cases. BAM pots entered were not split based on where each plot was collected on-ground. For example if a vegetation zone occurred across two IBRA regions/sub-regions, and three plots were collected in Peel and two collected in Tomalla, all five plots were entered into each BAM-C case.
    - This method is considered to most accurately represent the condition of the vegetation within the development footprint.
- Where benchmark data was used to substitute plots, the benchmark data was correct for each IBRA region.
    - One exception to this was PCT 490 Low, where no benchmarks exist for Nandewar, and benchmarks for the Brigalow Belt South were used.

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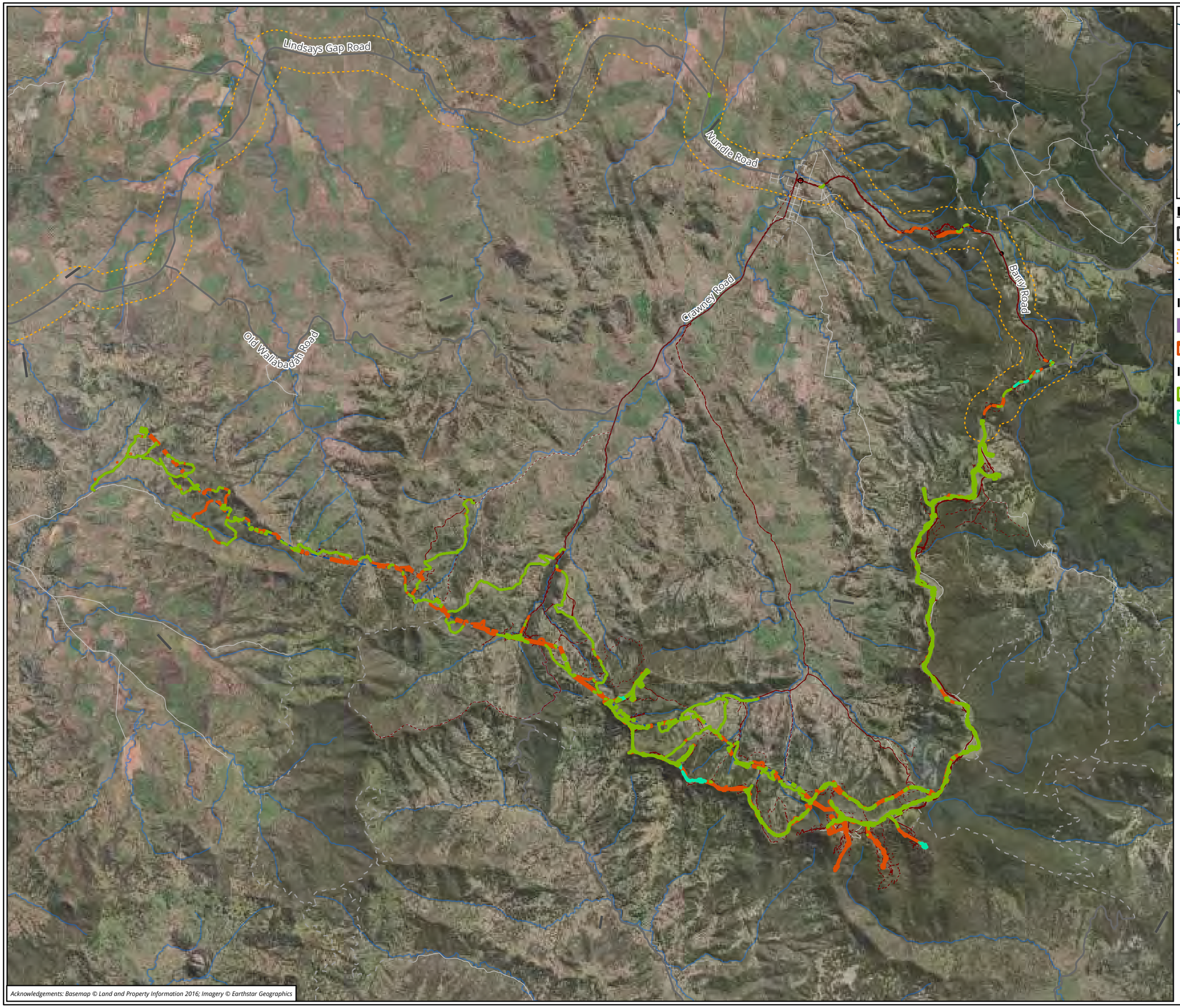

Legend

- Infrastructure footprint
- Transport haul routes
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation
- PCT 1194 DNG - VI score <15

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 1

0 1,000 2,000 3,000 4,000

Meters

Scale: 1:100,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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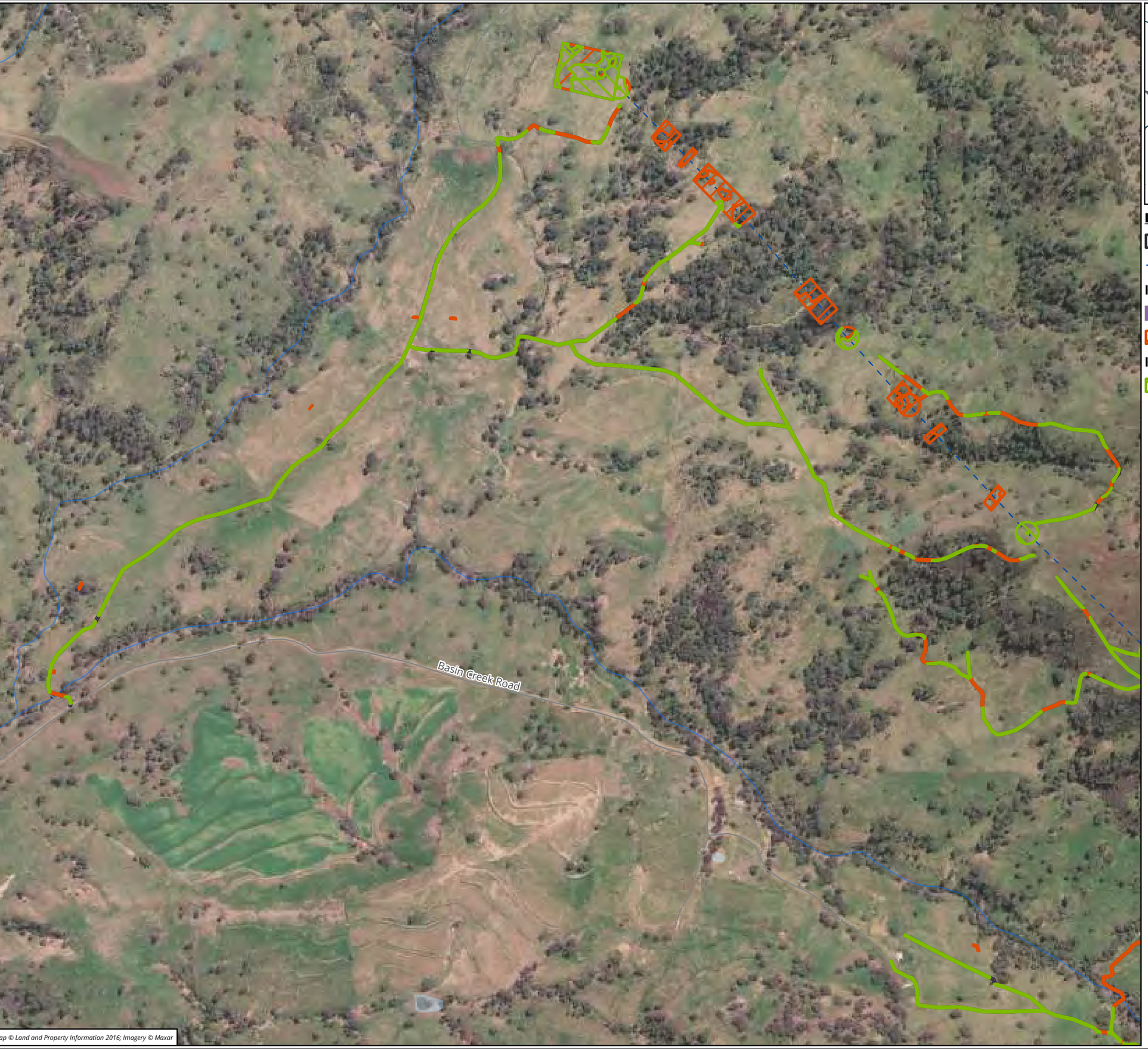

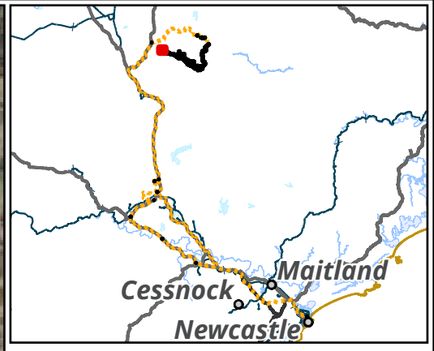

Legend

- Infrastructure footprint
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 2

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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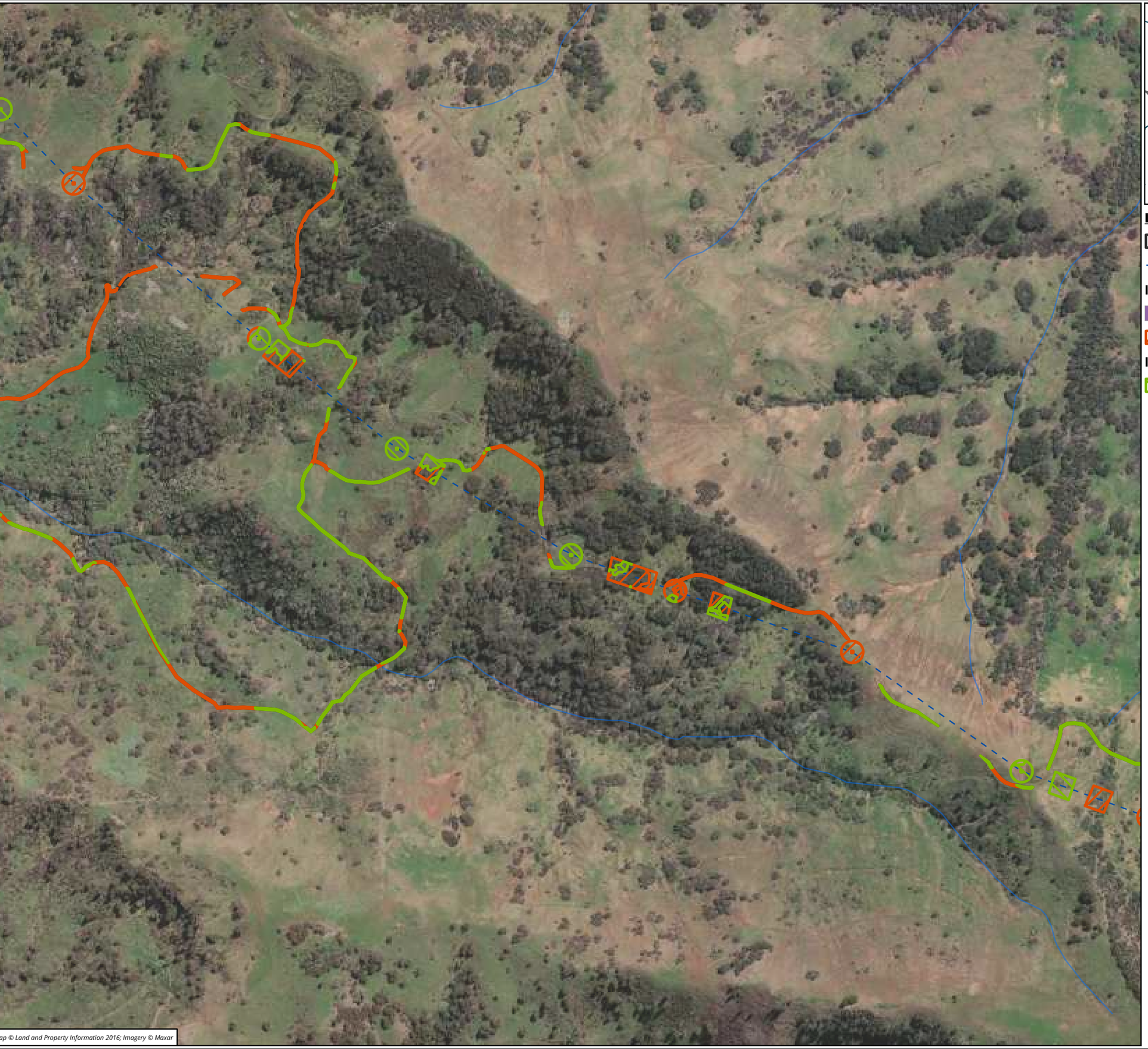
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Legend

- Infrastructure footprint
- Transmission line
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 4

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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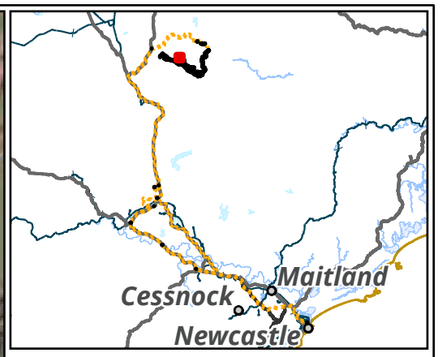

Legend

Infrastructure footprint

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 5

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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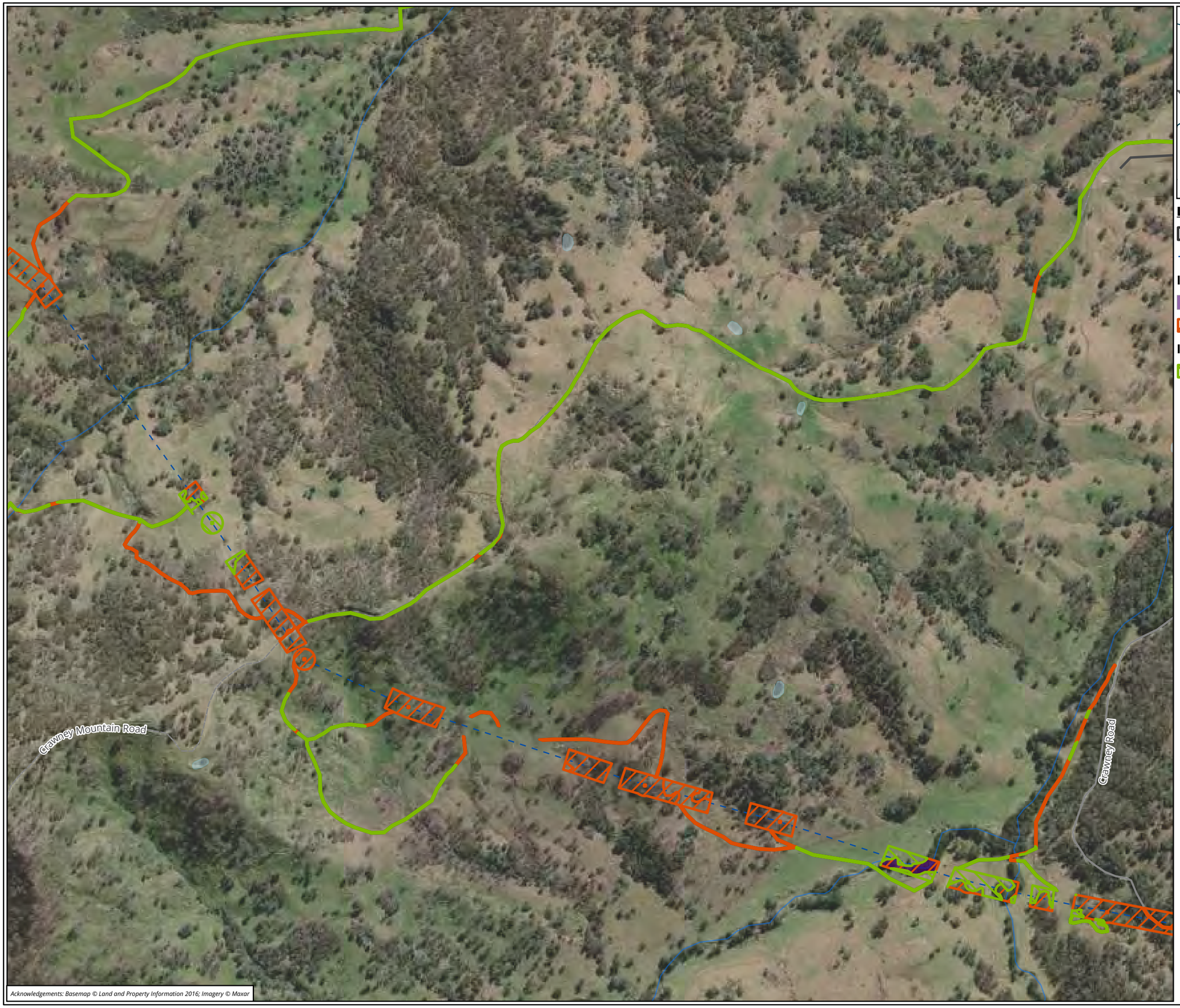

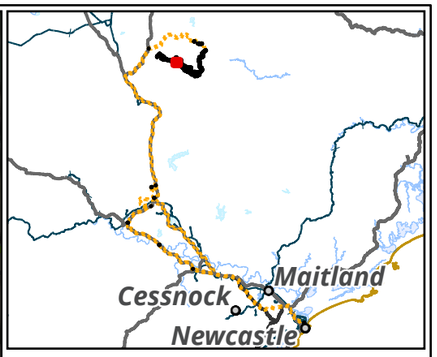

Legend

- Infrastructure footprint
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 6

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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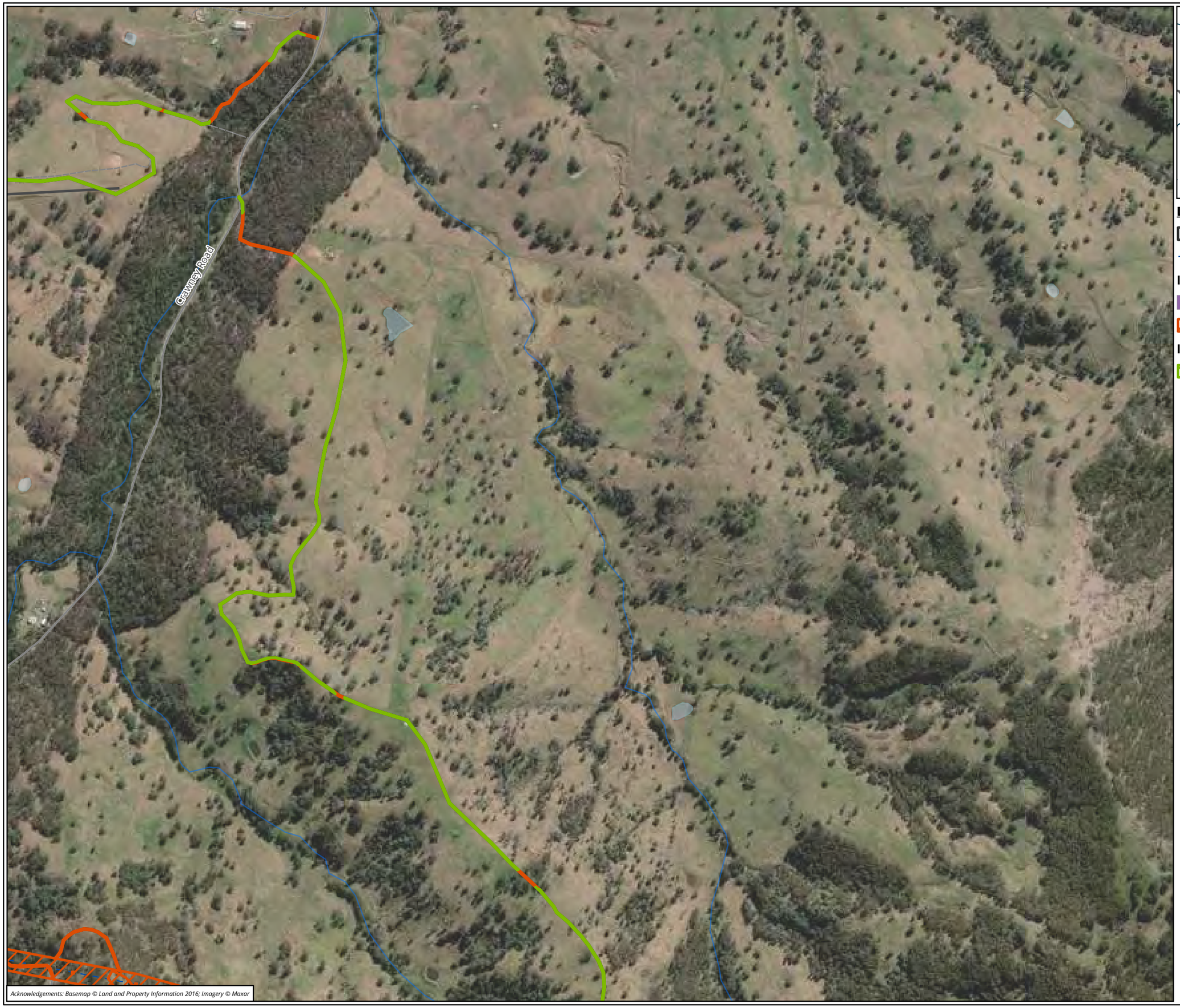

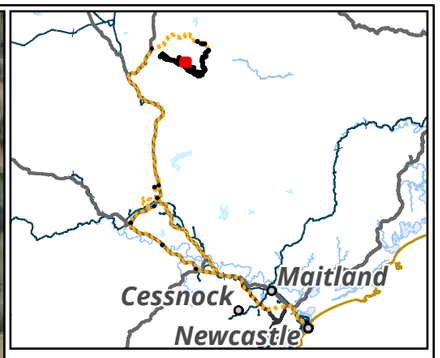

Legend

- Infrastructure footprint
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 7

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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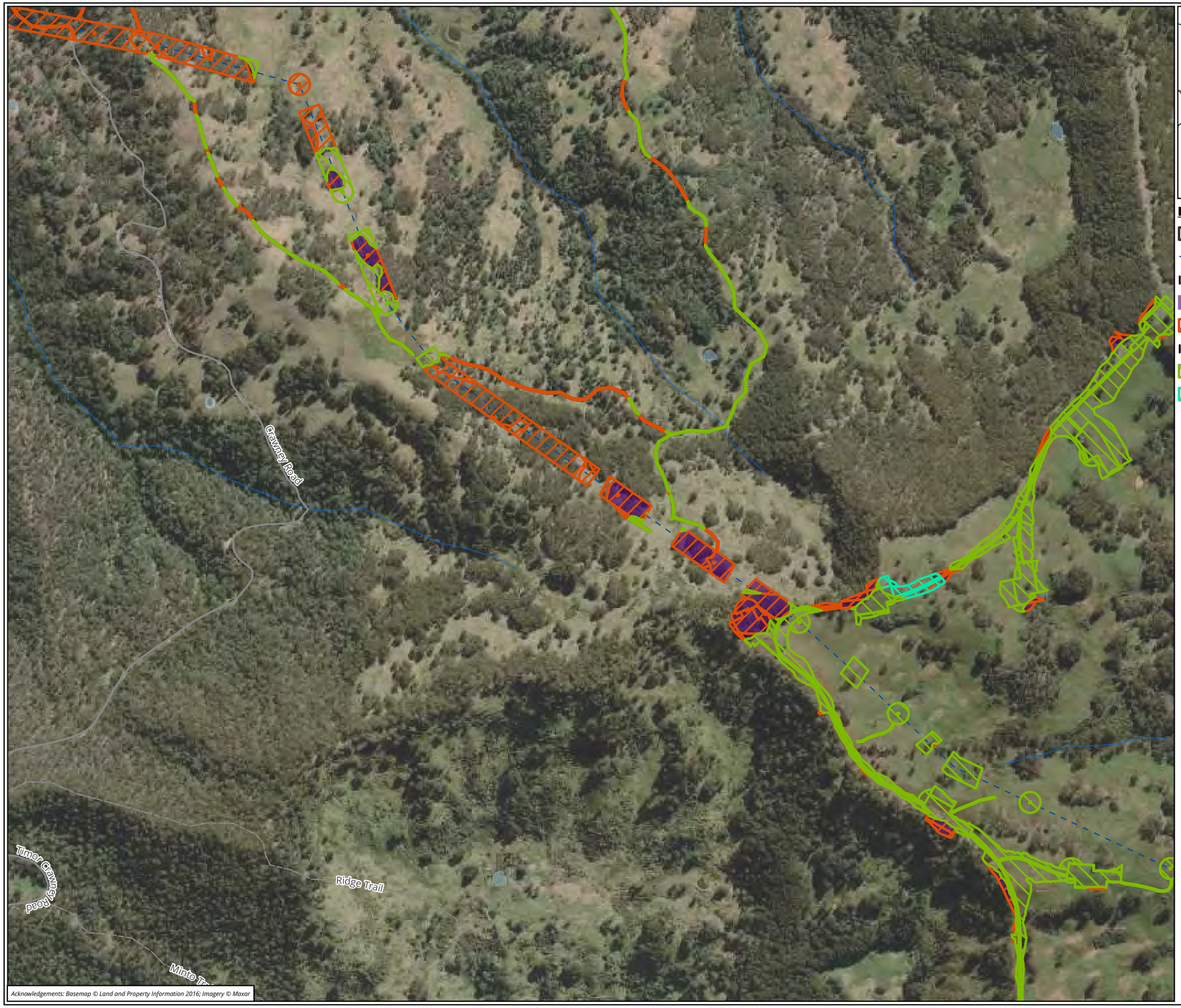

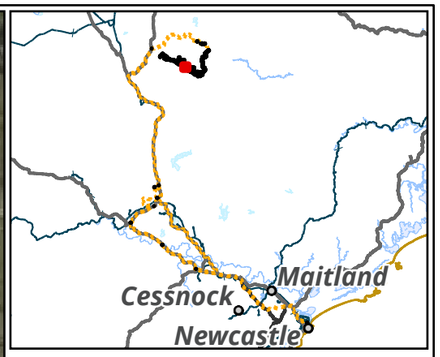

Legend

- Infrastructure footprint
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation
- PCT 1194 DNG - VI score <15

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 8

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

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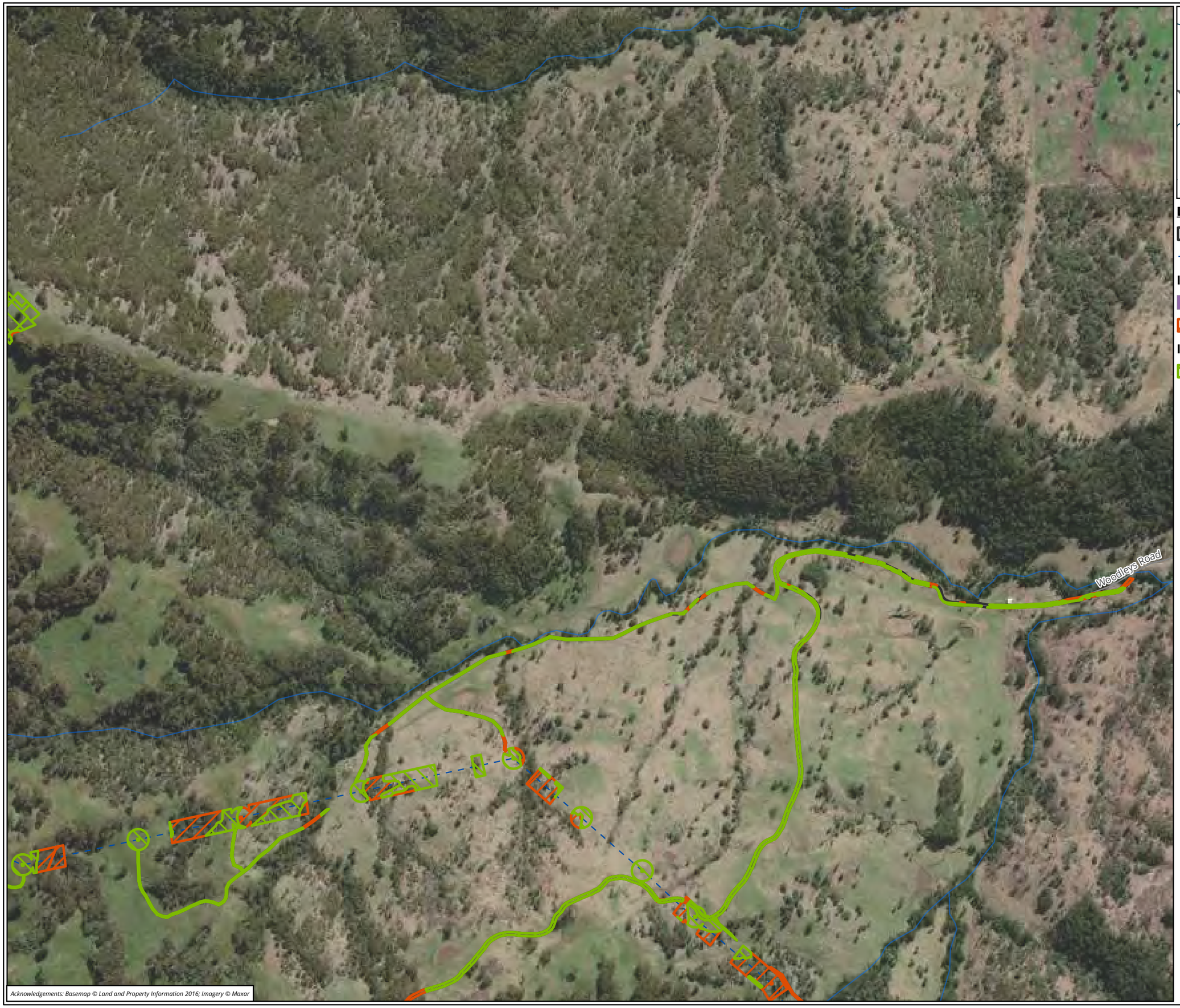

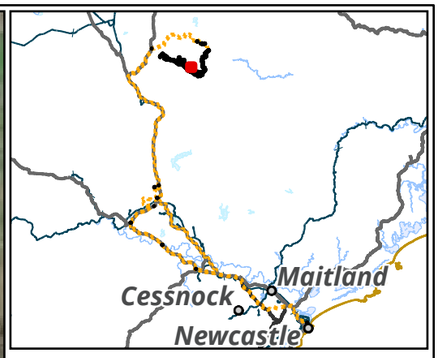

Legend

- Infrastructure footprint
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 9

0 125 250 375 500 Meters

N

Scale: 1:10,000 @ A3

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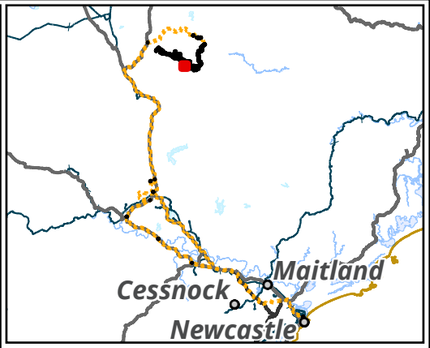

Legend

- Infrastructure footprint

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation
- PCT 1194 DNG - VI score <15

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 10

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

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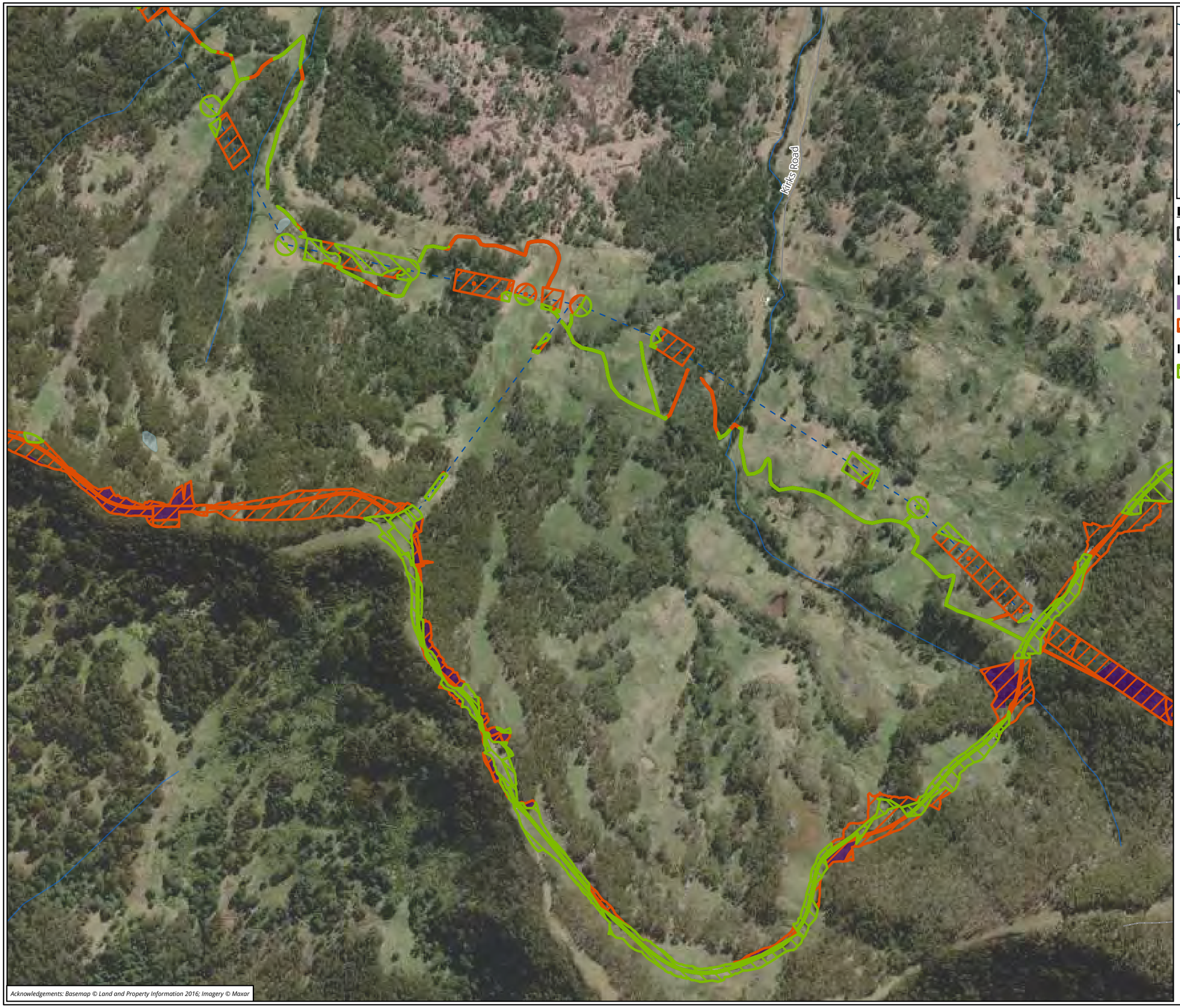

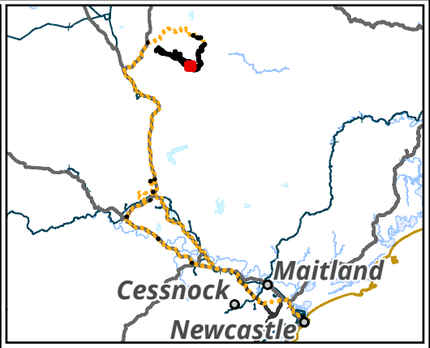

Legend

- Infrastructure footprint
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 11

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

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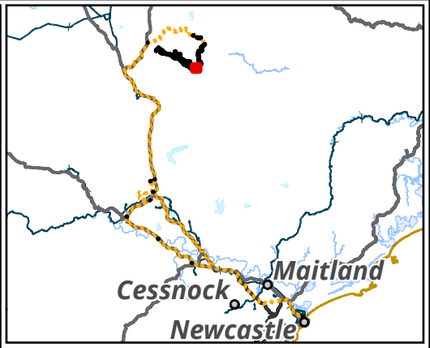

Legend

- Infrastructure footprint
- Transmission line

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation
- PCT 1194 DNG - VI score <15

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 12

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

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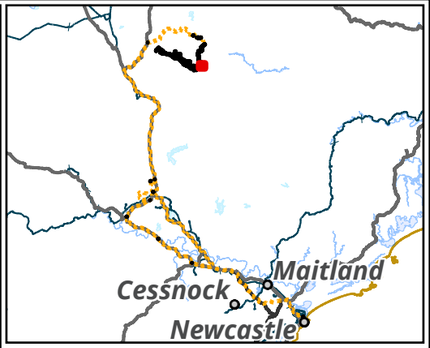

Legend

Infrastructure footprint

Impacts requiring offset

Threatened species habitat

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 13

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

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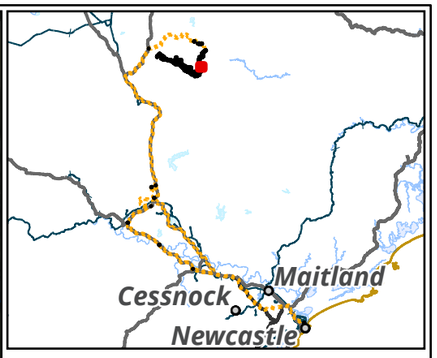

Legend

- Infrastructure footprint

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 14

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

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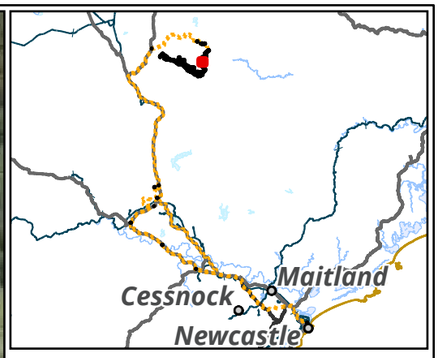

Legend

Infrastructure footprint

Impacts requiring offset

Threatened species habitat

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 15

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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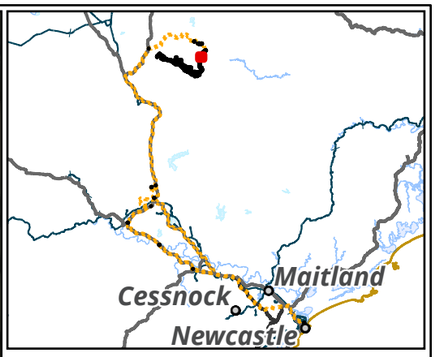

Legend

Infrastructure footprint

Impacts requiring offset

Threatened species habitat

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 16

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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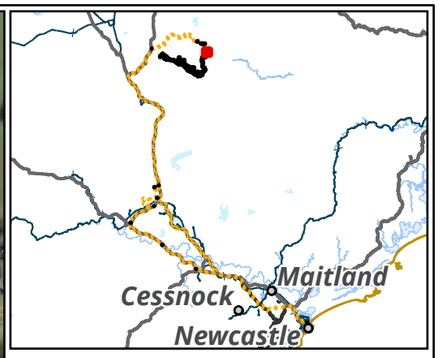

Legend

- Infrastructure footprint
- Transport haul routes

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation
- PCT 1194 DNG - VI score <15

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 17

0 125 250 375 500

Meters

Scale: 1:10,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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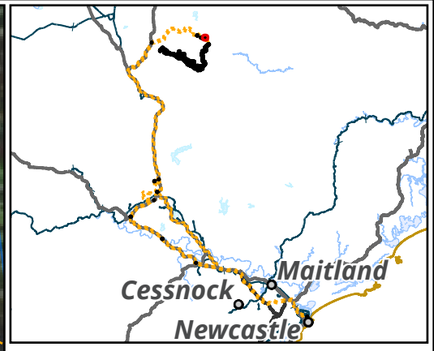

Legend

Transport haul routes

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 18

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
Date: 23 March 2022 ,
Prepared for: CW, Prepared by: LH, Last edited by: jtownsend
Layout: 34963_F30_Impacts
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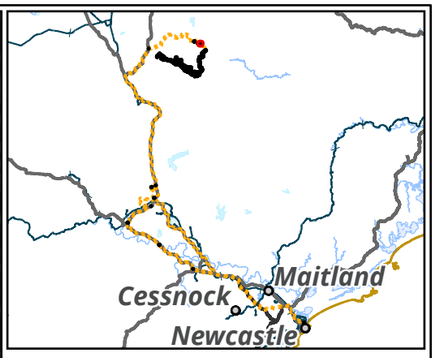

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 19

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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biosis

Matter: 34963,
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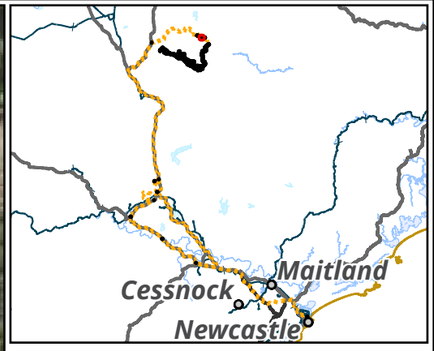

Legend

Transport haul routes

Impacts requiring offset

Threatened species habitat

Native vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 20

0 30 60 90 120

Meters

Scale: 1:3,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

biosis

Matter: 34963,
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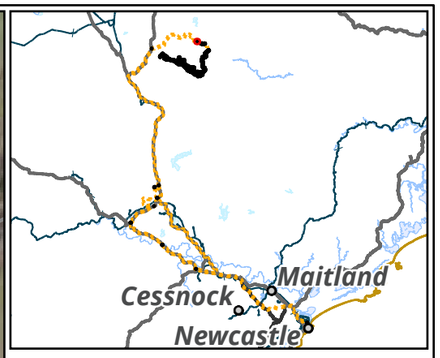

Legend

- Infrastructure footprint
- Transport haul routes

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 21

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

biosis

Matter: 34963,
Date: 23 March 2022 ,
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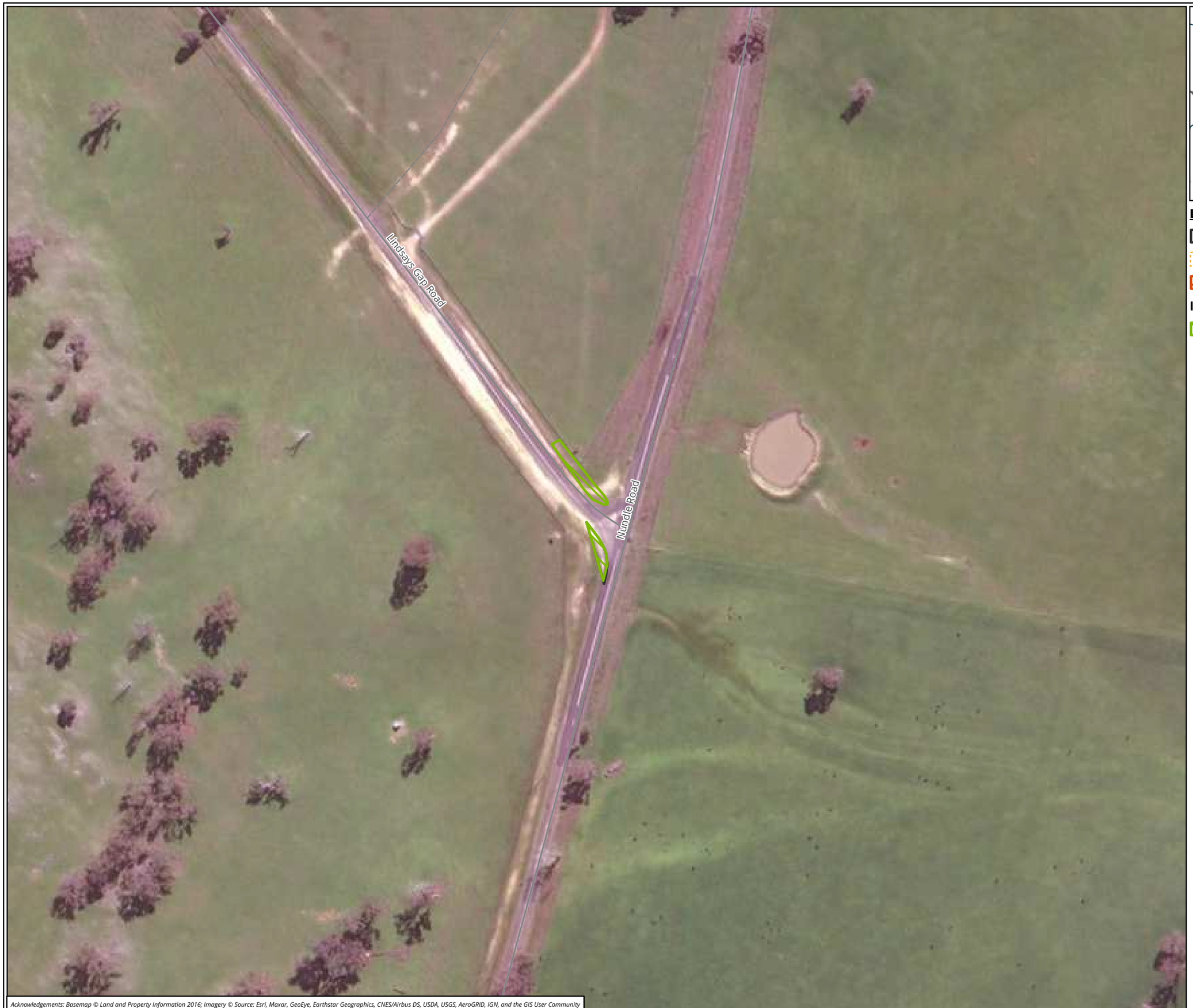

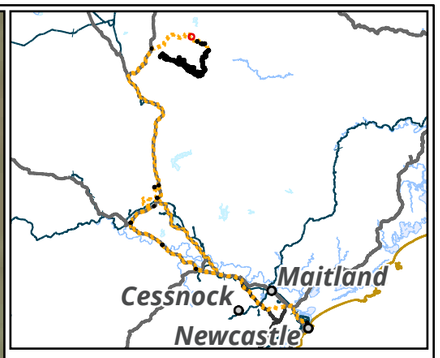

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 22

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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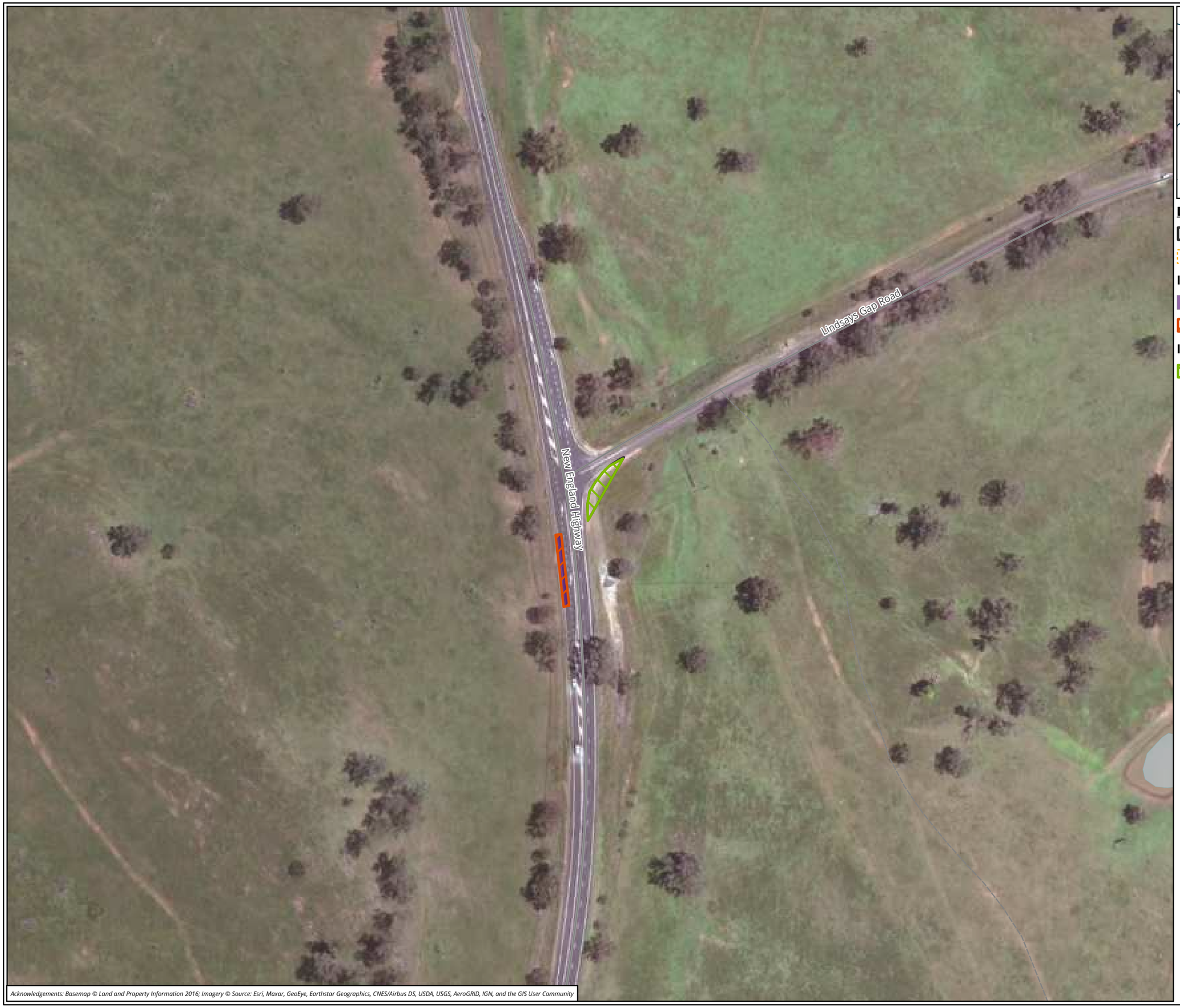

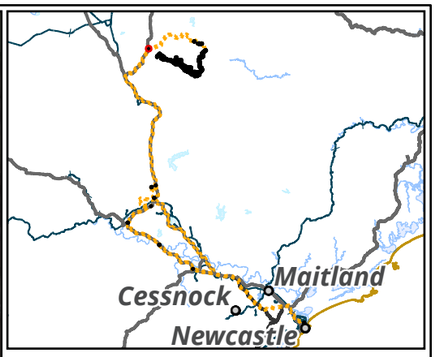

Legend

- Infrastructure footprint
- Transport haul routes

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 23

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

N

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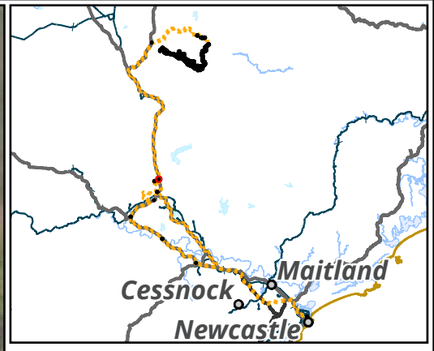

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 24

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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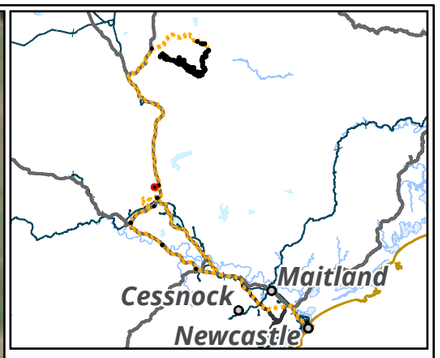

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 25

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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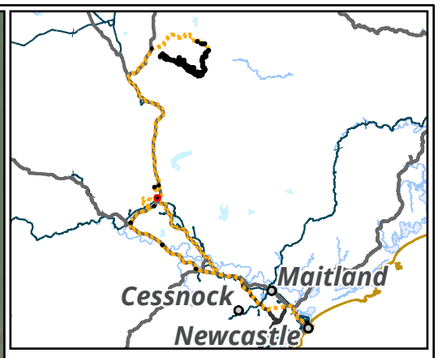

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 26

0 25 50 75 100 Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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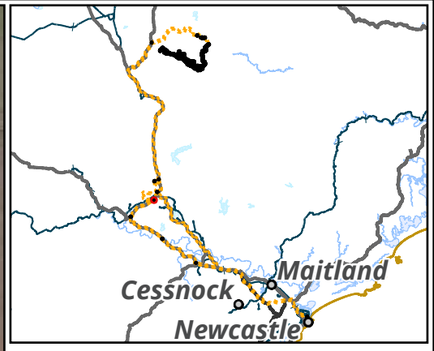

Legend

- Infrastructure footprint
- Transport haul routes

Impacts requiring offset

- Threatened species habitat
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 27

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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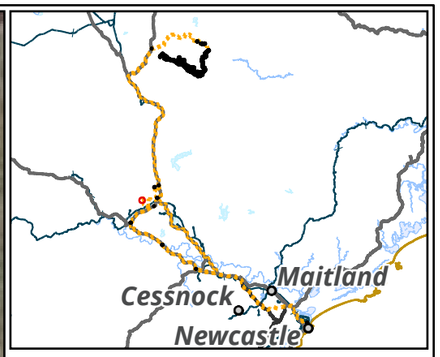

Legend

Transport haul routes

Impacts requiring offset

Threatened species habitat

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 28

0 25 50 75 100

Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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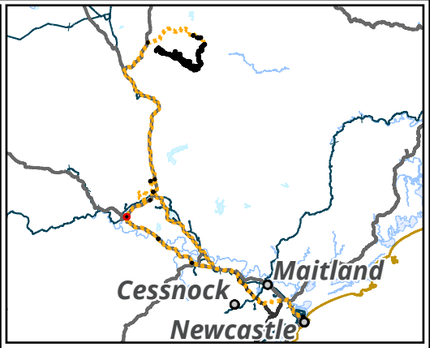

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 29

0 25 50 75 100 N

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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Matter: 34963,
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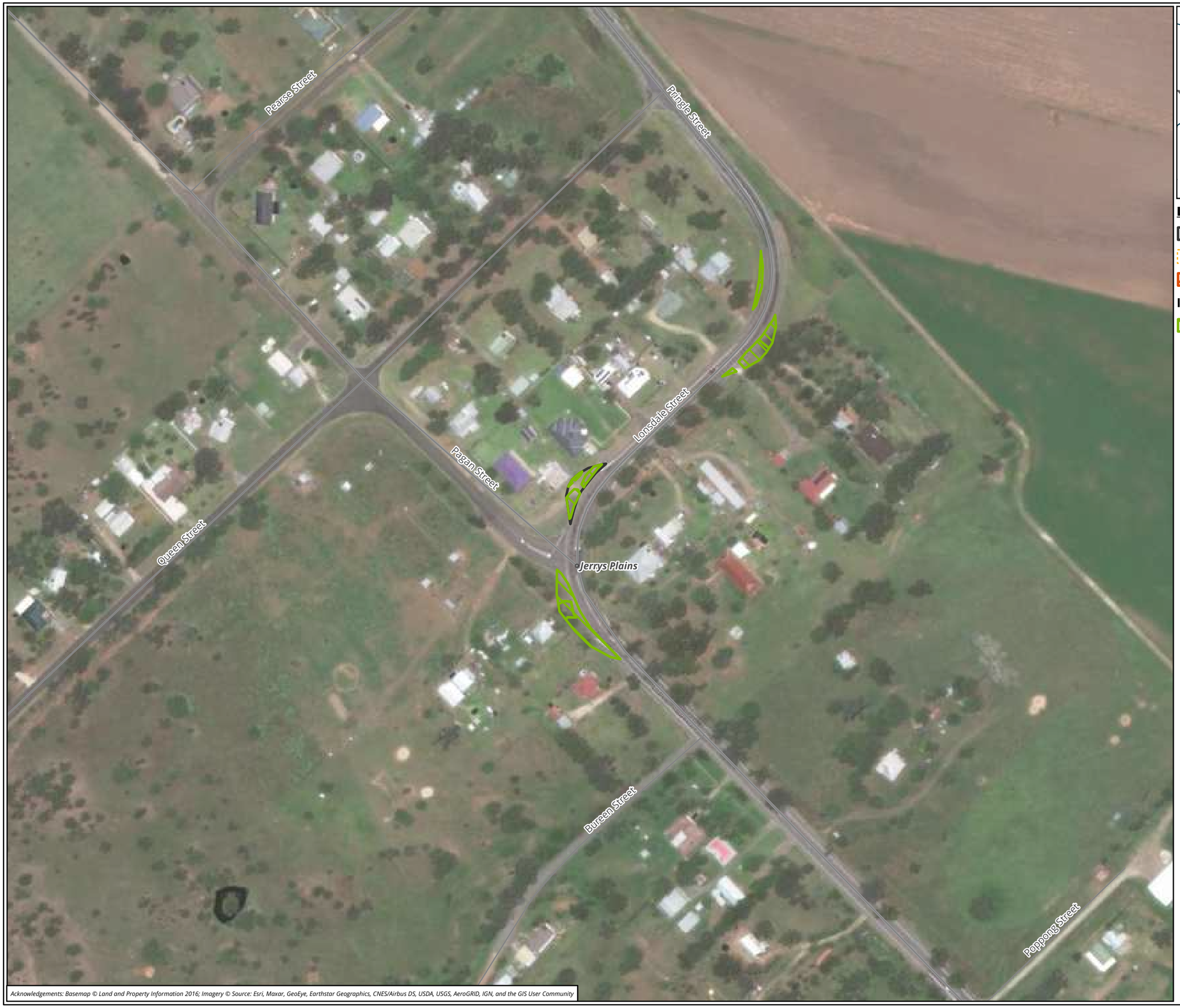

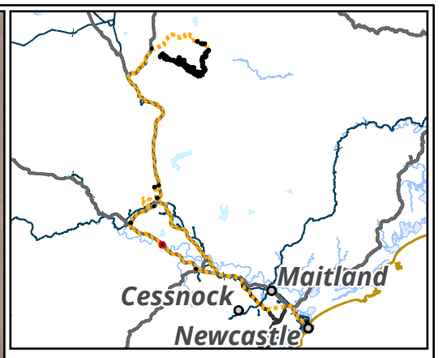

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 30

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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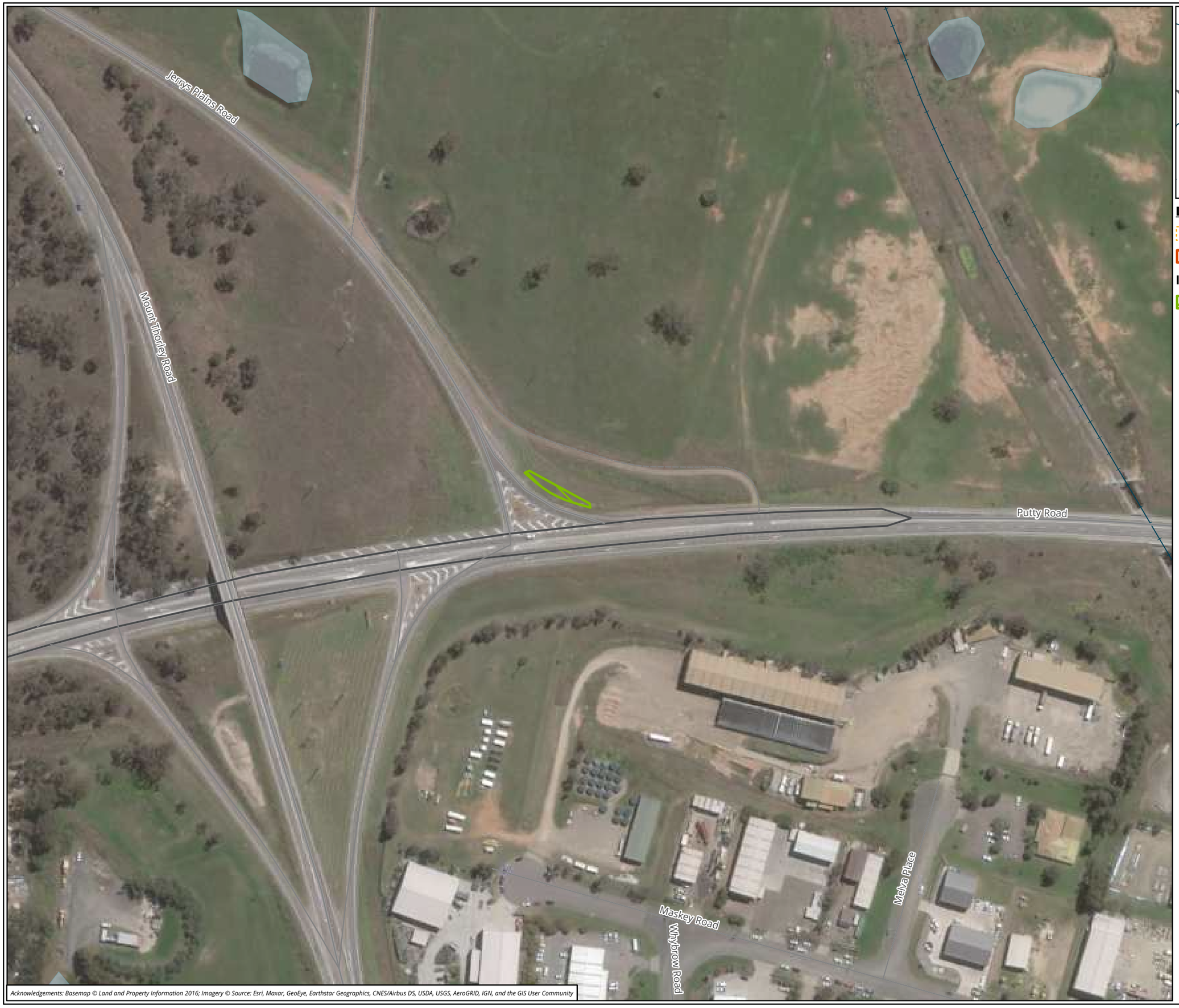

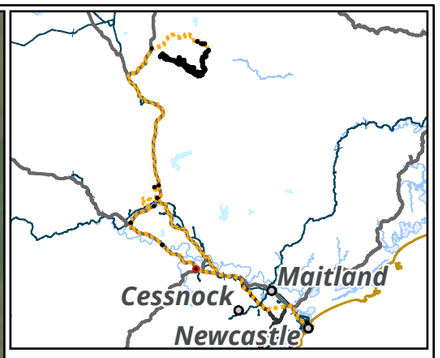

Legend

Transport haul routes

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 31

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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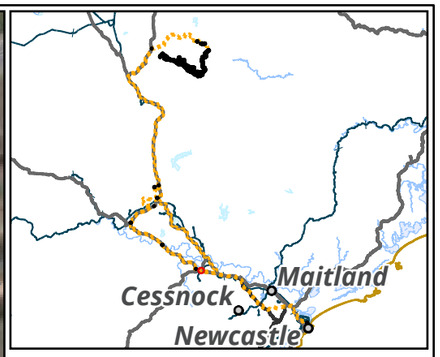

Legend

Transport haul routes

Native vegetation

Impacts not requiring offset

Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 32

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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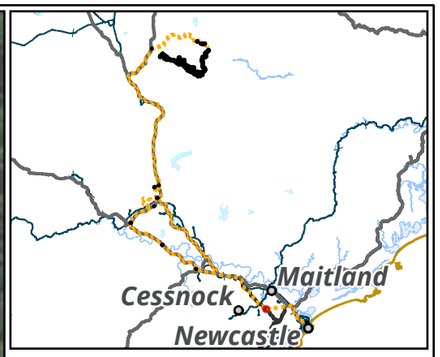

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 33

0 25 50 75 100 Meters

N

Scale: 1:2,000 @ A3

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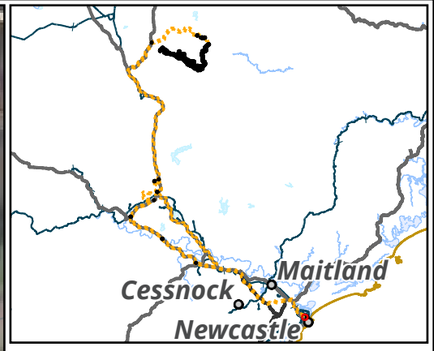

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 34

0 25 50 75 100

Meters

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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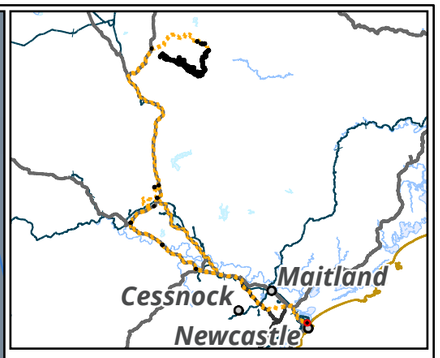

Legend

- Infrastructure footprint
- Transport haul routes
- Native vegetation

Impacts not requiring offset

- Exotic vegetation

Figure 30 Impacts requiring offsets, not requiring offset, not requiring assessment, Page 35

0 25 50 75 100 Meters

N

Scale: 1:2,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

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9.1 Biodiversity Offset Strategy

Biosis completed a Biodiversity Offset Strategy following public exhibition of the BDAR that confirms the potential for biodiversity stewardship sites for identifying, creating and retiring the required biodiversity credits. The project Porponent has commenced investigations on a number of properties adjacent to the project area where Biodiversity Stewardship Sites can be established. These properties are on similar elevated ridgelines, with similar PCTs and fauna habitats, also being subject to historical impacts associated with farming.

Due to the large size of the combined offset investigation area (almost 8500 hectares) opportunities to ground-truth vegetation types, to determine suitability, and assess management requirements to determine potential costs, were somewhat limited. To overcome this, existing vegetation mapping, including that developed this BDAR, was reviewed in combination with high definition aerial imagery, to define high potential areas for ground-truthing surveys, undertaken over four days in January 2021. Broad assumptions have been made when determining the potential suitability of vegetation and associated costs of management for areas both ground-truthed, as well as those not visited on ground. The aim of this work was to determine feasibility of potential Biodiversity Stewardship Sites on identified land in order to progress landowner discussions and preparation of Biodiversity Stewardship Agreements with the NSW Minister for the Environment.

In particular, the potential to create Biodiversity Stewardship Sites on land surrounding the Project to provide a wildlife corridor between Ben Halls Gap Nature Reserve and Crawney Pass / Wallabadah Nature Reserve has been investigated. There have been seven (7) neighbouring landowners identified who could potentially host a biodiversity stewardship site to deliver the wildlife corridor. The Proponent is seeking to enter into agreements with these neighbouring landowners to secure the potential wildlife corridor. Subject to these agreements being successfully concluded and Biodiversity Stewardship Sites established in accordance with legislative requirements, the Proponent commits to delivering a wildlife corridor between Ben Halls Gap Nature Reserve and Crawney Pass / Wallabadah Nature Reserve as part of the biodiversity offsets required for the Project. This wildlife corridor would improve local habitat connectivity between exiting conservation areas that would particularly benefit local Koala and Spotted-tailed Quoll populations impacted by the project.

9.1.1 Offsetting obligations and options

The amended BDAR records 3955 ecosystem credits related to 16 Plant Community Types (PCT) in 10 Offset Trading Groups (OTG), as being required to compensate for residual impacts of the development. Grouping of the PCTs by OTG provides insight into the volume of credits needed for each type in relation to the price of individual credits.

It should be noted that the level of impact calculated and assessed in the BDAR is considered to be a conservative overestimate of impacts, with future avoidance and minimisation opportunities available through project staging and design optimisations.

There are three broad options available for securing the offsets required for the project, each with their own benefits and drawbacks, these options are:

- Payment to the Biodiversity Conservation Fund (the Fund) managed by the BCT.
- Purchase of credits from the open market, with consideration of applying the 'Like for Like' Variation Rules.
- Establish a Biodiversity Stewardship Site(s) to generate credits to use for offsetting.

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Option 1: Payment to the Fund managed by the BCT

Satisfying an offset obligation by paying to the Fund has the major benefit of being an expedited and transparent way for proponents to meet their offset obligations. However, it does include increased costs associated with the 'Risk premium' included by the BCT, and an administrative cost per credit type required.

Meeting an offset obligation by paying to the Fund can therefore be completed within 2-3 weeks of receiving project approval, and the price provided by the BOP-C (honoured by the BCT as of the day of receipt of a completed application) includes all administrative costs associated with the process.

This process avoids delays to future project stages as a result of outstanding biodiversity offset requirements.

It should be noted that following the Commonwealth's formal endorsement of the BOS in March 2020, payment to the Fund to satisfy an offset obligation for EPBC Act listed species resulting from a significant impact due to a Controlled Action is now allowable.

Option 2: Purchase credits from the open market

Potential benefits from procuring credits from the open market include a potential increase in offsetting options when applying the like-for-like rules included in the BAM, and then further again when applying the 'Like for Like Variation Rules'. There is also the ability to negotiate with sellers on price, potentially with multiple credit holders. Drawbacks include a potential paucity of credits on the market, sellers setting a high price and not being willing to negotiate, timeframes associated with negotiations, timeframes associated with procurement of a range of credit types (if required), timeframes to process sales, and additional credit 'transfer' and 'retirement' fees.

It is difficult to accurately estimate potential costs of credits on the open market as the price is wholly determined by the credit holder (sellers) and is based on their requirements for funding the required management actions at their BioBank or Stewardship Site. However, recent investigations into the current credit market undertaken for other State Significant Development projects have shown that market prices are selling below that determined by the BOP-C in order for individual credit owners to secure credit sales over the BCT.

Initial analysis into the current market availability of the credits required for the project has been undertaken, the results of which are provided in Table 90 below. It should be noted that the credits presented below were available as of February 2021, however due to the nature of the open market their future availability cannot be guaranteed.

Table 90 Credit register searches for like-for-like credits

Offset trading group	Number required	Number available (BAM) Feb 2021
Northern Tableland Wet Sclerophyll Forests >=70% and <90%	495	-
Northern Escarpment Wet Sclerophyll Forests >=70% and <90%	560	-
White Box Yellow Box Blakely's Red Gum Woodland	329	1941
Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland	753	
New England Dry Sclerophyll Forests >=50% and <70%	1833	1395 (pending review)
Eastern Riverine Forests <50%	78	3 (pending review)

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Offset trading group	Number required	Number available (BAM) Feb 2021
Tableland Clay Grassy Woodlands >=70% and <90%	3	-
New England Grassy Woodlands <50%	68	-
Temperate Montane Grasslands >=70% and <90%	76	-
Northern Tableland Wet Sclerophyll Forests >=50% and <70%	54	-

Biodiversity credits may be available for purchase, but not listed on public registers for a number of reasons. Additionally, credits created under the previous BioBanking scheme (BBAM) are not easily cross-referenced related to changes in PCT naming conventions. An alternative market engagement tool is to lodge a Credits Wanted request via the online BAM Calculator tool (BAM-C), which lists the PCT and number of credits sought on the Credit Demand Register. Interested parties may then come forward with credits for sale and/or Biodiversity Stewardship Site opportunities.

Option 3: Establish a Biodiversity Stewardship Site

Establishment of a Biodiversity Stewardship Site (or multiple sites) with the intention of generating credits to satisfy the project's offset obligation appears to be a feasible option for the current BOS. This is due to the presence of land adjacent to the development site that supports similar biodiversity values.

The major benefit of establishing a Biodiversity Stewardship Site to offset the project's impacts is the reduction in the cost of the offset credits.

9.1.2 Local offset feasibility

Desktop review

Prior to commencing the field investigation, information including the BDAR's vegetation assessment, and aerial vegetation mapping projects were reviewed to identify which of the proposed properties were worth targeting for field investigations.

Of the initial 12 suggested offset investigation properties, seven were assessed as highest priority for field investigation based on the results of the desktop assessment suggesting a higher likelihood of the presence of like-for-like PCTs and offsetting options. Details of the prioritised properties are provided in Table 91 below.

Table 91 Highest priority offset investigation properties

Property	Approx. area (ha)	Comments
Property 01	1090 ha – mixed areas of vegetation and grazed land	Large property to the west of the wind farm assessment area with high ridgelines likely to support target PCTs / OTGs. Provides landscape connectivity over Crawney Mountain to Wallabadah Nature Reserve.
Property 02	830 ha – intact vegetation present of the slopes and gullies away from the norther edge of the property	Potential offset areas are immediately adjacent to the wind farm assessment area and already known to support areas of the target PCTs / OTGs. Provides a portion of the landscape connectivity to the south of the development footprint from Ben Halls Gap Nature Reserve to Crawney Pass National Park.
Property 03	780 ha – mixed areas of intact vegetation, razed and pasture	Potential offset areas are immediately adjacent to the wind farm and transmission line assessment areas and considered

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Property	Approx. area (ha)	Comments
	improved land	likely to support areas of the target PCTs / OTGs.
Property 04	1400 ha – areas on intact vegetation in the south and west, more cleared and grazed land to the north and east	Large property to the west of the wind farm assessment area with high ridgelines likely to support target PCTs / OTGs. Provides landscape connectivity over Crawney Mountain to Wallabadah Nature Reserve.
Property 05	830 ha – largely intact / patchy vegetation immediately below the ridgeline. South-eastern corner large ae of intact vegetation	Desktop assessment of offset potential partly combined with BDAR mapping. Ridgeline forming the northern boundary of the property targeted for rehabilitation and enhancement of local habitat connectivity.
Property 06	104 ha – largely intact vegetation	Potential offset areas are immediately adjacent to the wind farm assessment area and already known to support areas of the target PCTs / OTGs.
Property 07	1735 ha – large areas of intact vegetation in the south, remainder of the property is patchy with well vegetated and cleared areas	Desktop assessment only. Large property to the south-west of the wind farm assessment area with high ridgelines likely to support target PCTs / OTGs.
Property 08	207 ha – largely intact vegetation	Potential offset areas are immediately adjacent to the wind farm assessment area and already known to support areas of the target PCTs / OTGs.
Property 09	990 ha – intact to patchy vegetation on middle to upper slopes	Desktop assessment only. Potential offset areas to the north of the wind farm on middle and upper slopes. Large areas of intact to patchy vegetation, drainage lines expected to be weedy.

Due to the large size of a number of the above properties not all areas within each property were able to be assessed, and furthermore not all areas assessed were considered suitable for potential offsets. Access to the Property 07, Property 09 and Property 05 properties were not possible during the field investigation, however they remain important opportunities to establish a potential Biodiversity Stewardship Sites. The Property 06 property was excluded following completion of the field investigation and neither are discussed further.

Field investigation

A field investigation of the assessment area was undertaken on 19 to 22 February 2020 by Callan Wharfe (Senior Ecologist and Offset Lead) and Brooke Corrigan (Consulting Restoration Ecologist) of Biosis, prior to the updates to the BDAR. Vegetation within the assessment area was surveyed using the random meander technique (Cropper 1993) over 80 person hours.

General classification of native vegetation in NSW used in this BOS is based on the classification system in Keith (2004) which uses three groupings of vegetation: vegetation formation, vegetation class and vegetation type, with vegetation type the finest grouping. The target grouping referred to in this report is PCT as defined by the BAM (DPIE 2020)), and has been the standard used across NSW since 2016. However due to the rapid nature of the field investigations PCTs were not always able to be determined. Where PCTs could not be determine this was due to either the complex nature of PCTs present the assessment area, the disturbed

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nature of the vegetation in some areas due to bushfire and/or other disturbance factors, and the lack of floristic data due to the collection of floristic (BAM) plots being outside the scope of this assessment.

Where PCT could not be determined the vegetation class (Keith 2006) was able to be established, which forms the basis of the OTG for biodiversity credits, and as such is still a useable and useful guide to the suitability of proposed offset sites for matching the credit requirement at the wind farm.

Vegetation condition was assessed across all areas investigated to determine the required management actions and to facilitate the development of the TFDs. This data was again collected via rapid assessment and as such broad assumptions were made around required management actions based on the ecologists' knowledge and experience and assessment of the on-ground condition of the vegetation.

A habitat-based assessment was completed to determine the presence of suitable habitat for species credit species habitat species requiring offset (Arup 2020). This list was filtered according to species descriptions, life history, habitat preference and soil preference to determine those species most likely to be present within the assessment area.

Desktop assessment of credit yield (Part A)

Following completion of the field investigation, data analysis was undertaken to determine the expected credit yield for each of the potential offset properties. PCT benchmark data was assessed and appropriate vegetation integrity scores were determined for each condition class mapped for each PCT, and these values were input into the BAM Calculator.

TFDs were calculated based on data gathered during the field investigation and extrapolated across the areas considered as highest potential for inclusion in a Biodiversity Stewardship Site to calculate an estimated TFD for each property, and thus the minimum credit price.

Table 92 below provides a guide to the areas assessed for inclusion with potential Biodiversity Stewardship Sites across each of the five ground-truthed and three desktop properties, the potential credit yield, and provides an estimate of the potential surplus vs deficit in biodiversity credits based on total areas assessed across all offset investigation properties and the credits required at the development site as provided in this BDAR.

Table 92 Estimate of credit generation potential of potential offset lands

Offset Trading Group	Total estimated area (ha)	Total credits generated	Credits required	Surplus / deficit
Northern Tableland Wet Sclerophyll Forests / Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland	827	4689	1302	3387
Northern Escarpment Wet Sclerophyll Forests	353	1940	560	1380
New England Dry Sclerophyll Forests	847	4884	1833	3051
New England Grassy Woodlands	91	466	68	398
Totals	2117	11,979	3763	8216

It can be seen from the above table that there are opportunities for generation of the majority of the required offsets, based on OTGs, if Biodiversity Stewardship Sites can be established and matching like-for-like offsets can be confirmed.

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An assessment of the potential for each of the of the offset investigation properties to generate species credit was also undertaken, and advice is provided in Table 93 below.

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Table 93 Assessment of habitat for threatened fauna species credit species

Species credit species	Credits required	Potential habitat present	Likelihood of credit generation	Expected cost to generate credits	Notes
Eastern Cave Bat	690	Property 01 Property 02 Property 03 Property 04 Property 05 Property 07 Property 09	High	Low	Costs associated with deployment and collection of bat detection units, and associated data analysis. Surveys required to be undertaken in warmer months when bats are more active.
Large-eared Pied Bat	690				
Koala	1360	Property 01 Property 02 Property 03 Property 04 Property 05 Property 07 Property 08 Property 09	Moderate – High	Low – Moderate	Costs are associated with deployment and collection of remote cameras and analysis of data. However, remote cameras have a lower likelihood of capture of the species, when compared to active searched for signs of activity (scats, scratches), or nocturnal searches for individuals. These survey types have a higher associated cost.
Eastern Pygmy-possum	726	Property 02 Property 05 Property 04 Property 08	Low – Moderate	Moderate	Costs are associated with deployment and collection of remote cameras and analysis of data. However, camera trapping of Eastern Pygmy Possum requires a high level of habitat assessment to find the highest quality habitats due to the species' small home ranges.
Squirrel Glider	622	Property 01 Property 02 Property 03 Property 04 Property 05 Property 07 Property 08 Property 09	Moderate	Low - Moderate	Costs are associated with deployment and collection of remote cameras and analysis of data. However, camera trapping of Squirrel Gliders is less intensive than Eastern Pygmy Possum as the species is known to move over large distance. Spot-lighting and call-playback options are, also available to confirm presence, however these survey methods are more intensive and thus more expensive.

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Species credit species	Credits required	Potential habitat present	Likelihood of credit generation	Expected cost to generate credits	Notes
Southern Myotis	101	Property 02 Property 03 Property 08 Property 09	High	Low	Costs are associated with deployment and collection of bat detection units, and associated data analysis. Surveys required to be undertaken in warmer months when bats are more active
Booroolong Frog	33	Property 04 (possible) Property 08 (possible)	Low	Moderate	Cost are associated with nocturnal searches for the species within high quality habitat. However habitat for the species was not found to be present in any of the properties assessed on-ground as potential Biodiversity Stewardship Sites.
Border Thick-tailed Gecko	8	Property 01 Property 02 Property 03 Property 04 Property 05 Property 07 Property 08 Property 09	Low	High	Costs are associated with nocturnal searches for the species within high quality habitat. It is expected that a high level of repeat surveys would be required to confirm species presence.
Barking Owl **Powerful Owl** **Masked Owl** **Sooty Owl**	• 85 • 85 • 43 • 127	Property 02 Property 03 Property 04 Property 06 Property 07	Moderate	Moderate	Costs are associated with the requirement to locate the breeding tree for any of the target owl species. It is likely that these owls may be breeding on one or more of these properties, but locating the nest may become resource heavy.

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9.1.3 Enhancement of local habitat connectivity

The project's proposed offset strategy of targeting local properties for the establishment of Biodiversity Stewardship Sites provides potential opportunities for strategic enhancement of local habitat connectivity. Such enhancements could occur along the southern side of the ridgeline between Ben Halls Gap Nature Reserve and Crawney Pass National Park, and over Crawney Mountain to Wallabadah Nature Reserve, linking the three conservation areas. This enhancement of local connectivity can be achieved through the in-perpetuity conservation agreements being pursued over the Property 02, Property 05, Property 04 and Property 01 properties, which will improve the biodiversity values on the land and increase habitat connectivity. Connectivity enhancements realised in this strategic location will not only offset direct impacts resulting from the project, but also allow for potential indirect impacts associated with disruption of habitat connectivity to be mitigated against and offset through the establishment of a managed corridor linking local conservation reserves and high-quality habitats.

The location of any future Biodiversity Stewardship Sites, as well as any supplementary revegetation sites, will ensure that habitat restoration areas are located sufficiently remote from the influence of the turbines. This is to ensure species are not drawn into close proximity of turbines, potentially subjecting them to indirect impacts assessed in Sections 8.3 and 8.5 above.

9.1.4 Conclusion and recommendations

The analysis of potential offsets options set out above is preliminary in nature and would be subject to further assessment to confirm the appropriateness of individual properties to be used as Biodiversity Stewardship Sites as well as agreements being reached with each landholder. The estimated number of credits potentially generated from individual properties may change when field data is captured and utilised in the future.

To be considered a matching offset credit the vegetation at the development site and the proposed offset site need to be a match for OTG (commensurate with 'vegetation class (Keith 2004) and the estimate of percentage cleared for the PCT. PCT 1194 has a high percentage cleared value (>=70% and <90%), compared to the other PCT options in the same OTG (those being PCT 1551, 1555 and 1559). Alternative PCTs have been assessed as lower having percentage cleared (<50%), and thus would not be a suitable offset for impacts to PCT 1194. Due to this disparity, additional floristic data collection is required to determine the presence of PCTs at the potential offset sites that would be considered matching for PCT 1194.

The remaining PCTs and OTGs have a substantially higher level of confidence than the Wet Sclerophyll Forests / PCT 1194 complex.

It is recommended further work be undertaken to determine the presence of PCT 1194 matching vegetation at the offset properties due to the significant opportunity for cost saving that could be realised if matching credits can be generated at a Biodiversity Stewardship Site.

As outlined in this BDAR, the project has been assessed as having the potential to result in significant impacts to one ecological community and two fauna species listed under the Commonwealth, namely White Box-Yellow Box-Blakely's Red Gum Grassy Woodland, Koala and Spotted-tailed Quoll. Locally established Biodiversity Stewardship Sites are not expected to result in offset opportunities for White Box-Yellow Box-Blakely's Red Gum Grassy Woodland, due to the landscape positions of the proposed sites. Opportunities for offsetting impacts to Koala and Spotted-tailed Quoll are expected to be available within the proposed sites, and these would be expected to meet the requirements for offsetting under the EPBC Act.

Timeframes to complete the on-ground assessments and prepare the reports and BSA application are likely to be 2 to 3 months, and review by the BCT is likely to take a further 6 months. It can be expected that the whole process may take up to 12 months to reach a signed BSA and have the credits available for offsetting purposes. There are also specific survey timeframes that may need to be adhered to for threatened species credits looking to be generated. These are not entirely relevant for the project's impacts, however surveys

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over the warmer months would be much more likely to detect the targeted microbat species at any proposed offset site.

Commencing of the detailed investigations required to establish the Biodiversity Stewardship Sites should also occur as soon as possible to reduce any lead time referred to above. The generation of species credit should be pursued for those species noted as having a high likelihood of generation and a low to moderate associated cost.

9.1.5 Offset staging plan

As outlined in Section 1.6, the project proposes to stage the construction to ensure ongoing avoidance and minimisation of impact can be achieved as the detailed design of the project progresses, as well as staged retirement of biodiversity credit liabilities. A detailed staging plan will be based on final turbine and balance of plant contractor selected and associated construction plan preferences.

Prior to works commencing for each of the construction stages listed below, the biodiversity offset required associated with each stage will be secured and retired.

The following set of example construction stages (or components) provided in Table 94 has been considered possible to be discrete packages of work for which staging of offset obligations is feasible. The resultant offset credit liabilities for each of these stages is provided in Table 95 below.

Table 94 Construction Staging Concept Scope of Works

Scope of Work	Description
Haulage and External Route Upgrades	Required public road upgrades associated with bringing in materials and commencing construction on site.
Construction Compound and Internal Roads, Turbine Hardstands and Foundations	Establishment of construction facility and temporary laydown areas and commencement of internal road upgrades. This may be further broken up in stages by area of the project.
Ancillary Infrastructure	Substation, batching plant, O&M Facility and temporary laydown areas.
Transmission Line	External Transmission line construction.
Switching Station	This is located 20km from the wind farm Project Site and may be staged separately.

The Proponent will provide a final project staging plan to DPIE with final detailed layout plan, updated surveys (if required and outside of the current subject land) and BAM calculations during detailed design and prior to the commencement of construction.

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Table 95 Potential staged credit requirement

Project total impacts and credits				Stage impacts (Ha)					Stage credits				
Relevant matter	TEC	Direct impacts (ha)	Credits req.	Ancillary Infra.	Cmpnds, Intr. Rds, Trbne Hs & Fndtns	Haulage Route Upgrades	Switching Station	TxL	Ancillary Infra.	Cmpnds, Intr. Rds, Trbne Hs & Fndtns	Haulage Route Upgrades	Switching Station	TxL
Ecosystem credits													
PCT 433	Box Gum Woodland TEC	0.02	2			0.01		0.01			1		1
PCT 486	-	2.12	79		0.11			2.01		4			75
PCT 490	-	1.84	68					1.84					68
PCT 492	Box Gum Woodland TEC	4.62	225			2.68		1.94			130		95
PCT 507	-	0.09	3		0.09					3			
PCT 526	-	1.12	49		0.01	1.11				1	48		
PCT 540	Ribbon Gum - Mountain Gum - Snow Gum TEC	1.44	56		1.44					56			
PCT 540	-	39.2	1,340		9.83			29.37		336			1004
PCT 541	-	11.37	369		0.44	0.10	0.69	10.14		14	4	23	328
PCT 586		2.56	53		2.56					53			
PCT 599	Box Gum Woodland TEC	1.43	89			0.33		1.10			21		68
PCT 931	-	3.21	77	0.03	2.74	0.42		0.01	1	65	10		1
PCT 934	-	22.82	455	7.18	13.68			1.96	143	273			39
PCT 954	-	1.23	54		1.23					54			
PCT 1194	Ribbon Gum - Mountain Gum - Snow Gum TEC	22	479	0.72	18.73	0.86		1.61	16	408	19		36
PCT 1194	-	17.37	554		13.92			3.45		444			110
PCT 1604	-	0.02	1			0.02					1		
PCT 1691	-	0.04	2			0.04					2		
Total ECS		**132.5**	**3995**	**7.94**	**64.77**	**5.57**	**0.69**	**53.44**	**160**	**1711**	**236**	**23**	**1825**

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Project total impacts and credits				Stage impacts (Ha)					Stage credits				
Relevant matter	TEC	Direct impacts (ha)	Credits req.	Ancillary Infra.	Cmpnds, Intr. Rds, Trbne Hs & Fndtns	Haulage Route Upgrades	Switching Station	TxL	Ancillary Infra.	Cmpnds, Intr. Rds, Trbne Hs & Fndtns	Haulage Route Upgrades	Switching Station	TxL
Species credits													
Large-eared Pied Bat	-	19.68	625	1.21	18.14			0.33	38	576			11
Eastern Cave Bat	-	19.68	625	1.21	18.14			0.33	38	576			11
Southern Myotis	-	3.97	89		3.93	0.04				88	1		
Koala	-	36.44	1,225	0.76	26.40	2.26		7.02	26	887	76		236
Eastern Pygmy-possum	-	18.14	655	0.01	13.28	1.22		3.63	1	480	44		130
Squirrel Glider	-	16.06	544	0.72	11.20	1.76		2.38	25	379	60		80
Booroolong Frog	-	0.64	33					0.64					33
Border Thick-tailed Gecko	-	0.17	8			0.07		0.11			3		5
Powerful Owl	-	1.99	77		1.99					77			
Sooty Owl	-	1.99	114		1.99					114			
Barking Owl	-	1.99	77		1.99					77			
Masked Owl	-	0.99	39		0.99					39			
Total SCS		**121.74**	**4111**	**3.90**	**98.06**	**5.34**	**0.00**	**14.43**	**128**	**3293**	**184**	**0**	**506**
Grand totals		**254.24**	**8066**	**11.84**	**162.83**	**10.92**	**0.69**	**67.87**	**288**	**5004**	**420**	**23**	**2331**

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Appendices

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Appendix A Haul route desktop study

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File Note

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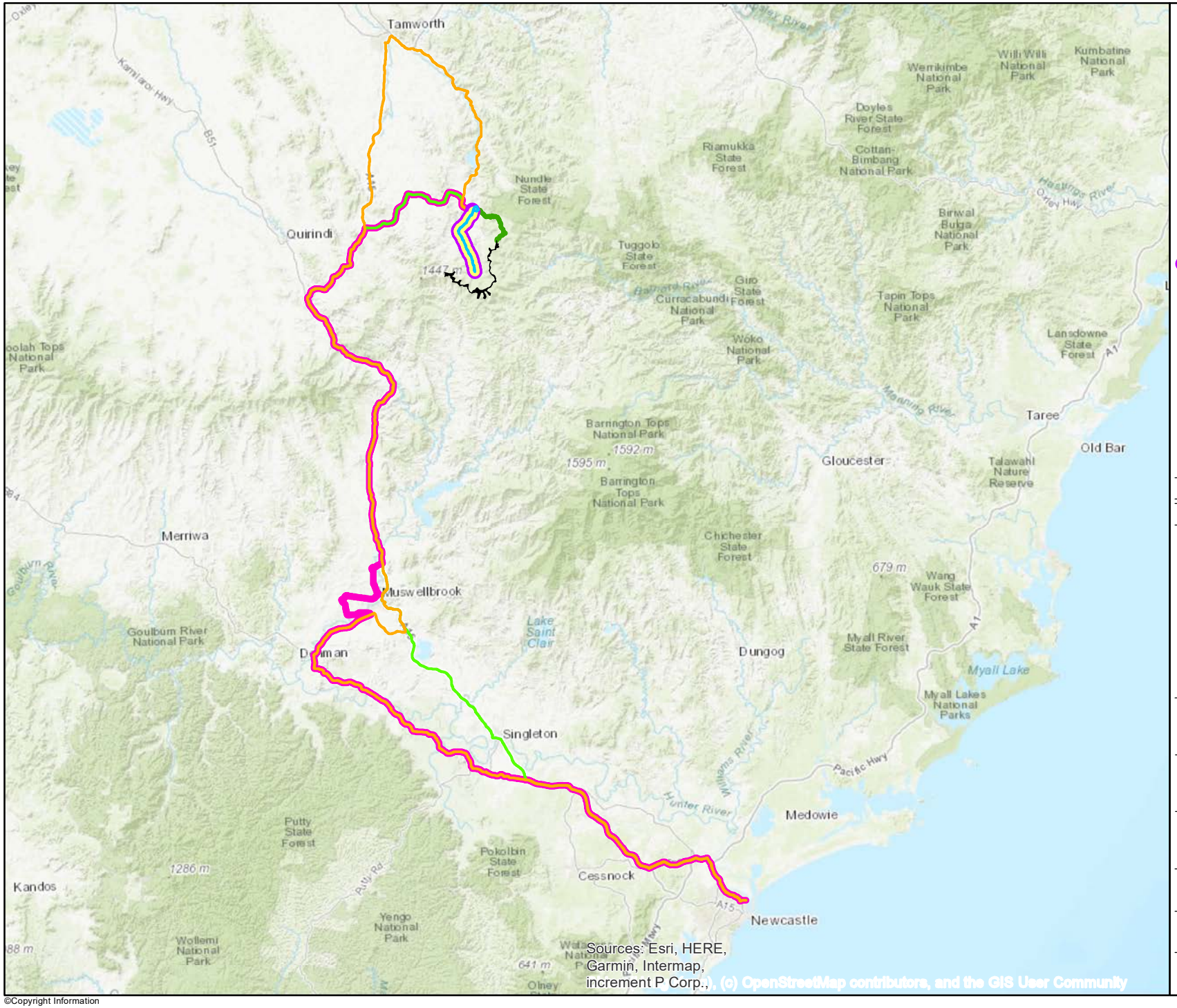
Project title	Hills of Gold Wind Farm	Job number	273023-00
cc	Wind Energy Partners Biosis	File reference	HoG_HaulRoute_TN_1.0
Prepared by	Chani Wheeler	Date	25 August 2020
Subject	Haul route assessment		

1 Introduction

A haul route from the Port of Newcastle to Nundle is proposed for the Hills of Gold Wind Farm development. Figure 1 shows haul route options currently being considered. Some selective clearing of vegetation and increased hardstand may be required in locations along the proposed routes to accommodate the transportation of construction materials to site. A number bridge/culvert upgrades may also be required at the following locations:

- Goonoo Goonoo Creek, Lindsay's Gap Road, Garoo
- Middlebrook Creek, Lindsay's Gap Road, Garoo
- Four separate tributaries of the Peel River, Head of Peel Road, Nundle
- Wardens Brook, Head of Peel Road, Nundle
- Peel River Nundle.

This Technical Note has been prepared to support the assessment of biodiversity impacts associated with the proposed haul routes. It documents the result of a desktop review of constraints at each proposed works area and is intended to inform requirements for additional survey works.



Wind Farm Development Corridor

Haul Route Options

- Newcastle to Nundle - Option 1 - Blades
- Newcastle to Nundle - Option 1 - Remaining Components
- Newcastle to Nundle - Option 2 - Towers
- Nundle to Site - Primary Options - All Components - Morrisons Gap Rd
- Nundle to Site - Secondary Option (a) - All Components - Head of the Peel Rd
- Nundle to Site - Secondary Option (b) - All Components - Head of the Peel Rd
- Nundle to Site - Secondary Option (c) - All Components - Head of the Peel Rd

Issue	Date	By	Chkd	Appd
D1	21/08/2020	CW	MJD	MJD

Kilometers

0 4.5 9 18 27 36 45 54

ARUP

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Client
Wind Energy Partners

Job Title
Hills of Gold Wind Farm

Drawing Title
Haul route options

Scale at A4	Drawing Status
1:1,200,000	**Draft**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Drawing No
270335-00	**Figure 1**

J:\270000\270335-00 Hills of Gold\Work\Internal\Design\GIS\Figures\Haul Route Assessment\Figure 1.mxd

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2 Method

A review of the following existing datasets and data was carried out:

- Greater Hunter Native Vegetation Mapping v4.0. VIS_ID_3855 (DPIE, 2012)
- State Vegetation Type Map: Border Rivers Gwydir/ Namoi Region v2.0. VIS_ID_4467 (DPIE, 2015)
- Aerial imagery (Google, 2020a)
- Street View imagery (Google, 2020b)

Based on the above information sources, sites were ranked from low to high risk depending on the likely presence of native vegetation communities and potential habitat for threatened species.

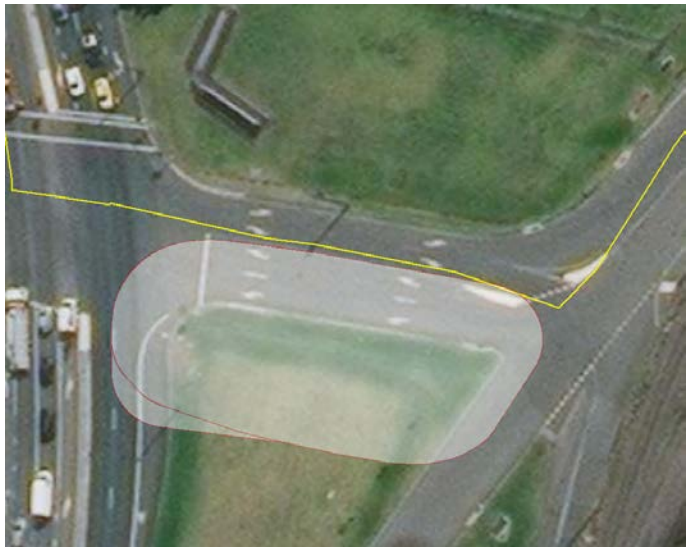
3 Results

Table 1: Haul route assessment results and site risk rating

Location	Assessment Results	Risk Rating
Selwyn Street, Mayfield North	Based on a review of DPIE (2012), River Red Gum/ River Oak grassy riparian woodland of the Hunter Valley is mapped within the northern portion of the works footprint. Review of latest aerial imagery and Street View indicates the site iss clear of vegetation. However, based on location of site, there is potential for marine plants where surface waters are saline. There is also potential for Green and Golden Bell Frog where bulrushes/ sedges are present. Survey of site recommended to confirm marine plants and potential habitat for Green and Golden Bell Frog.	Moderate

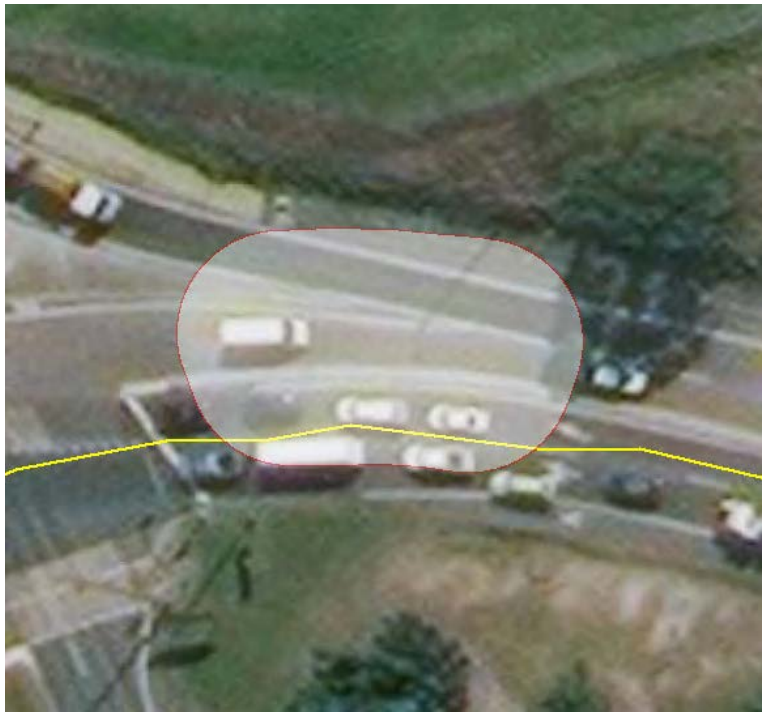
File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
George Street, Tighes Hill 	No native vegetation is mapped for the area (DPIE, 2012). Based on aerial imagery and street view, the site supports maintained lawns. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Industrial Drive, Mayfield West 	No native vegetation is mapped for the site (DPIE, 2012). Based on aerial imagery and street view, the site supports existing road hardstand and some grassed verges. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Hunter Expressway, adjacent to Buchanan Road, Buchanan	No native vegetation is mapped for the area (DPIE, 2012). Based on aerial imagery and street view, the site supports road hardstand and landscaped median. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr New England Highway and Golden Highway & Mitchell Line of Rd, Whittingham	No native vegetation is mapped for the area (DPIE, 2012). Based on aerial imagery and street view, the site supports existing road hardstand and grassed verges. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr of Golden Highway & Mitchell Line of Rd and Putty Road, Mount Thorley	No native vegetation is mapped for the site (DPIE, 2012). Based on aerial imagery and street view, site is within and adjacent to rail corridor. The site appears to support grassland with some regenerating woodland. No disturbance of vegetation is likely as the site is situated on a rail bridge and the extent of likely blade overhang will be elevated above the ground. No survey required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Mount Thorley Road exit lane, adjacent to Putty Highway, Mount Thorley	No native vegetation is mapped for the site (DPIE, 2012). Based on review of aerial imagery and street view, site is dominated by road hardstand and exotic grassland. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Golden Highway, Pagan and Pringle Streets, Jerry Plains	No native vegetation is mapped for the site (DPIE, 2012). Based on review of aerial imagery and street view, site is dominated by maintained road verges with scattered remnant native and exotic landscape trees. Survey required to confirm native trees within proposed clearing footprints, presence of habitat features and any requirements under the BAM.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Golden Highway and Denman Road, Denman	No native vegetation is mapped for the site (DPIE, 2012). Based on review of aerial imagery and street view, site is dominated by maintained road verges and pasture dominated by exotic grasses. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Denman Road and Bengalla Road, Muswellbrook	No native vegetation is mapped for the site (DPIE, 2012). However, review of aerial imagery and street view indicates potential presence of regenerating Eucalypt woodland immediately east of Bengalla Road. Other areas appear to be dominated by exotic grassland. Survey to confirm presence and extent of native vegetation within the works footprint.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Bengalla Road and Wybong Road, Castle Rock	No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site lacks woody vegetation and is dominated by grassed road verges. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Wybong Road and Kayuga Road, Muswellbrook	No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture and road hardstand. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Invermein Street and Stair Street, Kayuga	No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. Although some regenerating Eucalypts appear to be located on the northern periphery of proposed works. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Stair Street, Kayuga	No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. Although there are a couple of scattered regenerating Eucalypts on the north-western periphery of proposed works, adjacent to the carpark. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Stair Street and New England Highway, Aberdeen	No native vegetation is mapped for the site (DPIE, 2012). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr New England Highway and Lindsays Gap Road, Wallabadah	No native vegetation is mapped for the site (DPIE, 2015). Review of latest aerial imagery and street view indicates the site is dominated by exotic pasture. However some scattered Eucalypt trees are located on the periphery of proposed works. Survey not required.	Low

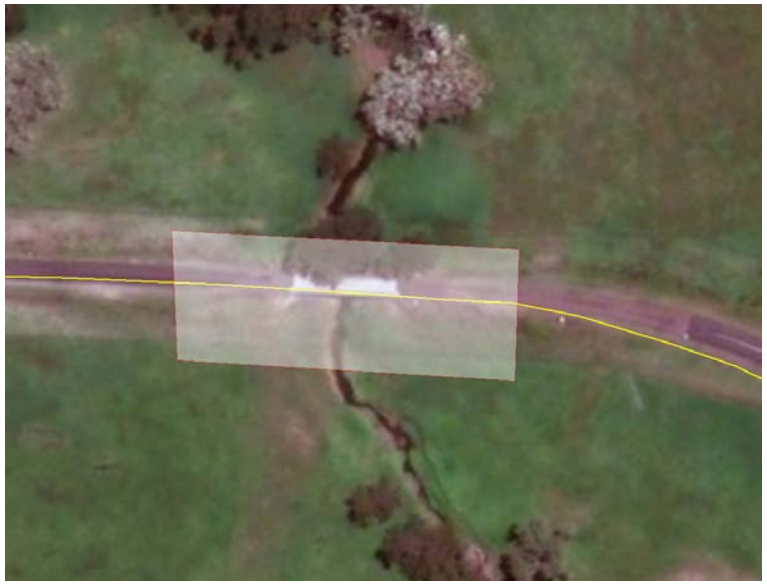
File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Goonoo Goonoo Creek crossing, Lindsay's Gap Road, Garoo	Review of DPIE (2015) indicates riparian vegetation is mapped as PCT 84- River Oak- Rough-barked Apple- Red Gum- Box riparian tall woodland (wetland of the Brigalow Belt South and Nandewar Bioregions. Review of the latest aerial imagery suggests the footprint largely lacks woody vegetation. Proposed works at the site are likely to include bridge upgrade or bypass. Survey of site required to confirm extent of native vegetation and potential habitat for threatened species within proposed footprint.	High

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Middlebrook Creek crossing, Lindsay's Gap Road, Garoo 	Review of DPIE (2015) indicates the presence of the following native vegetation communities within the proposed footprint: • PCT 84- River Oak- Rough-barked Apple- Red Gum- Box riparian tall woodland (wetland of the Brigalow Belt South and Nandewar Bioregions. • Candidate Native Grasslands Proposed works at the site are likely to include creek crossing upgrade. Survey of site required to confirm extent of native vegetation and potential habitat for threatened species within the works footprint.	High

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Lindsay's Gap Road and Nundle Road, Nundle	Review of DPIE (2015) indicates site supports Candidate Native Grasslands. Review of latest aerial imagery and street view indicates recent road works and a lack of native vegetation. Survey of footprint required to confirm extent of any native grasslands.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Oakenville Street, Herron Street, Innes Street and Jenkins Street, Nundle 	No native vegetation is mapped for the site (DPIE, 2015). Based on the review of aerial imagery and street view, lands within the works footprint is dominated by maintained road verges with scattered remnant native and exotic landscape trees. Site survey is recommended to confirm native trees, presence of habitat features and any requirements under the BAM.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Gill Street and Point Street, Nundle	No native vegetation is mapped for the site (DPIE, 2015). Review of latest aerial imagery and Streetview indicates the footprint is dominated by maintained road verges with some scattered landscape shrubs. Survey not required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr River Road and Happy Valley Road, Nundle	No native vegetation is mapped for the site (DPIE, 2015). Review of latest aerial imagery and Streetview indicates site supports grasslands with scattered Eucalypt regen. Site survey recommended to confirm presence and extent of native vegetation in works footprint.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Oakenvill Street and Old Hanging Rock Road, Nundle	Review of DPIE (2015) indicates riparian vegetation is mapped as PCT 84- River Oak- Rough-barked Apple- Red Gum- Box riparian tall woodland (wetland of the Brigalow Belt South and Nandewar Bioregions. Review of aerial imagery and Streetview indicates the site is dominated by exotic pasture with some scattered Eucalypt and Casuarina spp. trees. Survey recommended to confirm extent of vegetation.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr of Happy Valley Road and Old Hanging Rock Road, Nundle	Review of DPIE (2015) indicates presence of candidate native grasslands. Based on review of latest aerial imagery and Streetview lands immediately adjacent to the road appear to support exotic grasses and forbs. Although some regenerating Eucalypts are observed and native grasses may still be present in areas further from the road. Survey recommended to confirm the extent of native vegetation.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Hanging Rock State Forest, Barry Road, Nundle	Review of DPIE (2015) indicates the following native vegetation communities are present within the proposed works footprint: • PCT 492- Silvertop Stringybark – Yellow Box- Apple Box- Rough-barked Apple shrub grass open forest mainly on southern lopes of the Liverpool Range, Brigalow Belt South Bioregion • PCT526- Mountain Gum- Messmate- Broad-leaved Stringybark open forest on granitic soils of the New England Tablelands Bioregion • PCT 541- Silvertop Stringybark- Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tablelands and NSW North Coast Bioregion • PCT 563- White-box- Silvertop Stringybark ± White Cypress Pine grass shrub open forest of the southern Nandewar Bioregion and New England Tablelands Bioregion • PCT 486- River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range • Candidate Native Grasslands Survey of works footprints required to confirm native vegetation communities and map extent including any important habitat features.	High

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Morrisons Gap Road, Nundle 	Review of DPIE (2015) indicates the following native vegetation communities are present within the proposed works footprint: • PCT 494- Snow Gum- Mountain Gum- Silver Wattle tall open forest of the Liverpool Range, Brigalow belt South Bioregion • PCT1194- Snow Gum- Mountain Gum- Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tablelands Bioregion • PCT526- Mountain Gum- Messmate- Broad-leaved Stringybark open forest on granitic soils of the New England Tablelands Bioregion • Candidate Native Grasslands Survey of works footprints required to confirm native vegetation communities and map extent including any important habitat features.	High

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Crawney Road and Head of Peel Road, Nundle	Review of DPIE (2015) and latest aerial imagery indicates native vegetation is limited to scattered Eucalypt trees.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Tributary of the Peel River, Head of Peel Road, Nundle- heading south 	Review of DPIE (2015) indicates the site may support Candidate Native Grasslands with adjacent PCT 599- Blakely's Red Gum- Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion. Review of aerial imagery suggests works will not impact woody vegetation. Survey of site recommended to confirm extent of native vegetation communities relative to the works footprint.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Tributaries of the Peel River, Head of Peel Road, Nundle- heading south	Review of DPIE (2015) indicates the site may support Candidate Native Grasslands. Survey of works footprint recommended to confirm extent of native grasslands and habitat for threatened species where relevant.	Moderate.

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Tributary of the Peel River, Head of Peel Road, Nundle- heading south 	Review of DPIE (2015) indicates the site may support Candidate Native Grasslands. Survey of works footprint recommended to confirm extent of native grasslands and habitat for threatened species where relevant.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Wardens Brook, Head of Peel Road, Nundle- heading south	Review of DPIE (2015) indicates the site may support Candidate Native Grasslands. Survey of works footprint recommended to confirm extent of native grasslands and habitat for threatened species where relevant.	Moderate

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Peel River, Head of Peel River, Nundle- heading south	Review of DPIE (2015) indicates the site supports PCT 486- River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range and Candidate Native Grasslands. Survey of works footprint recommended to confirm extent of native vegetation communities.	High
Alternative route to Nundle via Tamworth		

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Goonoo Goonoo Rd/ New England Highway and Wilburtree Street, South Tamworth	Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only. No survey required.	Low

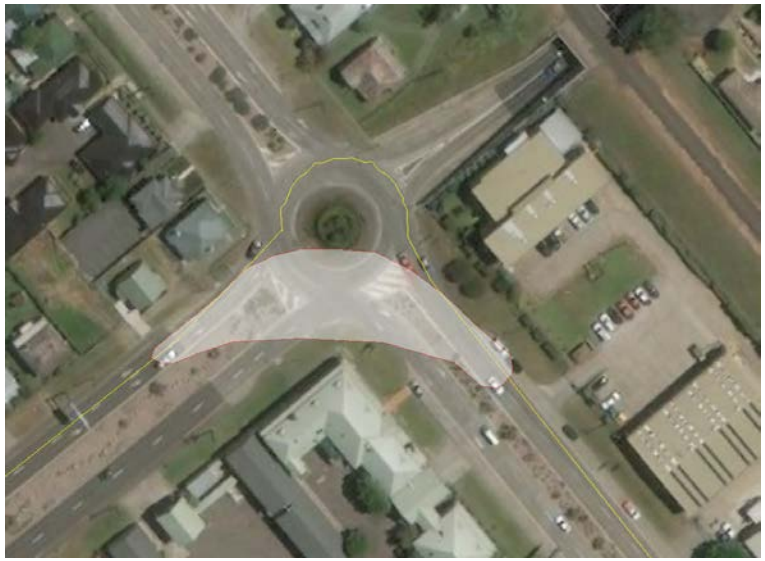
File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Goonoo Goonoo Rd/ New England Highway and Vera Street, South Tamworth	Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only. No survey required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Scott Rd/ New England Highway and Marius Street/ New England Highway, Tamworth 	Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only. No survey required.	Low

File Note

273023-00 25 August 2020

Location	Assessment Results	Risk Rating
Cnr Nundle Road and Ogunbil Road, Dungowan	Review of DPIE (2015) indicates the site is dominated by non-native vegetation. Based on a review of aerial imagery the works footprint includes disturbed road hardstand and verges only. No survey required.	Low

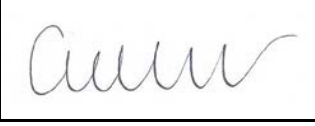
4 Summary

Based on the assessment, 19 sites were identified as having a low risk of biodiversity impacts and do not require further field survey. A total of 12 sites were identified as moderate risk and five sites as high risk. Further survey of these sites is recommended to confirm the presence and extent of any native vegetation communities and habitat for threatened species.

File Note

273023-00 25 August 2020

DOCUMENT CHECKING (not mandatory for File Note)

	Prepared by	Checked by	Approved by
Name	Chani Wheeler	Matt Davis	Matt Davis
Signature			

Appendix B Detailed PCT descriptions

PCT 433 - White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: Western Slopes Grassy Woodlands

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 0.02 hectares

No. BAM plots: 0

Characteristic species (NSW BioNet):

- Canopy: *Eucalyptus albens, Acacia pendula, Brachychiton populneus* subsp. *populneus,*
- Shrub: *Sclerolaena birchii, Sclerolaena muricata* var. *muricata, Acacia implexa,*
- Ground: *Austrostipa aristiglumis, Mentha satureioides, Boerhavia dominii, Austrostipa bigeniculata, Chloris ventricosa, Plantago debilis, Elymus scaber* var. *scaber, Rumex brownii, Chamaesyce drummondii, Oxalis perennans, Euchiton sphaericus, Bothriochloa decipiens, Bothriochloa macra, Desmodium varians, Aristida leptopoda, Wahlenbergia communis, Rhynchosia minima, Vittadinia pterochaeta, Vittadinia muelleri, Einadia nutans* subsp. *nutans.*

Justification of PCT: PCT commonly mapped in the locality (DPIE 2019, DPIE 2015) and noted as present with *Eucalyptus albens* scattered along the western end of the transmission line.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
434	White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion	• Similar PCT however it BioNet notes it does not occur in any of the IBRA sub-regions relevant to the project. PCT 433 is the better fit based on the low condition of vegetation considered to potentially represent PCT 434 along the transmission line.
496	Yellow Box - White Box - Silvertop Stringybark - Blakely's Red Gum grass shrub woodland mainly on the Liverpool Range, Brigalow Belt South Bioregion	• Additional characteristic canopy species not recorded • Mid-dense shrub layer not recorded • Not present on northern aspects of Liverpool Range
589	White Box - White Cypress Pine - Silver-leaved Ironbark grassy woodland on mainly clay loam soils on hills mainly in the Nandewar Bioregion	• Additional characteristic canopy species not recorded • Shrub layer floristics not well matched
590	White Box grassy woodland on the Inverell basalts mainly in the Nandewar Bioregion	• Soils not characteristic of the study area
599	Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion	• Additional characteristic canopy species not recorded • Shrub layer floristics not well matched
1383	White Box grassy woodland of the Nandewar Bioregion and Brigalow Belt South Bioregion	• Incorrect landscape position

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PCT 486 - River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range

Vegetation formation: Forested Wetlands

Vegetation class: Eastern Riverine Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 2.12 hectares

No. BAM plots: 0

Characteristic species (NSW BioNet):

- Canopy: *Casuarina cunninghamiana subsp. cunninghamiana, Eucalyptus viminalis, Angophora floribunda, Ficus coronata, Ficus rubiginosa, Daphnandra sp. A, Eucalyptus saligna*.
- Shrub: *Melicytus dentatus, Pittosporum undulatum, Breynia oblongifolia, Clerodendrum tomentosum, Notelaea microcarpa var. microcarpa, Hymenosporum flavum, Claoxylon australe*.
- Ground: *Bothriochloa macra, Microlaena stipoides var. stipoides, Urtica incisa, Elymus scaber var. scaber, Austrocynoglossum latifolium, Adiantum aethiopicum, Nyssanthes diffusa, Doodia aspera, Echinopogon ovatus, Hypolepis glandulifera, Asplenium flabellifolium, Plectranthus parviflorus, Acaena novae-zelandiae, Solanum aviculare, Adiantum formosum, Pellaea falcata, Sigesbeckia orientalis* subsp*. orientalis, Adiantum hispidulum*

Justification of PCT: PCT commonly mapped in the locality (DPIE 2019, DPIE 2015) and noted as present with *Casuarina cunninghamiana* subsp. *cunninghamiana, Eucalyptus viminalis,* and *Angophora floribunda* occurring within and surrounding creeks and drainage lines surrounding the development footprint.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
84	River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South Bioregion and Nandewar Bioregion	• Additional characteristic canopy species not frequently recorded
1106	River Oak riparian woodland of the NSW North Coast Bioregion and northern Sydney Basin Bioregion	• Canopy and understorey vegetation not well matched
1761	River Oak - Rough-barked Apple grassy riparian forest of the Liverpool Plains	• Absent mid-stratum not representative of PCT within subject land

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PCT 490 - Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: New England Grassy Woodlands

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 1.84 hectares

No. BAM plots: 0

Characteristic species (NSW BioNet):

- Canopy: *Eucalyptus laevopinea, Eucalyptus nobilis, Eucalyptus dalrympleana* subsp. *heptantha, Acacia melanoxylon, Eucalyptus pauciflora, Eucalyptus stellulata, Eucalyptus melliodora, Eucalyptus bridgesiana.*
- Shrub: *Acacia dealbata, Hibbertia obtusifolia, Eustrephus latifolius, Smilax australis, Leucopogon lanceolatus var. lanceolatus, Bursaria spinosa* subsp. *spinosa, Hibbertia acicularis, Indigofera australis, Pittosporum undulatum, Daviesia genistifolia, Pimelea curviflora var. curviflora, Acrothamnus hookeri, Xanthorrhoea glauca* subsp. *glauca.*
- Ground *Poa sieberiana, Pteridium esculentum, Rubus parvifolius, Poranthera microphylla, Themeda australis, Glycine clandestina, Hydrocotyle laxiflora, Desmodium varians, Geranium solanderi var. solanderi, Viola betonicifolia, Lomandra longifolia, Hardenbergia violacea, Imperata cylindrica var. major, Gonocarpus tetragynus, Brachyscome nova-anglica.*

Justification of PCT: PCT commonly mapped in the locality (DPIE 2019, DPIE 2015) on high ridgelines and noted as present with *Eucalyptus laevopinea, Eucalyptus dalrympleana subsp. heptantha* and *Acacia melanoxylon,* in the overstorey and *Poa sieberiana*, *Pteridium esculentum* and *Lomandra longifolia* occurring in the ground layer over a ridgeline in the central portion of the transmission line footprint.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
492	Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion	• Additional characteristic canopy species less commonly recorded • Mid-dense shrub layer is not representative of PCT within subject land
567	Broad-leaved Stringybark - Yellow Box shrub/grass open forest of the New England Tableland Bioregion	• Additional characteristic canopy species less commonly recorded • Low hills landscape position is not representative of PCT within subject land
1171	Silvertop Stringybark grass/herb forest of the Brigalow Belt South and Nandewar Bioregion and western New England Tableland Bioregion	• Characteristic canopy and mid-storey species are not representative of PCT within subject land
1174	Silvertop Stringybark open forest of the New England Tableland Bioregion	• Characteristic canopy and mid-storey species are not representative of PCT within subject land
1683	Silvertop Stringybark - Tussock Grass grassy open forest of the Northern Tablelands escarpment and Barrington Tops	• Characteristic canopy and mid-storey species are not representative of PCT within subject land

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PCT 492 – Silvertop Stringybark – Yellow Box – Apple Box – Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: New England Grassy Woodlands

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 4.62 hectares

No. Bam plots: 6

Species recorded:

- Canopy: *Angophora floribunda, Eucalyptus laevopinea, Eucalyptus melliodora, Eucalyptus nobilis* subsp*. nobilis.*
- Shrub: *Acacia melanoxylon, Bursaria spinosa* subsp*. spinosa.*
- Ground: *Anthosachne scabra, Arthropodium milleflorum, Brachyscome macrocarpa, Cheilanthes sieberi, Dianella longifolia, Echinopogon ovatus, Geranium solanderi, Glycine clandestine, Vittadinia cuneate, Wahlenbergia stricta.*

Justification of PCT: Species characteristic of the PCT recorded in all strata with understorey moderately shrubby where found to occur in higher condition states. The PCT determined to be present on shallower soils derived from basalt on hills across the development footprint.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
488	Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, Brigalow Belt South Bioregion	• Sparse shrub layer not representative of PCT within subject land • Noted, in comparisons to PCT 492, as more grassy and occurring on the northern slopes of the Liverpool Range
496	Yellow Box - White Box - Silvertop Stringybark - Blakely's Red Gum grass shrub woodland mainly on the Liverpool Range, Brigalow Belt South Bioregion	• Canopy species assemblage not well matched to PCT within the subject land • Understorey species floristically poor match to PCT within the study area • Steep hillslopes with a northern aspect landscape position and is not representative
565	Silvertop Stringybark - Mountain Gum grassy open forest of the New England Tableland Bioregion	• Characteristic canopy and mid-storey species are not representative of PCT within subject land
1171	Silvertop Stringybark grass/herb forest of the Brigalow Belt South and Nandewar Bioregion and western New England Tableland Bioregion	• Characteristic canopy and mid-storey species are not representative of PCT within subject land
1174	Silvertop Stringybark open forest of the New England Tableland Bioregion	• Characteristic canopy and mid-storey species are not representative of PCT within subject land

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PCT 507 - Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: Tableland Clay Grassy Woodland

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed as vegetation not present within New England Tablelands IBRA Bioregion.

Extent within development footprint: 0.09 hectares

No. BAM plots: 1

Recorded species:

- Canopy: *Eucalyptus stellulata,*
- Shrubs: *Acacia melanoxylon,* Bursaria spinosa, Olearia microphylla,
- Ground: *Dichondra repens*, *Desmodium gunnii*, Poa sieberiana var. sieberiana, *Lobelia purpurascens, Einadia trigonos, Geranium potentilloides, Hardenbergia violace, Smilax australis.*

Justification of PCT: PCT was found to support a common occurrence of *Eucalyptus stellulata* within the canopy with and understorey of native shrubs and groundcovers. The PCT was found to represent an open forest with a mid-dense crown cover, at high elevation undulating plateaux, on basalt-derived heavy soils.

Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	**PCT name**	
498	Black Sallee plateau low woodland in the southern Brigalow Belt South Bioregion	• Very dense shrub layer not representative of PCT within the subject land

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
		• PCT occurs on organic loamy clay soils or peaty soils on the edges of swamps or valleys on high plateaux, which is not representative of PCT within the subject land
681	Black Sallee grassy woodland of the New England Tableland Bioregion	• PCT occurs on lower slopes, drainage lines and valley flats, often occurs in frost hollow sites, which is not representative of PCT within the subject land
1188	Snow Gum - Black Sallee grassy woodland of the New England Tableland Bioregion	• Assemblage of characteristic canopy species is not representative of PCT within subject land • Understorey species floristically poor match to PCT within the study area
1689	Black Sallee grassy woodland of the Barrington plateau	• This community is confined to Barrington Top NP

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PCT 526 - Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrub/grass sub-formation)

Vegetation class: New England Dry Sclerophyll Forests

Conservation status:

- EPBC Act: not listed
- BC Act: Not listed

Extent within development footprint: 1.12 hectares

No. BAM plots: 0

Characteristic species (NSW BioNet):

- Canopy: *Eucalyptus nobilis, Eucalyptus caliginosa, Eucalyptus obliqua, Eucalyptus campanulata, Eucalyptus radiata* subsp*. sejuncta.*
- Shrub: *Acacia filicifolia, Banksia integrifolia* subsp*. monticola, Leucopogon lanceolatus var. lanceolatus, Persoonia cornifolia, Monotoca scoparia, Acacia falciformis, Bursaria spinosa subsp. spinosa, Lomatia silaifolia.*
- Ground: *Poa sieberiana, Pteridium esculentum, Rubus parvifolius, Poranthera microphylla, Themeda australis, Glycine clandestina, Hydrocotyle laxiflora, Desmodium varians, Geranium solanderi var. solanderi, Viola betonicifolia, Lomandra longifolia, Hardenbergia violacea, Imperata cylindrica var. major, Gonocarpus tetragynus, Brachyscome nova-anglica.*

Justification of PCT: PCT commonly mapped in the locality (DPIE 2019, DPIE 2015) on mid to high hills and ridgelines, and noted as present with *Eucalyptus obliqua, Banksia integrifolia* subsp*. monticola, Poa sieberiana,* and *Pteridium esculentum* occurring commonly throughout. Occurs as a dry sclerophyll forest within the subject land, with other PCTs with similar characteristic camopy species repreenting wet sclerophyll forests.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
738	Broad-leaved Stringybark - Mountain Ribbon Gum - Messmate open forest of the NSW North Coast Bioregion and New England Tableland Bioregion	• Occurs mainly on the eastern parts of the New England Tablelands
934	Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion	• A wet sclerophyll forest with characteristic understorey species a poor match to the PCT within the subject land
954	Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion	• Similar PCT but representative of a wet sclerophyll forest
1574	Messmate grassy tall open forest on Barrington and Northern Tablelands escarpment	• Similar PCT but representative of a wet sclerophyll forest
1575	Messmate - Forest Ribbon Gum - New England Blackbutt shrub - grass tall open forest of Barrington Tops and Northern Tablelands escarpment	• Similar PCT but representative of a wet sclerophyll forest

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PCT 540 - Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrub/grass formation)

Vegetation class: New England Dry Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 40.63 hectares

No. BAM plots: 9

Recorded species:

- Canopy: *Eucalyptus laevopinea, Eucalyptus viminallis, Angophora floribunda*
- Shrub: *Bursaria spinosa,* Cassinia laevis.
- Ground: *Ajuga australis, Aristida ramos, Arthropodium milleflorum, Carex inversa, Brachyscome spathulata, Cheilanthes sieberi* subsp. *sieberi, Cymbopogon refractus, Dianella longifolia, Dichondra repens, Echinopogon mckiei, Glycine microphylla, Lomandra confertifolia, Rytidosperma penicillatum, Poa sieberiana.*

Justification of PCT: PCT commonly recorded on mid to high hills below the ridgeline, generally with a north-facing aspect. *Eucalyptus laevopinea* is dominant in the canopy with *Eucalyptus viminallis,* and *Angophora floribunda* sub-dominant. Understorey vegetation was found to be generally open, with native species most common and diverse in the ground layer.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
493	Forest Oak - Rough-barked Apple - Silvertop Stringybark shrub grass open forest on protected slopes of the Liverpool Range	• PCT dominated by Forest Oak which was only occasionally recorded within the PCT within the subject land • Notes as a very restricted community where Forest Oak dominates forests
541	Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	• *Eucalyptus nortonii* more common in PCT 541, with *Eucalyptus viminalis* more common in PCT 540 • Understorey cover was generally found to be more dense in PCT 41, with tree cover higher in PCT 540
542	Stringybark - Rough-barked Apple - cypress pine shrubby open forest of the eastern Nandewar Bioregion and western New England Tableland Bioregion	• Cypress Pine not recorded within the subject land • PCT geographical extent does not is not representative of the subject land
565	Silvertop Stringybark - Mountain Gum grassy open forest of the New England Tableland Bioregion	• Mountain Gum not recorded within the PCT within the subject land • PCT usually supports a sparse to mid-dense shrub/small tree layer, not representative of the PCT within the subject land
1164	Silvertop Stringybark - Mountain Ribbon Gum open forest of the New England Tableland Bioregion	• Characteristic canopy species are not representative of the PCT within the subject land
1223	Stringybark shrubby open forest of the north east parts of the New England Tableland Bioregion	• Restricted to the far north-east part of the tablelands, for example Boonoo National Park and Basket Swamp Nature Reserve
1396	Rough-barked Apple - Silvertop Stringybark - Ribbon Gum shrub/grass open forest on hills of the southern Nandewar Bioregion	• Characteristic canopy species are not representative of the PCT within the subject land

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PCT 541 - Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion

Vegetation formation: Dry Sclerophyll Forests (Shrub/grass formation)

Vegetation class: New England Dry Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 11.37 hectares

No. BAM plots: 8

Recorded species:

- Canopy: *Angophora floribunda, Eucalyptus blakelyi, Eucalyptus laevopinea, Eucalyptus nortonii*
- Shrub: *Acacia implexa, Cassinia laevis, Melicytus dentatus, Solanum aviculare*
- Ground: *Crassula sieberiana, Dichondra repens, Echinopogon mckiei, Einadia nutans, Einadia trigonos, Eustrephus latifolius, Galium aparine Geranium solanderi var. solanderi, Glycine microphylla, Microlaena stipoides, Mentha diemenica, Rytidosperma leave.*

Justification of PCT: PCT commonly recorded as a mosaic with PCT 540 on mid to high hills below the ridgeline, generally with a north-facing aspect. *Eucalyptus laevopinea* is dominant in the canopy with *Eucalyptus nortonii,* and *Angophora floribunda* sub-dominant. Understory is grassy with shrub cover generally found to be quite low.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
493	Forest Oak - Rough-barked Apple - Silvertop Stringybark shrub grass open forest on protected slopes of the Liverpool Range	• PCT dominated by Forest Oak which was only occasionally recorded within the PCT within the subject land • Notes as a very restricted community where Forest Oak dominates forests
540	Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion	• *Eucalyptus nortonii* more common in PCT 541, with *Eucalyptus viminalis* more common in PCT 540 • Understorey cover was generally found to be more dense in PCT 541, with tree cover higher in PCT 540
542	Stringybark - Rough-barked Apple - cypress pine shrubby open forest of the eastern Nandewar Bioregion and western New England Tableland Bioregion	• Cypress Pine not recorded within the subject land • PCT geographical extent does not is not representative of the subject land
565	Silvertop Stringybark - Mountain Gum grassy open forest of the New England Tableland Bioregion	• Mountain Gum not recorded within the PCT within the subject land • PCT usually supports a sparse to mid-dense shrub/small tree layer, not representative of the PCT within the subject land
1164	Silvertop Stringybark - Mountain Ribbon Gum open forest of the New England Tableland Bioregion	• Characteristic canopy species are not representative of the PCT within the subject land
1223	Stringybark shrubby open forest of the north east parts of the New England Tableland Bioregion	• Restricted to the far north-east part of the tablelands, for example Boonoo National Park and Basket Swamp Nature Reserve
1396	Rough-barked Apple - Silvertop Stringybark - Ribbon Gum shrub/grass open forest on hills of the southern Nandewar Bioregion	• Characteristic canopy species are not representative of the PCT within the subject land

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PCT 586 - Snow Grass - Swamp Foxtail tussock grassland sedgeland of cold air drainage valleys of the New England Tableland Bioregion

Vegetation formation: Grasslands

Vegetation class: Temperate Montane Grasslands

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 2.56 hectares

No BAM plots: 3

Recorded species:

- Canopy: n/a
- Shrub: n/a
- Ground: *Pennisetum alopecuroides, Poa sieberiana, Carex inversa, Rumex brownii, Persicaria decipiens, Haloragis heterophylla, Juncus subsecundus*

Justification of PCT: PCT was found to occur as a grassland / sedgeland / swamp meadow dominated by *Pennisetum alopecuroides* and *Poa sieberiana*. PCT was found to occur along flats, bwteen slpopes, at mid elevation along the transverse track section of the development footprint.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
497	Tea tree shrubland / sedgeland / forbland swamp wetland on the Liverpool Range, mainly Brigalow Belt South Bioregion	• PCT represents a tall shrubland over a low forbland or sedgeland wetland, which is not representative of the PCT within the subject land
569	Derived Snow Grass +/- Kangaroo Grass +/- Wild Sorghum tussock grassland of the NSW Northern Tablelands	• A broadly defined community covering high altitude derived snow grass pastures, is not representative of the PCT within the subject land

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PCT 599 - Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion

Vegetation formation: Grassy Woodlands

Vegetation class: Western Slopes Grassy Woodlands

Conservation status:

- EPBC Act: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
- BC Act: White Box Yellow Box Blakely's Red Gum Woodland

Extent within development footprint: 1.43 hectares

No BAM plot: 0

Characteristic species (NSW BioNet):

- Canopy: *Eucalyptus blakelyi, Eucalyptus melliodora, Angophora floribunda, Eucalyptus albens, Eucalyptus melanophloia, Brachychiton populneus* subsp*. populneus, Eucalyptus conica, Callitris glaucophylla,*
- Shrub: *Acacia implexa, Geijera parviflora, Acacia decora, Myoporum montanum, Olearia elliptica* subsp*. elliptica, Pimelea neo-anglica, Maireana microphylla, Hibbertia riparia, Pimelea curviflora var. curviflora, Notelaea microcarpa, Acacia deanei* subsp*. deanei,*
- Ground: *Aristida personata, Glycine tabacina, Carex inversa, Themeda triandra, Cyperus gracilis, Austrostipa verticillata, Bothriochloa macra, Microlaena stipoides var. stipoides, Aristida ramosa, Geranium solanderi var. solanderi, Hydrocotyle laxiflora, Ajuga australis, Dichelachne micrantha, Lomandra longifolia, Lomandra filiformis* subsp*. coriacea, Desmodium brachypodum.*

Justification of PCT: PCT commonly mapped in the locality (DPIE 2019, DPIE 2015) with *Eucalyptus albens, Eucalyptus blakelyi, Eucalyptus melliodora, Angophora floribunda* commonly noted as the dominant species in the canopy, *Acacia implexa* and *Notelaea macrocarpa* dominant in the generally sparse midstorey, with *Themeda triandra, Microlaena stipoides* var. *stipoides, Dichelachne micrantha* and *Lomandra filiformis* subsp. *coriacea* dominating parts of the ground layer.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	**PCT name**	
510	Blakely's Red Gum - Yellow Box grassy woodland of the New England Tableland Bioregion	• PCT noted as similar to PCT 599, however the locality is noted as surrounding the Mt Kaputar, Hotron and Inverell areas.
704	Blakely's Red Gum - Yellow Box grassy open forest or woodland of the New England Tableland Bioregion	• Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
1329	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion	• Landscape position of fertile loamy-clay soils on slopes, drainage lines and alluvial plains is not repetitive of the PCT within the subject land • Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
1332	Yellow Box - Grey Box - Red Gum woodland of the central eastern parts of the New England Tableland Bioregion	• PCT locality noted as east of Armidale

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PCT 931 - Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: Northern Escarpment Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 3.21 hectares

No. BAM plots: 5

Recorded species:

- Canopy: *Eucalyptus obliqua*, *Eucalyptus dalrympleana* subsp. *heptantha, Eucalyptus viminalis*, *Acacia melanoxylon*
- Shrub: *Lomatia arborescens, Melicytus dentatus,*
- Ground: *Calochlaena dubia, Cotula australis, Dichondra repens, Geranium potentilloides, Lobelia concolo, Microlaena stipoides, Poa sieberiana var. sieberiana, Pteridium esculentum, Solanum prinophyllum*

Justification of PCT: PCT commonly recorded on high hills, on or just below the ridgeline moving down into deep gullies, generally with a south-facing aspect. *Eucalyptus obliqua* is dominant in the canopy with *Eucalyptus dalrympleana subsp. heptantha,* and *Acacia melanoxylon* sub-dominant. Understorey vegetation was found to be generally dense and closed (compared to the similar PCT934) where the PCT occurred in high condition, with native species common and diverse in the understorey.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	**PCT name**	
934	Messmate open forest of the tableland edge of the NSW North Coast Bioregionand New England Tableland Bioregion	• *Eucalyptus nobillis* more common in PCT 934, with *Eucalyptus dalrympleana* more common in PCT 931 • Understorey cover was generally found to be more dense in PCT 934, however tree cover was more sparse, when compared to PCT 931
935	Messmate tall moist open forest of the escarpment ranges, southern New England Tableland Bioregion and NSW North Coast Bioregion	• Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
954	Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion	• Characteristic canopy species assemblage are representative of the PCT within the subject land
1555	Mountain Gum - Messmate - Snow Gum grassy open forest of the New England Tablelands	• PCT noted as Open forests with a canopy dominated by *Eucalyptus dalrympleana* which is not representative of the PCT within the subject land
1574	Messmate grassy tall open forest on Barrington and Northern Tablelands escarpment	• Characteristic canopy species assemblage are representative of the PCT within the subject land

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PCT 934 - Messmate open forest of the tableland edge of the NSW North Coast Bioregion and New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Shrubby sub-formation)

Vegetation class: Northern Escarpment Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 22.82 hectares

No. BAM plots: 4

Recorded species:

- Canopy: *Eucalyptus obliqua, Eucalyptus nobilis, Eucalyptus pauciflora*.
- Shrub: *Dicksonia antarctica,* Coprosma quadrifida, Daviesia ulicifolia, Melicytus dentatus
- Ground: *Smilax australis, Asperula conferta, Desmodium varians, Dichondra repens, Ehrharta calycina, Einadia trigonos Galium gaudichaudii, Glycine microphylla, Glycine tabacina, Gonocarpus teucrioides, Hydrocotyle laxiflora, Microlaena stipoides, Oxalis perennans, Plantago debilis, Poa labillardierei, Poa sieberiana var. sieberiana, Pseuderanthemum variabile, Pteridium esculentum, Rytidosperma carphoides, Rytidosperma laeve, Urtica incisa, Veronica plebeian, Viola betonicifolia, Wahlenbergia gracilis.*

Justification of PCT: PCT commonly recorded on high hills, on or just below the ridgeline generally with a south-facing aspect. *Eucalyptus obliqua* is dominant in the canopy with *Eucalyptus nobilis* and *Eucalyptus pauciflora* sub-dominant. Understorey vegetation was found to be generally more open (compared to the similar PCT931) where the PCT occurred in high condition, with native species common and diverse in the understroey. A large area of this PCT occurs as a derived native grassland/shrubland in the central portion of the development footprint following historical clearing and ongoing low intensity farms landuse.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
931	Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion	• *Eucalyptus nobillis* more common in PCT 934, with *Eucalyptus dalrympleana* more common in PCT 931 • Understorey cover was generally found to be more dense in PCT 934, however tree cover was more sparse, when compared to PCT 931
935	Messmate tall moist open forest of the escarpment ranges, southern New England Tableland Bioregion and NSW North Coast Bioregion	• Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
954	Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion	• Characteristic canopy and understorey species assemblages are representative of the PCT within the subject land
1555	Mountain Gum - Messmate - Snow Gum grassy open forest of the New England Tablelands	• PCT noted as Open forests with a canopy dominated by *Eucalyptus dalrympleana* which is not representative of the PCT within the subject land
1574	Messmate grassy tall open forest on Barrington and Northern Tablelands escarpment	• Characteristic canopy species and ground-layer assemblages are representative of the PCT within the subject land

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PCT 954 - Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Grassy sub-formation)

Vegetation class: Northern Escarpment Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 1.23 hectares

No. BAM plots: 0

Characteristic species (NSW BioNet):

- Canopy: *Eucalyptus nobilis, Eucalyptus obliqua, Eucalyptus campanulata, Eucalyptus viminalis.*
- Shrub: *Acacia falciformis, Acacia melanoxylon, Banksia integrifolia* subsp. *monticola, Bursaria spinosa* subsp. *spinosa, Leucopogon lanceolatus, Podolobium ilicifolium, Rubus parvifolius.*
- Ground: *Acaena novae-zelandiae, Desmodium varians, Dichondra repens, Galium propinquum, Geranium potentilloides, Glycine clandestina, Gonocarpus teucrioides, Hibbertia scandens, Lomandra longifolia, Poa sieberiana var. sieberiana, Pteridium esculentum, Themeda australis, Wahlenbergia stricta, Viola betonicifolia, Viola hederacea.*

Justification of PCT: PCT present on upper slopes with a northern aspect in the western portion of the wind farm corridor. Species present include *Eucalyptus obliqua* and *Eucalyptus nobilis*.

Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	**PCT name**	
931	Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion	• Characteristic canopy and understorey species assemblages are representative of the PCT within the subject land
934	Messmate open forest of the tableland edge of the NSW North Coast Bioregionand New England Tableland Bioregion	• Characteristic canopy and understorey species assemblages are representative of the PCT within the subject land
954	Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion	• Characteristic canopy and understorey species assemblages are representative of the PCT within the subject land
1555	Mountain Gum - Messmate - Snow Gum grassy open forest of the New England Tablelands	• PCT noted as Open forests with a canopy dominated by *Eucalyptus dalrympleana* which is not representative of the PCT within the subject land
1574	Messmate grassy tall open forest on Barrington and Northern Tablelands escarpment	• Characteristic canopy species and ground-layer assemblages are representative of the PCT within the subject land

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PCT 1194 - Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion

Vegetation formation: Wet Sclerophyll Forests (Grassy sub-formation)

Vegetation class: Northern Tableland Wet Sclerophyll Forests

Conservation status:

- EPBC Act: Not listed
- BC Act: Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (when present within the New England Tablelands IBRA Bioregion)

Extent within development footprint: 39.29 hectares

No. BAM plots: 14

Recorded species:

- Canopy: *Eucalyptus viminalis, Eucalyptus pauciflora, Eucalyptus nobilis*
- Shrub: *Acacia melanoxylon, Melicytus dentatus, Lomatia arborescens, Bursaria spinosa*
- Ground: *Anthoxanthum odoratum, Asperula conferta, Dichondra repens, Geranium homeanum, Hybanthus monopetalus, Microlaena stipoides, Poa sieberiana, Pteridium esculentum, Veronica plebeia, Stellaria pungens, Urtica incisa, Lomandra longifolia*

Justification of PCT: The PCT was found to commonly occur on slopes and plateaux at high elevation with the canopy a co-dominant mix of *Eucalyptus viminalis, Eucalyptus pauciflora*, and *Eucalyptus nobilis*. The understorey was found to be generally open and grassy with the ground layer supporting the highest diversity in native species recorded.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
525	Mountain Gum - Snow Gum grassy open forest at high altitudes in the Kaputar area of the Nandewar Bioregion	• PCT noted as occurring on clay loam soil derived from basalt or trachyte substrate at high altitudes on plateau in a mountain landform pattern in Mount Kaputar National Park in the Nandewar Bioregion.
554	Ribbon Gum - Mountain Gum - Snow Gum grassy open forest or woodland of the New England Tableland Bioregion	• PCT description notes Guyra Plateau almost 200km north of the subject land. • Description notes the shrub layer is absent to very sparse which is not representative of the PCT within the subject land. • Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
1104	Ribbon Gum - Mountain Gum - Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	• PCT described as a grassy forest/woodland, and part of the Grassy Woodland vegetation formation. This is not representative of the PCT within the subject land which supports a shrubbier and fernier understorey. • Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
1198	Snow Gum - New England Peppermint grassy open forest of the New England Tableland Bioregion	• PCT noted as occurring mainly on sandstone geologies not representative of the subject land. • Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land

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PCT 1604 - Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter

Vegetation formation: Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

Conservation status:

- EPBC Act: Not listed
- BC Act: Not listed

Extent within development footprint: 0.02 hectares

No BAM plots: 0

Characteristic species (NSW BioNet):

- Canopy: *Eucalyptus crebra, Eucalyptus moluccana, Corymbia maculata.*
- Shrub: *Bursaria spinosa, Olearia elliptica.*
- Ground: *Eremophila debilis, Cymbopogon refractus, Aristida ramosa, Aristida vagans, Microlaena stipoides, Austrodanthonia fulva, Cheilanthes sieberi, Lomandra multiflora, Brunoniella australis.*

Justification of PCT: PCT was found to occur on the road verge along the transport haul route as scattered occurrences of *Corymbia maculata Eucalyptus moluccana* and *Eucalyptus crebra*, over a generally disturbed understorey in low condition.

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
623	Narrow-leaved Ironbark +/- Grey Box grassy woodland of the upper Hunter Valley, mainly Sydney Basin Bioregion	• PCT noted as occurring on hillcrests and upper hillslopes, not representative of the PCTs occurrence within the subject land. • Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	• PCT was found to be grassier and less shrubby than areas of PCT 1604 within the subject land

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PCT 1691 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter

Vegetation formation: Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

Conservation status:

- EPBC Act: Central Hunter Valley eucalypt forest and woodland
- BC Act: Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions

Extent within development footprint: 0.04 hectares

No. Bam plots: 0

Characteristic species (NSW BioNet:

- Canopy: *Eucalyptus crebra, Eucalyptus moluccana, Brachychiton populneus.*
- Shrub: *Notelaea macrocarpa.*
- Ground: *Eremophila debilis, Aristida ramosa, Cymbopogon refractus, Chloris ventricosa, Calotis lappulacea, Dichondra repens, Eragrostis leptostachya, Microlaena stipoides, Austrostipa verticillata.*

Justification of PCT: PCT was found to occur on the road verge along the transport haul route, with impacts only to occur to a highly degraded edge of the PCT, too disturbed to meet the listing requirements as a BC Act or EPB Act TEC. The PCT occurs as scattered occurrences of *Eucalyptus crebra* and *Eucalyptus tereticornis*, over a grassy understorey in low to moderate condition to the north and away from the road verge**.**

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Similar PCTs		Justification of best fit (BioNet PCT data)
PCT ID	PCT name	
623	Narrow-leaved Ironbark +/- Grey Box grassy woodland of the upper Hunter Valley, mainly Sydney Basin Bioregion	• PCT noted as occurring on hillcrests and upper hillslopes, not representative of the PCTs occurrence within the subject land. • Characteristic canopy and shrub species assemblages are representative of the PCT within the subject land
1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter	• PCT was found to be shrubbier and less grassy than areas of PCT 1691 within the subject land

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Appendix C Threatened species habitat suitability assessment

Table 96 Consideration of species requiring further assessment

BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
Species name	Common name	Credit class	Species geographic constraints	Species associated with site PCT?	Native vegetation cover required	Required patch size	Requires further assessment	Habitat constraints	Suitable habitat	Habitat assessment	Likelihood of occurrence
Frogs											
Litoria booroolongensis	Booroolong Frog	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Live along permanent streams with some fringing vegetation cover such as ferns, sedges, or grasses. ;1|Adults occur on or near cobble banks and other rock structures within stream margins.;2|Shelter under rocks or amongst vegetation near the ground on the stream edge.;3|Sometimes bask in the sun on exposed rocks near flowing water during summer.;4|Breeding occurs in spring and early summer and tadpoles metamorphose in late summer to early autumn.;5|Eggs are laid in	Marginal habitat supported by a number of minor waterbodies within the subject land. Low quality potential habitat present where transmission line corridor crosses Wombramurra Creek	Moderate

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools.;6|		
Litoria daviesae	Davies' Tree Frog	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Other; Streams or swamps or within 250 m of waterbodies	Davies' Tree Frog occurs in permanent, slow-flowing small streams above 400 m elevation, mostly in the headwaters of eastern-flowing streams (although it does occur in the headwaters of the western-flowing Peel River).;1|On the tablelands, riparian habitat may be montane heath or dry open forest with fringing tea tree, tussocks and ferns. Escarpment habitat is typically rainforest and wet sclerophyll with a rainforest understorey.;2|Breeding occurs in spring and early summer. Daytime calling is common during the breeding season. At night, males can be found calling from perched positions on trees and shrubs 0.5 - 1.5	Marginal habitat supported by a number of minor waterbodies within the subject land. Habitats degraded on transmission line corridor	Moderate

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									m above streams.;3|The species has rarely been observed away from the riparian zone, implying a reliance on that zone for breeding and foraging. However, nothing is known of habitat use outside the breeding season.;4|		
Litoria subglandulosa	Glandular Frog	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Glandular Frogs may be found along streams in rainforest, moist and dry eucalypt forest or in subalpine swamps.;1|Breeding occurs in summer, and possibly in spring.;2|	Marginal habitat supported by a number of minor waterbodies within the subject land. Habitats degraded on transmission line corridor. Species records associated with large areas on intact vegetation to the east of the project site, with no records within 100kms of the project site.	Low
Mixophyes balbus	Stuttering Frog	Species		Yes	Variegated - 31-	5 - 24 ha	Yes		Found in rainforest and	Marginal habitat	Low

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
					70% habitat retained				wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.;1|Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor.;2|Feed on insects and smaller frogs.;3|Breed in streams during summer after heavy rain.;4|Eggs are laid on rock shelves or shallow riffles in small, flowing streams.;5|As the tadpoles grow they move to deep permanent pools and take approximately 12 months to metamorphose.;6|	supported by a number of minor waterbodies within the subject land. Habitats degraded on transmission line corridor. Species records associated with large areas on intact vegetation to the east of the project site, with no records within 100kms of the project site.	
Philoria sphagnicolus	Sphagnum Frog	Species	No	Yes	Intact (> 70% natural habitat retained)	5 - <25 ha	Yes	No	The habitat of the Sphagnum Frog is characterised by high moisture levels. They are typically found in high rainfall areas at high elevation in Sphagnum Moss beds or seepages on steep slopes. Habitat often	Typically found in high rainfall areas at high elevation in Sphagnum Moss beds or seepages on steep slopes. This habitat is not present	Nil

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									occurs in rainforest (including Antarctic Beech forest) and wet sclerophyll forest. They can also occur at lower elevation (to about 250 m) in wet coastal foothills.;1|Sphagnum Frogs burrow in loose, moist soil or moss, under leaf litter often in soaks or seepages, or may use cracks and cavities behind and beside large or small waterfalls where the environment remains saturated with moisture.;2|They eat ants and other insects.;3|The Sphagnum Frog breeds in spring - summer and calls diurnally. Eggs are laid in moist locations such as rock crevices, under logs or in burrows in Shpagnum Moss. Larvae emerge from the nest after about one month.;4|	within the development footprint. Records >50kms to the north-east of the subject land	
Birds											
Anthochaera	Regent	Species/		Yes	Relictual - 10% or	< 5 ha	Yes	Other; As per	The Regent Honeyeater is a	Potential forage	Moderate

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
phrygia	Honeyeater	Ecosystem			less habitat retained			mapped areas	flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes.;1 | Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are	habitat supported across the development footprint. Project site does not occur within mapped Important Areas for the species	

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									occasionally seen on the south coast.;2| In the last 10 years Regent Honeyeaters have been recorded in urban areas around Albury where woodlands tree species such as Mugga Ironbark and Yellow Box were planted 20 years ago.;3|The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Other tree species may be regionally important. For example, the Lower Hunter Spotted Gum forests have recently been demonstrated to support regular breeding events. Flowering of associated species such as Thin-leaved Stringybark		

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									Eucalyptus eugenioides and other Stringybark species, and Broad-leaved Ironbark E. fibrosa can also contribute important nectar flows at times. Nectar and fruit from the mistletoes Amyema miquelii, A. pendula and A. cambagei are also utilised. When nectar is scarce lerp and honeydew can comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings. ;4|Colour-banding of Regent Honeyeater has shown that the species can undertake large-scale nomadic movements in the order of hundreds of kilometres. However, the exact nature of these movements is still poorly understood. It is likely that		

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									movements are dependent on spatial and temporal flowering and other resource patterns. To successfully manage the recovery of this species a full understanding of the habitats used in the non-breeding season is critical.;5|There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria.;6|An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female. Two or		

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									three eggs are laid and incubated by the female for 14 days. Nestlings are brooded and fed by both parents at an average rate of 23 times per hour and fledge after 16 days. Fledglings fed by both parents 29 times per hour.;7|		
Artamus cyanopterus cyanopterus	Dusky Woodswallow	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.;1|Primarily eats invertebrates, mainly	Potential forage habitat supported across the development footprint	Moderate

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									insects, which are captured whilst hovering or sallying above the canopy or over water. Also, frequently hovers, sallies and pounces under the canopy, primarily over leaf litter and dead timber. Also occasionally take nectar, fruit and seed. ;2|Depending on location and local climatic conditions (primarily temperature and rainfall), the dusky woodswallow can be resident year-round or migratory. In NSW, after breeding, birds migrate to the north of the state and to southeastern Queensland, while Tasmanian birds migrate to southeastern NSW after breeding. Migrants generally depart between March and May, heading south to breed again in spring. There is some evidence of site fidelity for breeding. Although dusky		

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									wood swallows generally breed as solitary pairs or occasionally in small flocks, large flocks may form around abundant food sources in winter. Large flocks may also form before migration, which is often undertaken with other species. ;3|Nest is an open, cup-shape, made of twigs, grass, fibrous rootlets and occasionally casuarina needles, and may be lined with grass, rootlets or infrequently horsehair, occasionally unlined. Nest sites vary greatly, but generally occur in shrubs or low trees, living or dead, horizontal or upright forks in branches, spouts, hollow stumps or logs, behind loose bark or in a hollow in the top of a wooden fence post. Nest sites may be exposed or well concealed by foliage. ;4|		

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
Burhinus grallarius	Bush Stone-curlew	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	No	Fallen/standing dead timber including logs; Null	Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber.;1|Largely nocturnal, being especially active on moonlit nights.;2|Feed on insects and small vertebrates, such as frogs, lizards and snakes.;3|Nest on the ground in a scrape or small bare patch.;4|Two eggs are laid in spring and early summer.;5|	Species occurs at altitudes much lower than the development footprint with the highest elevation record of the species within over 120kms of the project site at an altitude of 500 metres (approx.). The lowest point of the project site occurs along the transmission line at an altitude of 750 metres (approx.) and as such the development footprint does not support habitat for the species. Two records of the species occur at an elevation of approximately 1000 metres, one	Negligible

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										hears Armidale over 120kms from the project site, and the other in Washpool NP, over 270kms from the project site. When these records are compared to the remainder of the 1350 species' records in BioNet, these occurrences are considered to be a vagrant.	
Callocephalon fimbriatum	Gang-gang Cockatoo	Species/ Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	No	Hollow bearing trees; Eucalypt tree species with hollows greater than 9 cm diameter	In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. ;1|In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands,	Of the 16,000 records of the species in ebird (and >600 in BioNet), none occur north of Muswellbrook NSW, except occasional records along coast just south	Negligible

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas.;2|May also occur in sub-alpine Snow Gum (Eucalyptus pauciflora) woodland and occasionally in temperate rainforests.;3|Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10 cm in diameter or larger and at least 9 m above the ground in eucalypts.;4|	of Coffs Harbour. As such the development footprint does not support habitat for the species.	
Calyptorhynchus lathami	Glossy Black-Cockatoo	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Forage: Presence of Allocasuarina and casuarina species Breeding: Hollow bearing trees; Living	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (Allocasuarina littoralis) and Forest Sheoak (A. torulosa) are important foods.;1|Inland	Marginal potential forage habitat supported across the development footprint, very few Casuarina spp or Allocasuarina spp. have been	Moderate

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
								or dead tree with hollows greater than 15cm diameter and greater than 5m above ground.	populations feed on a wide range of sheoaks, including Drooping Sheoak, Allocasuaraina diminuta, and A. gymnathera. Belah is also utilised and may be a critical food source for some populations.;2|In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (Casuarina cristata).;3|Feeds almost exclusively on the seeds of several species of she-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill.;4|Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.;5|	recorded during floristic surveys of fauna habitat assessments. Breeding habitat potentially present in the form of hollow trees.	
Chthonicola	Speckled	Ecosystem		Yes	Relictual - 10% or	< 5 ha	Yes		The Speckled Warbler lives	Potential forage	Moderate

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
sagittata	Warbler				less habitat retained				in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies.;1|Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.;2|Large, relatively undisturbed remnants are required for the species to persist in an area.;3|The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees.;4|Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding.;5|The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground	habitat supported across the development footprint	

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside.;6|A clutch of 3-4 eggs is laid, between August and January, and both parents feed the nestlings. The eggs are a glossy red-brown, giving rise to the unusual folk names 'Blood Tit' and 'Chocolatebird'.;7|Some cooperative breeding occurs. The species may act as host to the Black-eared Cuckoo.;8|Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-rumped, Brown and Striated Thornbills.;9|		
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of	Potential forage habitat supported across the development footprint	Moderate

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									the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (Eucalyptus camaldulensis) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.;1|Sedentary, considered to be resident in many locations throughout its range; present in all seasons or year-round at many sites;		

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									territorial year-round, though some birds may disperse locally after breeding.;2|Gregarious and usually observed in pairs or small groups of 8 to 12 birds; terrestrial and arboreal in about equal proportions; active, noisy and conspicuous while foraging on trunks and branches of trees and amongst fallen timber; spend much more time foraging on the ground and fallen logs than other treecreepers. ;3|When foraging in trees and on the ground, they peck and probe for insects, mostly ants, amongst the litter, tussocks and fallen timber, and along trunks and lateral branches; up to 80% of the diet is comprised of ants; other invertebrates (including spiders, insects larvae, moths, beetles, flies, hemipteran bugs,		

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									cockroaches, termites and lacewings) make up the remaining percentage; nectar from Mugga Ironbark (Eucalyptus sideroxylon) and paperbarks, and sap from an unidentified eucalypt are also eaten, along with lizards and food scraps; young birds are fed ants, insect larvae, moths, craneflies, spiders and butterfly and moth larvae.;4|Hollows in standing dead or live trees and tree stumps are essential for nesting. ;5|The species breeds in pairs or co-operatively in territories which range in size from 1.1 to 10.7 ha (mean = 4.4 ha). Each group is composed of a breeding pair with retained male offspring and, rarely, retained female offspring. Often in pairs or cooperatively breeding groups of two to five birds.		

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									;6|		
Daphoenositta chrysoptera	Varied Sittella	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.;1|Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.;2|Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.;3|Generation length is estimated to be 5 years.;4|	Potential forage habitat supported across the development footprint	Moderate
Glossopsitta pusilla	Little Lorikeet	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Forages primarily in the canopy of open Eucalyptus forest and woodland, yet	Potential forage habitat supported across the development	Moderate

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									also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity.;1|Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.;2|Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards;3|Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries.;4|Roosts in treetops, often distant from feeding areas.;5|Nests in proximity to feeding areas	footprint	

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									if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like Allocasuarina.;6|Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown.;7|		
Grantiella picta	Painted Honeyeater	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Inhabits Boree/ Weeping Myall (Acacia pendula), Brigalow (A. harpophylla) and Box-Gum Woodlands and Box-Ironbark Forests.;1|A	Potential forage habitat supported across the development footprint	Moderate

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									specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.;2|Insects and nectar from mistletoe or eucalypts are occasionally eaten.;3|Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.;4|		
Haliaeetus leucogaster	White-bellied Sea-Eagle	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	No	Waterbodies; Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines; Living or dead mature trees within suitable vegetation within 1km of	Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea.;1|Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. ;2|Terrestrial	Project site does not occur within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines. Where Peel River occurs within 1km of the development footprint it is a minor watercourse.	Negligible

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								a rivers, lakes, large dams or creeks, wetlands and coastlines	habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). ;3|Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts. Nests are large structures built from sticks and lined with leaves or grass. ;4|Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion.;5|Hunts its prey from a perch or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). Prey is usually carried to a feeding platform or (if small)		

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									consumed in flight, but some items are eaten on the ground.;6|May be solitary, or live in pairs or small family groups consisting of a pair of adults and dependent young. ;7|Typically lays two eggs between June and September with young birds remaining in the nest for 65-70 days.;8|		
Hamirostra melanosternon	Black-breasted Buzzard	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Waterbodies; Land within 40 m of riparian woodland on inland watercourses /waterholes containing dead or dying eucalypts	Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat.;1|Also hunts over grasslands and sparsely timbered woodlands.;2|Not a powerful hunter, despite its size, mostly taking reptiles, small mammals, birds, including nestlings, and carrion.;3|Also specialises in feeding on large eggs, including those of emus, which it cracks on a	Riparian habitats are degraded within the development footprint.	Negligible

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									rock.;4|Breeds from August to October near water in a tall tree. The stick nest is large and flat and lined with green leaves. Normally two eggs are laid.;5|		
Hieraaetus morphnoides	Little Eagle	Species/ Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Other; Nest trees - live (occasionally dead) large old trees within vegetation.	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used.;1|Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.;2|Lays two or three eggs during spring, and young fledge in early summer.;3|Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.;4|	Potential forage and breeding habitat supported across the development footprint	Moderate
Lathamus discolor	Swift Parrot	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Other; As per mapped areas	Migrates to the Australian south-east mainland between February and October.;1|On the mainland they occur in	Potential forage habitat supported across the development footprint. Project	Moderate

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									areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.;2|Favoured feed trees include winter flowering species such as Swamp Mahogany Eucalyptus robusta, Spotted Gum Corymbia maculata, Red Bloodwood C. gummifera, Forest Red Gum E. tereticornis, Mugga Ironbark E. sideroxylon, and White Box E. albens.;3|Commonly used lerp infested trees include Inland Grey Box E. microcarpa, Grey Box E. moluccana, Blackbutt E. pilularis, and Yellow Box E. melliodora.;4|Retur	site does not occur within mapped Important Areas for the species	

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									n to some foraging sites on a cyclic basis depending on food availability.;5|Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum Eucalyptus globulus.;6|		
Lophoictinia isura	Square-tailed Kite	Species/ Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Other; Nest trees	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.;1|In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland.;2|Is a specialist hunter of passerines, especially honeyeaters, and most	Potential forage and breeding habitat supported across the development footprint	Moderate

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									particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage.;3|Appears to occupy large hunting ranges of more than 100km2.;4|Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.;5|		
Melanodryas cucullata	Hooded Robin (south-eastern form)	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas.;1|Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.;2|Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method	Potential forage habitat supported across the development footprint	Moderate

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									of hunting insect prey.;3|Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season.;4|May breed any time between July and November, often rearing several broods.;5|The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than 1 m to 5 m above the ground.;6|The nest is defended by both sexes with displays of injury-feigning, tumbling across the ground.;7|A clutch of two to three is laid and incubated for fourteen days by the female. Two females often cooperate in brooding.;8|		
Ninox connivens	Barking Owl	Species/ Ecosystem		Yes	Fragmented - 11-30 % habitat retained	25 - 100 ha	Yes	Hollow bearing trees; Living or dead trees with hollows	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use,	Potential forage and breeding habitat supported across the development	Moderate

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								greater than 20 cm diameter and greater than 4m above the ground.	and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey found on these fertile riparian soils.;1|Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance.;2|Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on	footprint	

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									birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch.;3|Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.;4|Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas).;5|Nesting occurs during mid-winter and spring, being variable between pairs and among years. As a rule of thumb, laying occurs during August		

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									and fledging in November. The female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging occurs 2-3 weeks later. Young are dependent on their parents for several months.;6|Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 km away, though humans rarely hear this response farther than 1.5 km. Because disturbance reduces the pair's foraging time and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season.;7|		
Ninox strenua	Powerful Owl	Species/ Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Hollow bearing trees; Living or dead trees with hollow greater than	The Powerful Owl inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest.;1|The Powerful	Potential forage and breeding habitat supported across the development footprint	Moderate

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								20cm diameter	Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine Syncarpia glomulifera, Black She-oak Allocasuarina littoralis, Blackwood Acacia melanoxylon, Rough-barked Apple Angophora floribunda, Cherry Ballart Exocarpus cupressiformis and a number of eucalypt species. ;2|The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail		

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									Possum and Sugar Glider. There may be marked regional differences in the prey taken by Powerful Owls. For example, in southern NSW, Ringtail Possum make up the bulk of prey in the lowland or coastal habitat. At higher elevations, such as the tableland forests, the Greater Glider may constitute almost all of the prey for a pair of Powerful Owls. Flying foxes are important prey in some areas; birds comprise about 10-50% of the diet depending on the availability of preferred mammals. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. ;3|Pairs of Powerful Owls demonstrate high fidelity to a large territory, the size of which varies with habitat quality and thus prey		

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									densities. In good habitats a mere 400 can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha.;4|Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him.;5|Powerful Owls are monogamous and mate for life. Nesting occurs from late autumn to mid-winter but is slightly earlier in north-eastern NSW (late summer - mid autumn). Clutches consist of two dull white eggs and incubation		

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									lasts approximately 38 days.;6|		
Pachycephala olivacea	Olive Whistler	Ecosystem		Yes	Variegated - 31-70% habitat retained	25 - 100 ha	Yes		Mostly inhabit wet forests above about 500m. During the winter months they may move to lower altitudes.;1|Forage in trees and shrubs and on the ground, feeding on berries and insects.;2|Make nests of twigs and grass in low forks of shrubs.;3|Lay two or three eggs between September and January;4|	Potential forage habitat supported across the development footprint	Moderate
Petroica boodang	Scarlet Robin	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs.;1|This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps.;2|Scarlet Robin habitat usually contains abundant logs and fallen	Potential forage habitat supported across the development footprint	Moderate

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									timber: these are important components of its habitat.;3|The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude.;4|The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding.;5|In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees.;6|The Scarlet Robin is a quiet and unobtrusive species which is often quite tame and easily approached.;7|Birds forage from low perches, fence-posts or on the ground, from where they		

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									pounce on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer.;8|Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season.;9|This species' nest is an open cup made of plant fibers and cobwebs and is built in the fork of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub.;10|Eggs are pale greenish-, bluish- or brownish-white, spotted with brown; clutch size ranges from one to four.;11|Birds usually occur singly or in pairs, occasionally in small family		

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									parties; pairs stay together year-round.;12|In autumn and winter, the Scarlet Robin joins mixed flocks of other small insectivorous birds which forage through dry forests and woodlands.;13|		
Petroica phoenicea	Flame Robin	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes.;1|Prefers clearings or areas with open understoreys.;2|The ground layer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense.;3|Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes.;4|In winter, birds migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to	Potential forage habitat supported across the development footprint	Moderate

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									the western slopes and plains).;5|Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration.;6|In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees.;7|In winter, occasionally seen in heathland or other shrublands in coastal areas.;8|Birds forage from low perches, from which they sally or pounce onto small invertebrates which they take from the ground or off tree trunks, logs and other coarse woody debris.;9|Flying insects are often taken in the air and sometimes gleans for invertebrates from foliage and bark.;10|In their autumn and winter habitats, birds often sally from fence-posts or thistles		

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									and other prominent perches in open habitats.;11|Occur singly, in pairs, or in flocks of up to 40 birds or more; in the non-breeding season they will join up with other insectivorous birds in mixed feeding flocks.;12|Breeds in spring to late summer.;13|Nests are often near the ground and are built in sheltered sites, such as shallow cavities in trees, stumps or banks.;14|Builds an open cup nest made of plant materials and spider webs.;15|Eggs are oval in shape and are pale bluish- or greenish-white and marked with brownish blotches; clutch size is three or four eggs.;16|		
Stagonopleura guttata	Diamond Firetail	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora	Potential forage habitat supported across the development footprint	Moderate

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									Woodlands.;1|Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.;2|Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.;3|Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season).;4|Usually encountered in flocks of between 5 to 40 birds, occasionally more.;5|Groups separate into small colonies to breed, between August and January.;6|Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests.;7|Birds roost		

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									in dense shrubs or in smaller nests built especially for roosting.;8|Appears to be sedentary, though some populations move locally, especially those in the south.;9|Has been recorded in some towns and near farm houses.;10|		
Tyto novaehollandiae	Masked Owl	Species/ Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes	Hollow bearing trees; Living or dead trees with hollows greater than 20cm diameter.	Lives in dry eucalypt forests and woodlands from sea level to 1100 m.;1|A forest owl, but often hunts along the edges of forests, including roadsides.;2|The typical diet consists of tree-dwelling and ground mammals, especially rats.;3|Pairs have a large home-range of 500 to 1000 hectares.;4|Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.;5|	Potential forage and breeding habitat supported across the development footprint	Moderate
Tyto tenebricosa	Sooty Owl	Species/ Ecosystem		Yes	Intact - over 70% natural habitat retained	> 100 ha	Yes	Caves; Caves or clifflines/ledg	Occurs in rainforest, including dry rainforest, subtropical and warm	Potential forage and breeding habitat	Moderate

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								es Hollow bearing trees; Living or dead trees with hollows greater than 20cm diameter.	temperate rainforest, as well as moist eucalypt forests.;1|Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (Pseudocheirus peregrinus) or Sugar Glider (Petaurus breviceps).;2|Nests in very large tree-hollows.;3|	supported across the development footprint	
Mammals											
Aepyprymnus rufescens	Rufous Bettong	Species		Yes	Variegated - 31-70% habitat retained	< 5 ha	Yes		Rufous Bettongs inhabit a variety of forests from tall, moist eucalypt forest to open woodland, with a tussock grass understorey. A dense cover of tall native grasses is the preferred shelter.;1|They sleep during the day in cone-shaped nests constructed of grass in a shallow depression at the base of a	Marginal potential habitat occurs within the subject land and habitats within the transmission line corridor are degraded	Moderate

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									tussock or fallen log.;2|At night they feed on grasses, herbs, seeds, flowers, roots, tubers, fungi and occasionally insects.;3|		
Cercartetus nanus	Eastern Pygmy-possum	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest.;1|Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable.;2|Also feeds on insects throughout the year; this feed source may be more important in	Potential habitat is present within the development footprint.	Moderate

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									habitats where flowers are less abundant such as wet forests.;3|Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (Pseudocheirus peregrinus) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.;4|Appear to be mainly solitary, each individual using several nests, with males having non-exclusive home-ranges of about 0.68 hectares and females about 0.35 hectares.;5|Young can be born whenever food sources are available, however most births occur between late spring and		

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									early autumn.;6|Agile climbers, but can be caught on the ground in traps, pitfalls or postholes; generally nocturnal.;7|Frequently spends time in torpor especially in winter, with body curled, ears folded and internal temperature close to the surroundings.;8|		
Chalinolobus dwyeri	Large-eared Pied Bat	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (Petrochelidon ariel), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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									remain loyal to the same cave over many years.;1|Found in well-timbered areas containing gullies.;2|The relatively short, broad wing combined with the low weight per unit area of wing indicates maneuverable flight. This species probably forages for small, flying insects below the forest canopy.;3|Likely to hibernate through the coolest months.;4|It is uncertain whether mating occurs early in winter or in spring.;5|		
Dasyurus maculatus	Spotted-tailed Quoll	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.;1|Individual animals use hollow-bearing trees, fallen logs, small	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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									caves, rock outcrops and rocky-cliff faces as den sites.;2|Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and will hunt possums and gliders in tree hollows and prey on roosting birds.;3|Use communal 'latrine sites', often on flat rocks among boulder fields, rocky cliff-faces or along rocky stream beds or banks. Such sites may be visited by multiple individuals and can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals.;4|A generalist predator with a preference for medium-sized (500g-5kg) mammals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots,		

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									rabbits, reptiles and insects. Also eats carrion and takes domestic fowl.;5|Females occupy home ranges of 200-500 hectares, while males occupy very large home ranges from 500 to over 4000 hectares. Are known to traverse their home ranges along densely vegetated creeklines.;6|Average litter size is five; both sexes mature at about one year of age. Life expectancy in the wild is about 3-4 years.;7|		
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Ecosystem		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes		Prefers moist habitats, with trees taller than 20 m.;1|Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.;2|Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy.;3|Hibernates in	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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									winter.;4|Females are pregnant in late spring to early summer.;5|		
Macropus parma	Parma Wallaby	Species		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes		Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest.;1|Typically feed at night on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas.;2|During the day they shelter in dense cover.;3|	Potential habitat occurs in higher condition areas connected to Ben Halls Gap Nature Reserve. Potential habitats within the transmission line corridor are degraded	Moderate
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range.;1|Roost mainly in tree hollows but will also roost under bark or in man-made structures.;2|Usually solitary but also recorded roosting communally, probably insectivorous.;3|	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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Miniopterus australis	Little Bent-winged Bat	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Caves; Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature.	Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas.;1|Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.;2|They often share roosting sites with the Common Bentwing-bat and, in winter, the two species may form mixed clusters.;3|In NSW the largest maternity colony is in close association with a large maternity colony of Large Bentwing-bats (Miniopterus orianae) and appears to depend on the large colony	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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									to provide the high temperatures needed to rear its young.;4|Maternity colonies form in spring and birthing occurs in early summer. Males and juveniles disperse in summer.;5|Only five nursery sites /maternity colonies are known in Australia.;6|		
Miniopterus orianae oceanensis	Large Bent-winged Bat	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Caves; Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC - in cave;" observation type code "E nest-roost;"	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.;1|Form discrete populations centered on a maternity cave that is used annually in spring and summer for the birth and rearing of young.;2|Maternity caves have very specific temperature and humidity regimes.;3|At other times of the year, populations disperse within about 300 km range of maternity	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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								with numbers of individuals >500	caves.;4|Cold caves are used for hibernation in southern Australia.;5|Breeding or roosting colonies can number from 100 to 150,000 individuals.;6|Hunt in forested areas, catching moths and other flying insects above the tree tops.;7|		
Myotis macropus	Southern Myotis	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.;1|Forage over streams and pools catching insects and small fish by raking their feet across the water surface.;2|In NSW females have one young each year usually in November or December.;3|	Habitat occurs within and adjacent to the development footprint	Recorded by survey
Nyctophilus corbeni	Corben's Long-eared Bat	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes		Inhabits a variety of vegetation types, including	Potential habitat is present within	Moderate

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									mallee, bulloke Allocasuarina leuhmanni and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland.;1|Roosts in tree hollows, crevices, and under loose bark.;2|Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground.;3|Mating takes place in autumn with one or two young born in late spring to early summer.;4|	the development footprint	
Petauroides volans	Greater Glider	Ecosystem		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes			Habitat occurs within and adjacent to the development footprint	Recorded by survey
Petaurus australis	Yellow-bellied	Ecosystem		Yes	Variegated - 31-	25 - 100 ha	Yes		Occur in tall mature	Habitat occurs	Moderate

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	Glider				70% habitat retained				eucalypt forest generally in areas with high rainfall and nutrient rich soils.;1|Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south.;2|Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein.;3|Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar.;4|Live in small family groups of two - six individuals and are nocturnal.;5|Den, often in family groups, in hollows of large trees.;6|Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed	within and adjacent to the development footprint	

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									and seasonally variable food resources.;7|		
Petaurus norfolcensis	Squirrel Glider	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas.;1|Prefers mixed species stands with a shrub or Acacia midstorey.;2|Live in family groups of a single adult male one or more adult females and offspring.;3|Require abundant tree hollows for refuge and nest sites.;4|Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.;5|	Potential habitat is present within the development footprint	Moderate
Petrogale penicillata	Brush-tailed Rock-wallaby	Species		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes		Occupy rocky escarpments, outcrops and cliffs with a preference for complex	Potential habitat is present within the development	Moderate

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									structures with fissures, caves and ledges, often facing north.;1|Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night when foraging.;2|Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.;3|Highly territorial and have strong site fidelity with an average home range size of about 15 ha. Males tend to have larger home ranges than females.;4|The home range consists of a refuge area and a foraging range linked by habitually used commuting routes.;5|Females settle in or near their mother's range, while males mainly disperse between female groups within colonies, and less commonly between colonies.;6| Dominant	footprint	

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									males associate and breed with multiple females.;7|Breeding occurs throughout the year with a peak in births between February and May, especially in the southern parts of the range and at higher altitudes.;8|		
Phascogale tapoatafa	Brush-tailed Phascogale	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter.;1|Also inhabit heath, swamps, rainforest and wet sclerophyll forest.;2|Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater..;3|Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates.;4|Females have exclusive territories of approximately 20 - 40 ha, while males have overlapping territories	Potential habitat is present within the development footprint. However, BioNet notes the species occurrences in the following IBRA subregions relevant to the project site. Walcha Plateau IBRA - Known to occur, but a geographic restriction exists stating "East of the Tia River". This river's headwaters	Negligible

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									often greater than 100 ha.;5|Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span.;6|Mating occurs May - July; males die soon after the mating season whereas females can live for up to three years but generally only produce one litter.;7|	occur >50kms north-east of the assessment area. Nearest record of the species is 56kms east. Tomala IBRA - species known, with no geographic restrictions listed. However, only records of the species comprise an inaccurate record (10kms) noted as Mount Royal SF (or NP) from 1991, one more low accuracy (10kms) in similar location (but in Barrington Tops IBRA), one further single record in the IBRA from 1974, and >66kms from the	

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										assessment area. Peel IBRA - Species predicted to occur (i.e. not known), no geographic restrictions listed. Species never recorded in IBRA.	
Phascolarctos cinereus	Koala	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Other; Areas identified via survey as important habitat (see comments)	Inhabit eucalypt woodlands and forests.;1|Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.;2|Inactive for most of the day, feeding and moving mostly at night.;3|Spend most of their time in trees, but will descend and traverse open ground to move between trees.;4|Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.;5|Generally solitary,	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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									but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery.;6|Females breed at two years of age and produce one young per year.;7|		
Phoniscus papuensis	Golden-tipped Bat	Ecosystem		Yes	Variegated - 31-70% habitat retained	< 5 ha	Yes		Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, Casuarina-dominated riparian forest and coastal Melaleuca forests.;1|Bats will fly up to two kilometres from roosts to forage in rainforest and sclerophyll forest on mid and upper-slopes.;2|Roost mainly in rainforest gullies on small first- and second-order streams in usually abandoned hanging Yellow-throated Scrubwren	Potential habitat is present within the development footprint	Moderate

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									and Brown Gerygone nests modified with an access hole on the underside. Bats may also roost under thick moss on tree trunks, in tree hollows, dense foliage and epiphytes.;3|Bats will use multiple roost and change roosts regularly.;4|Bats roost individually or in small colonies which can contain up to approximately 20 bats of both males and females or just a single sex.;5|Maternity roots may occur away from water sources with one maternity roost found 450m upslope of the nearest water course in a broken bough.;6|Specialist feeder on small web-building spiders.;7|There is one breeding cycle per year.;8|		
Potorous tridactylus	Long-nosed Potoroo	Species	No	Yes	Variegated (between 31 and 70% habitat retained)	5 - <25 ha	Yes	Dense shrub layer or alternatively high canopy	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with	Inhabits coastal heaths and dry and wet sclerophyll	Low

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								cover exceeding 70% (i.e. to capture populations inhabiting wet sclerophyll and rainforest))	occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.;1|The fruit-bodies of hypogeous (underground-fruiting) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae and other soft-bodied animals in the soil.;2|Often digs small holes in the ground in a similar way to bandicoots.;3|Mainly nocturnal, hiding by day in dense vegetation - however, during the winter months animals may forage during daylight hours.;4|Individuals are mainly solitary, non-territorial and have home range sizes ranging between 2-5	forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. this habitat is not present wihtn the development footprint, furthermore the species was not recorded during terrestriual mammal camera trap surveys. Records <35-70kms to the south-east, east, north-east of the subject land	

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									ha.;5|Breeding peaks typically occur in late winter to early summer and a single young is born per litter. Adults are capable of two reproductive bouts per annum.;6|		
Pteropus poliocephalus	Grey-headed Flying-fox	Species/ Ecosystem		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes	Other; Breeding camps	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.;1|Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.;2|Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young.;3|Annual mating commences in January and conception occurs in April or May; a single young is born in October or	Potential forage habitat supported across the development footprint	Recorded by survey

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									November.;4|Site fidelity to camps is high; some camps have been used for over a century.;5|Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km.;6|Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.;7|Also forage in cultivated gardens and fruit crops.;8|		
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	Yes		Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.;1|When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.;2|Forages in most habitats across its very wide range, with and	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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									without trees; appears to defend an aerial territory.;3|Breeding has been recorded from December to mid-March, when a single young is born.;4|Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.;5|		
Scoteanax rueppellii	Greater Broad-nosed Bat	Ecosystem		Yes	Variegated - 31-70% habitat retained	5 - 24 ha	Yes		Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.;1|Although this species usually roosts in tree hollows, it has also been found in buildings.;2|Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m.;3|Open woodland habitat and dry open forest suits the direct	Habitat occurs within and adjacent to the development footprint	Recorded by survey

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									flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.;4|Little is known of its reproductive cycle, however a single young is born in January; prior to birth, females congregate at maternity sites located in suitable trees, where they appear to exclude males during the birth and raising of the single young.;5|		
Thylogale stigmatica	Red-legged Pademelon	Ecosystem		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes		Inhabits forest with a dense understorey and ground cover, including rainforest, moist eucalypt forest and vine scrub.;1| Wet gullies with dense, shrubby ground cover provide shelter from predators.;2|In NSW, rarely found outside forested habitat.;3|They disperse from dense shelter areas to feed from late afternoon to	Potential forage habitat supported across the development footprint	Moderate

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									early morning, favouring native grasses and herbs on the edge of the forest.;4|Also known to feed on fruits, young seedling leaves and stems, fungi and ferns.;5|		
Vespadelus troughtoni	Eastern Cave Bat	Species		Yes	Fragmented - 11-30 % habitat retained	5 - 24 ha	Yes	Caves; Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds"	Very little is known about the biology of this uncommon species.;1|A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals.;2|Occasionally found along cliff-lines in wet eucalypt forest and rainforest.;3|Little is understood of its feeding or breeding requirements or behaviour.;4|	Habitat occurs within and adjacent to the development footprint	Recorded by survey
Reptiles											
Hoplocephalus bitorquatus	Pale-headed Snake	Species		Yes	Fragmented - 11-30 % habitat retained	< 5 ha	No		The Pale-headed Snake is a highly cryptic species that	Species known only to occur at	Negligible

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									can spend weeks at a time hidden in tree hollows.;1|Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest.;2|In drier environments, it appears to favour habitats close to riparian areas.;3|Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees.;4|The main prey is tree frogs although lizards and small mammals are also taken.;5|The Pale-headed Snake is relatively unusual amongst elapid snakes in that it is well adapted to climbing trees.;6|	altitudes much lower than the development footprint, within highest elevation BioNet records including 550m elevation (approx.) north of Bindarri NP (>200kms from the project site), 390m elevation (approx.) west of Kwiambal NP (>150kms from the project site) and 375m elevation (approx.) west of Gunnedah (>100kms from the project site). The lowest point of the project site occurs along the transmission line at an altitude of 750 metres (approx.) and as	

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										such the development footprint does not support habitat for the species.	
Hoplocephalus stephensii	Stephens' Banded Snake	Species	No	Yes	Variegated (between 31 and 70% habitat retained)	25 - <100 ha	Yes	Hollow bearing trees;Or within 500 m of this habitat|Other;Within 500 m of aboreal vine tangles|Fallen/standing dead timber including logs;Or within 500 m of this habitat	Rainforest and eucalypt forests and rocky areas up to 950 m in altitude.;1|Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day.;2| At night it hunts frogs, lizards, birds and small mammals.;3|	Rainforest and eucalypt forests and rocky areas up to 950 m in altitude. The species uses very old primary forest with many large old hollow bearing trees. Habitat needs to be well connected and geographically large. Potential habitat combining old primary forest <950m elevation does not occur within the development footprint.	

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										Records >35kms to the east of the subject land	
Uvidicolus sphyrurus	Border Thick-tailed Gecko	Species		Yes	Relictual - 10% or less habitat retained	< 5 ha	Yes		As implied by another of its common names (Granite Thick-tailed Gecko), this species often occurs on steep rocky or scree slopes, especially granite. Recent records from basalt and metasediment slopes and flats indicate its habitat selection is broader than formerly thought and may have extended into areas that were cleared for agriculture.;1|Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter. Occupied sites often have a dense tree canopy that helps create a sparse understorey.;2|These Geckos are active at night and shelter by day under rock slabs, in or under logs, and under the bark of standing trees.	Species distribution is north of the project site and has never been recorded (or predicted to occur in) Tomala or Walcha Plateau IBRA subregions. Peel IBRA has records 20-25kms north of the site across cleared land, which are at the southern extent of the species' occurrence. Peel IBRA abuts parts of the subject land and includes the western 60% of the transmission line corridor.	Low

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
Plants											
Acacia atrox	Myall Creek Wattle	Species	N/A	Yes	N/A	N/A	Yes	N/A	Species grows in soils ranging from deep black clay over basalt to shallow red stony loams on the upper slope and crest of a low hill. Currently known from two populations near Delungra and Gurley. There individuals grow in a partly cleared paddock of box woodland with a native grassy understorey.	Known populations more than 200km north/ northwest of the assessment area. No records within proximity to the site. Potential habitat in PCT599 is marginal and unlikely to support the species.	Unlikely
Callistemon pungens	Callistemon pungens	Species	N/A	Yes	N/A	N/A	Yes	N/A	Habitats range from riparian areas dominated by Casuarina cunninghamiana subsp. cunninghamiana to woodland and rocky shrubland.;1|Often in rocky watercourses, usually with sandy granite (occasionally basalt) creek beds;2|Flowers over spring and summer, mostly in November.;3|	Habitats range from riparian areas dominated by Casuarina cunninghamiana subsp. cunninghamiana to woodland and rocky shrubland. Often in rocky watercourses, usually with sandy granite	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										(occasionally basalt) creek beds. Marginal habitat may occur along the transmission line corridor however the subject land occur outside the known area of occurrence of the species. Records <80-100kms to the north and north-east, with the species never having been recorded south of Tamworth / Port Macquarie	
Eucalyptus nicholii	Narrow-leaved Black Peppermint	Species	N/A	No	N/A	N/A	Yes	N/A	Typically grows in dry grassy woodland, on shallow soils of slopes and ridges- prefers infertile soils derived from granite or metasedimentary rock. The species occurs from Nundle to north of	Potential habitat within grassy woodland and dry sclerophyll forests within the site	Possible

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									Tenterfield being most common in the central portions of its range.		
Chiloglottis anaticeps	Bird Orchid	Species	N/A	Yes	N/A	N/A	Yes	N/A	Bird Orchid often grows near streams or on the edges of low, flat rock outcrops.;1|It grows in eucalypt forest in areas with very little ground cover, in gravely loam soils.;2|	Often grows near streams or on the edges of low, flat rock outcrops, in grows in eucalypt forest in areas with very little ground cover, in gravely loam soils. Very broad habtat descritions do not fit well with the habitats or soils present within the development footprint. Furthermore the subject land occurs well outside the species known area of occurrence..	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										Records of two known areas of occurrnce occure >100kms and >150 kms to the north-east of the subject land	
Chiloglottis platyptera	Barrington Tops Ant Orchid	Species	N/A	Yes	N/A	N/A	Yes	N/A	Grows in moist areas in tall open Eucalypt forest with a grassy understorey and also around rainforest edges; generally on rich brown loam soils. Known to occur within the area including at Ben Halls Gap Nature Reserve.	Potential habitat within grassy woodland and open forests within the site.	Likely
Cryptostylis hunteriana	Leafless Tongue Orchid	Species	N/A	Yes	N/A	N/A	Yes	N/A	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.;1 | The larger populations typically occur in woodland dominated by Scribbly Gum (Eucalyptus sclerophylla), Silvertop Ash (E. sieberi), Red Bloodwood (Corymbia gummifera) and	EPBC Act SPRAT profile sates habitat associated for the species in the NSW Northern Tables lands regions include New England Blackbutt (Eucalyptus andrewsii) Grassy Forest and New	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									Black Sheoak (Allocasuarina littoralis); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (C. subulata) and the Tartan Tongue Orchid (C. erecta).;2|Little is known about the ecology of the species; being leafless it is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material.;3|In addition to reproducing from seed, it is also capable of vegetative reproduction and thus forms colonies which can become more or less permanent at a site.;4|On the Central Coast of NSW, populations have been recorded in woodland	England Blackbutt Shrubby Forest and Large-fruited Blackbutt (Eucalyptus pyrocarpa) / Strawberry Gum (Eucalyptus olida) Woodland. These habitats do not occur within the subject land. Records >35-40kms to the north-east of the subject land	

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									dominated by Scribbly Gum (Eucalyptus haemastoma), Brown Stringybark (Eucalyptus capitellata), Red Bloodwood (Corymbia gummifera) and also associated with Large Tongue Orchid (C. subulata) and the Tartan Tongue Orchid (C. erecta).;5|		
Dichanthium setosum	Bluegrass	Species	N/A	Yes	N/A	N/A	Yes	N/A	Found in heavy basaltic black soil and red-brown loams with clay subsoil. Often in moderately disturbed areas including cleared woodland, grassy roadside remnants and high disturbed pasture; associated with species including Eucalyptus albens, E.melanophloia, E.melliodora, E.viminalis, Myoporum debile, Aristida ramose, Themeda triandra, Poa sieberiana, Bothriochloa ambigua, Medicago minima.	Potential habitat within dry sclerophyll forests, derived native grassland and forested wetlands within the site.	Possible

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
Digitaria porrecta	Finger Panic Grass	Species	N/A	Yes	N/A	N/A	Yes	N/A	Occurs in native grassland, woodland or open forest with a grassy understorey on richer soils. Typically associated with E.albens, Acacia pendula Austrostipa aristiglumis, Enteropogon acicularis, Cyperus bifax, Hibiscus trionum and Neptunia gracilis.	Habitat within box woodland marginal for the species. No other suitable habitat within the site.	Unlikely
Diuris pedunculata	Small Snake Orchid	Species	N/A	Yes	N/A	N/A	Yes	N/A	The Small Snake Orchid grows on grassy slopes or flats.;1|Often on peaty soils in moist areas.;2|Also on shale and trap soils, on fine granite, and among boulders.;3|It flowers during late September-October.;4|Pollination is mostly by sexual deception, with the Small Snake-orchid attracting mostly males of an native bee Halictus lanuginosus. However, the flowers produce nectar and emit a strong scent that attracts a range of other pollinators.;5|	Grows on grassy slopes or flats, often on peaty soils in moist areas, also on shale and trap soils, on fine granite, and among boulders. This habitat is not present within the development footprint. Nearest record occurs approximately 7km to the north of the subject	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										land. However the records is noted as a Royal Botanic Gardens Herbarium Specimen Register (with an "endDate" noted as 29/10/2000), and despite its relatively high level of accuracy (50m) it is located in the centre of a pine plantation that was recently cleared and is now regrowing, thus puts its accuracy into question. The next neatest records occur >60kms to the north, >115kms to the north-east, and >100kms to the south-east.	
Eucalyptus	Northern Blue	Species	N/A	Yes	N/A	N/A	Yes	N/A	Grassy open forest or	Occurs in grassy	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
magnificata	Box								woodland on shallow, sandy or loamy soils.;1|Occurs on moderately hilly sites and at the edge of gorges, usually at altitudes from 900 - 1050 m.;2|Known populations are small, numbering 5-400 plants per location.;3|	open forest or woodland on shallow, sandy or loamy soils, on moderately hilly sites and at the edge of gorges, usually at altitudes from 900 - 1050 m. Potential habitat combining grassy open forest or woodland on shallow, sandy or loamy soils at 900 - 1050 m elevation does not occur within the development footprint. Records >90-100kms to the north-east of the subject land	
Eucalyptus oresbia	Small-fruited Mountain Gum	Species	N/A	Yes	N/A	N/A	Yes	N/A	Found at altitudes between 800 and 1100 m in very steep valleys and deeply incised creeklines with	Steep valleys and deeply incised creeklines do not occur within the	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									primarily south to southwest exposure (i.e. warm yet moist). ;1|Three subpopulations exist with some outlying individuals.;2|Replaced by Eucalyptus pauciflora, E. elliptica and E. melliodora in less rocky habitat.;3|Seedlings more commonly observed in disturbed areas and rare elsewhere. ;4|Age structure suggests populations are largely regrowth after disturbance from mining, forestry and road construction during the past century (data collected by J.T. Hunter and L. M. Copeland) ;5|	development footprint	
Euphrasia ciliolata	Polblue Eyebright	Species	N/A	Yes	N/A	N/A	Yes	N/A	Occurs on the edge of montane and sub-alpine swamps and on open grassy slopes bordering swamps, Snow Grass meadows, Snow Gum woodland, open boggy meadows amidst Black	Species Flowers December to May and occurs on the edge of montane and sub-alpine swamps and on open grassy	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									Sallee woodland, and in seasonally inundated upland grassland.;1|Flowers December to May.;2|Polblue Eyebright is an 'annual', ie each plant lives for one year and dies after flowering and fruit-set has finished. Some plants may merely die back to ground level, leaving the underground parts to resprout the following season. This annual 'disappearance' means that surveys for this plant must be confined to its flowering season.;3|Polblue Eyebright is partly parasitic upon other plants, such as Snow Grass, and may only be able to grow in close proximity to such host plants.;4|	slopes bordering swamps, Snow Grass meadows, Snow Gum woodland, open boggy meadows amidst Black Sallee woodland, and in seasonally inundated upland grassland. Potential habitat for the species within the development footprint, comprising PCT 586, is degraded by weed invasion. Furthermore the species was not recorded during targeted meander and plot surveys undertaken within degraded habitats in March	

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										2021. Records >15 kms to the north-east of the subject land	
Homoranthus prolixus	Granite Homoranthus	Species	N/A	Yes	N/A	N/A	Yes	On or near granite outcrops and slabs or within 100m	Grows in heath patches, in skeletal soil among crevices of granite outcrops within the Ironbark Nature Reserve (east of Barraba) and neighbouring properties. The species has not been recorded in a survey of other granitic outcrop areas in the region.	No suitable habitat within the site	Unlikely
Monotaxis macrophylla	Large-leafed Monotaxis	Species	N/A	Yes	N/A	N/A	Yes	N/A	Found in coastal heath, arid shrubland, forests and montane heath from sea level to 1300m altitude, subject to regular fire.	No suitable habitat within the site	Unlikely
Picris evae	Hawkweed	Species	N/A	Yes	N/A	N/A	Yes	N/A	Occurs within open Eucalypt forest including a canopy of E.melliodora, E.crebra, E.populnea, E.albens, Angophora subvelutina, Allocasuarina torulosa, Cunninghamiana with a Dichanthium grassy	Open Eucalypt woodland within site does not support Dichanthium spp. dominated ground layer and is marginal for	Unlikely

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									understorey. Recorded north of Inverell and at Oxley Park Tamworth.	the species.	
Polygala linariifolia	Native Milkwort	Species	N/A	Yes	N/A	N/A	Yes	N/A	Sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of Eucalyptus caleyi, Eucalyptus dealbata and Callitris, and in yellow podsolic soil on granite in layered open forest	Potential habitat within PCT 1194	Possible.
Prasophyllum sp. Wybong	Prasophyllum sp. Wybong	Species	N/A	Yes	N/A	N/A	Yes	N/A	A perennial orchid, appearing as a single leaf over winter and spring;1|Flowers in spring and dies back to a dormant tuber over summer and autumn;2|Known to occur in open eucalypt woodland and grassland ;3|	BioNet notes that the species is known to occur in open eucalypt woodland and grassland, however species records to not occur in habitats that are remotely similar to those present within the development	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										footprint. Impacts associated with the transport haul routes are to highly degraded road edges, that do not support habitat for the species. Records >100kms to the north-west and >75kms to the south-west of the subject land	
Pterostylis elegans	Elegant Greenhood	Species	N/A	Yes	N/A	N/A	Yes	N/A	Known to occur on red-brown loams at elevations between 950m and 1200m. Found among grass and shrubs in tall open Eucalypt forest.	BioNet notes that the species restricted distribution from the Barrington Tops to the Walcha district, which is outside the occurrence of the subject land. Records >20-25kms to the	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
										east of the subject land	
Pterostylis riparia	Pterostylis riparia	Species	Species	N/A	Yes	N/A	N/A	Yes	Grows on the edge of small streams under shrubs.;1|Forms small clonal colonies.;2|May be inundated during times of high flow.;3|	BioNet notes the species grows on the edge of small streams under shrubs, and is restricted to the Barrington Tops. Riparian habitats within the development footprint are degraded and generally relate to ephemeral first order watercourses at the highest point of the catchment. These areas do not support habitat for the species. Records >30-50kms to the east and south-east of the subject land	No

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
Commersonia procumbens	Commersonia procumbens	Species	N/A	N/A	N/A	N/A	Yes	Piliga sandstone	Grows in sandy sites, often along roadsides. The species is often found as a pioneer species of disturbed habitats. It has been recorded colonising disturbed areas such as roadsides, the edges of quarries and gravel stockpiles and a recently cleared easement under power lines.	No PCTs known to be associated with the species occur within the site	Unlikely
Senna acclinis	Rainforest Cassia	Species	Yes	N/A	N/A	N/A	Yes	N/A	Grows on the margins of subtropical, littoral and dry rainforests.;1|Often found as a gap phase shrub.;2|Flowering occurs in spring and summer and the fruit is ripe in summer and autumn.;3|Primarily pollinated by a variety of bees.;4|	Species grows on the margins of subtropical, littoral and dry rainforests. The subject land does not support habitat for the species. Records >40-60kms to the east and south-east of the subject land	No
Tasmannia glaucifolia	Fragrant Pepperbush	Species	Yes	N/A	N/A	N/A	Yes	N/A	Usually grows in or near Antarctic Beech Nothofagus moorei	Eucalypt forest within PCT 934, 931 and 927	Possible

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									rainforest along streams in mountain areas at altitudes of between 1200 and 1500 m altitude. Also occurs in tall scrub, on seepage lines in tall eucalypt forest and in grassy woodland.	offers marginal habitat for the species.	
Tasmannia purpurascens	Broad-leaved Pepperbush	Species	Yes	N/A	N/A	N/A	Yes	N/A	Grows in tall, moist eucalypt forest, sub-alpine woodland and cool temperate rainforest. Has been observed growing on cleared land, logged forest and graded fire trails.	Suitable habitat within open woodland and forest within the site (PCT 934, 931, 927 and 1194)	Likely
Thesium australe	Austral Toadflax	Species	Yes	N/A	N/A	N/A	Yes	N/A	It occurs in shrubland, grassland or woodland, often on damp sites. Vegetation types include open grassy heath dominated by Leptospermum myrtifolium, Hakea microcarpa, Callistemon sieberi, Grevillea lanigera, Epacris microphylla and Poa spp., Kangaroo Grass grassland surrounded by Eucalyptus woodland; and grassland dominated by	Suitable habitat within open woodland, Eucalypt forest and derived native grasslands.	Possible

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
									Cymbopogon refractus.		
Tylophora linearis	Tylophora linearis	Species	Yes	N/A	N/A	N/A	Yes	N/A	Grows in dry scrub and open forest. Records from low altitude (300-400m) sedimentary flats and dry woodlands of E.fribosa, E.sideroxylon, E.albens, Callitris endlicheri, Callitris glaucophylla and Allocasuarina luehmannii.	Associated PCTs within the subject land occur at higher altitudes than recorded for the species.	Unlikely
***Asterolasia* sp. 'Dungowan Creek'**	Dungowan Starbush	Species	Yes	N/A	N/A	N/A	Yes	N/A	In the vicinity of Dungowan Dam the Dungowan Starbush grows in rocky alluvial soil along a creekbank dominated by Casuarina cunninghamiana with or without Eucalyptus viminalis. Recent populations have been found growing near (100-150m) major drainage lines on lower and mid slopes in open forest in moderately deep brown loamy soils. Overstorey trees at these locations were dominated by Eucalyptus obliqua and E. nobilis with or without E. radiata ssp. sejuncta.	Marginal habitat within PCT 934.	Possible.

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BAM candidate species identification			Step 1: Identify threatened species for assessment					Step 2	Step 3: Identify candidate species credit species for further assessment		
Homopholis belsonii	Belson's Panic	Species	Yes	N/A	N/A	N/A	Yes	N/A	Grows in dry woodland (e.g. Belah) often on poor soils. Found mostly on heavy texture cracking soils derived from basalt or alluvials between 00-520m altitude.	Site lacks suitable habitat.	Unlikely
Euphrasia arguta	Euphrasia arguta	Species	Yes	N/A	N/A	N/A	Yes	N/A	Plants from the Nundle area have been recorded in Eucalypt forest with a mixed grass and shrub understorey. Also know to occur in highly disturbance areas including road edges	Suitable habitat within the assessment area	Likely

* Conservation advice taken from BioNet and Commonwealth SPRAT databases

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Appendix D Collision Risk Model Report

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Hills of Gold Wind Farm
Bird Collision Risk Assessment

Prepared for Arup Group Pty Ltd

30 September 2020

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1. Introduction

This document presents a collision risk assessment for birds at the proposed Hills of Gold Wind Farm, near Nundle New South Wales (NSW).

Biosis Pty Ltd has conducted a range of ecological assessments for the project. These surveys have included seasonal bird utilisation surveys at 21 sites across the wind farm study area. The data collected during those surveys forms the basis of the collision risk model presented in this report.

A background to risk modelling is provided in Section 1.1, and a description of the Biosis collision risk model can be found in Smales et al. (2013), provided in Appendix 1.

The risk modelling for Hills of Gold Wind Farm followed a three-stage approach, as detailed in this report. In the first stage, a brief evaluation was made of three different models of turbine that are under consideration for the project. The object of this stage was to ascertain which turbine might represent a 'worst-case' collision risk. This turbine was then used for subsequent stages of modelling with the intention that if either of the other two turbines are chosen for operational use by the project, the potential collision risk they pose will be lower than that presented herein.

In the second stage, the collision risk model was run to obtain results expressed as the probable annual number of flights at risk of collision (see Section 1.2.3) for all species that were recorded flying at rotor-swept height for the 'worst-case' turbine.

In the third stage, a likely size of the site-population was estimated for species of raptors and those values were incorporated into the model to obtain results expressed as the probable annual number of collisions (see Section 1.2.3) for those species.

1.1 Background to quantitative risk modelling

Collisions of birds and bats with wind turbines have been documented to occur at various frequencies around the world. Quantitative modelling to estimate the number of collision mortalities of threatened and non-threatened taxa is widely used as part of environmental impact assessments for proposed wind energy facilities (Masden & Cook 2016).

The impact of any collisions on the viability of threatened and non-threatened fauna populations is more important than determination of simple numbers of mortalities, and population models can be used in combination with results of collision risk models to evaluate such impacts, but population modelling would be a separate exercise to the collision risk modelling presented here.

Modelling of collision risk is reliant on empirical data for flights by species at the wind farm site. There is no practicable method to obtain species-specific flight data for bats that are likely to utilise the site and bat-call data does not provide information about the number of flights by bats. The modelling presented here is therefore confined to diurnal birds.

Mathematical modelling of risk is intended to provide an articulated, transparent and replicable evaluation of what may occur in the real world. The rationale behind projections is explicitly stated in the mathematics of a model, which means that the logical consistency of the predictions can be easily evaluated. The explicit nature of inputs and rigour entailed in modelling means that the process is replicable and consistent and it is open to analysis, criticism or modification when new information becomes available. Modelling is designed as a mechanism to evaluate uncertainties – if there was no uncertainty there would be no need to use a model. As a consequence of

uncertainty in various parameters, some assumptions are required and while it is necessary to include some assumptions and arbitrary choices when deciding on the structure and parameters of a model, these choices are explicit. To the extent feasible, assumptions are informed by the best available information.

Models are also valuable for their heuristic capacities as they focus attention on important processes and parameters entailed in risk (Brook et al. 2002). Their very nature facilitates incorporation of information as it is learnt (Burgman 2005) and refinements should thus be expected of any model.

Most factors related to the layout, dimensions and geometry of turbines are known. The risk modelling detailed here entails the use of informed assumptions related particularly to the flights of birds. The bird utilisation data collected from the site provides an empirical basis for extrapolations required for use in the model. We consider the assumptions and values used are reasonable and they are informed by available information about the ecology of relevant species. As a consequence, we consider the results of modelling detailed here provide a basis for evaluation of probable effects of the proposed Hills of Gold Wind Farm on relevant species of birds.

The only alternative to a quantitative modelling approach is one of qualitative subjective judgement. All the benefits of using mathematical modelling outlined above are difficult, if not impossible to achieve with a purely qualitative assessment.

1.2 Turbine collision risk model

The risk of birds colliding with turbines at the proposed Hills of Gold Wind Farm has been assessed using the Biosis Pty. Ltd. Deterministic Collision Risk Model. The model was first developed in 2002 and has been refined over time to incorporate new data and knowledge, and has been applied at a wide range of proposed wind farm sites in Australia. A full description of the model (Smales *et al.* 2013) is provided in Appendix 1.

1.2.1 Overview of the model

The collision risk model takes account of bird flights that occur within the height zone that will be occupied by turbines. Data for the number of flights and their heights was documented by a regime of fixed-time point counts at locations representative of future turbine locations across the site. The model uses the empirical sample of flight data for each species and extrapolates that to determine a potential number of such flights that might occur over an entire 12-month period. This factor takes into account what is known about seasonal presence of particular species that may be migratory or may be present only for part of the year for other reasons.

In the model, the turbine is decomposed into its static and dynamic components. The entire turbine (including the tower, nacelle and the rotor *when stationary*) represents the static component. The dynamic component is the volume swept by the leading edge of the rotor blades in the time it takes the species of interest to pass across the depth of the swept disk.

Since the turbine tower below rotor swept height is always a static component and poses minimal collision risk, the model takes this into account by dividing flights into those below turbine rotor height, and those within the height zone swept by turbine rotors and allocating different risk rates to these height classes.

The risk assessment accounts for a combination of variables that are specific to the proposed wind farm and to data for birds from the vicinity of the farm. They include the following:

- The numbers flights of each species below rotor height, and for which just the lower portion of turbine towers present a collision risk.
- The numbers of flights at heights within the zone swept by turbine rotors, and for which the upper portion of towers, nacelles and rotors present a collision risk.
- The numbers of bird movements-at-risk, as recorded during timed point counts, extrapolated to determine an estimated number of movements-at-risk the species makes in an entire year. Account is taken of the portion of the year that birds are within proximity of the site and that they may thus be at risk.
- The mean area (m^2 per turbine), of tower, nacelle and stationary rotor blades of a wind generator that present a risk to birds. Thus, the mean area presented by a turbine is between the maximum (where the direction of the bird is perpendicular to the plane of the rotor sweep) and the minimum (where the direction of the bird is parallel to the plane of the rotor sweep). The mean presented area is determined from turbine specifications supplied to Biosis for specific make and model of a turbine. It represents the average area presented to an incoming flight from any direction.
- The additional area (m^2 per turbine) presented by the movement of rotors during the potential flight of a bird through a turbine. This information is determined via a calculation involving species-specific, independent parameters of flight speed and body length and supplied turbine specifications.
- The model assumes that all turbines in the site represent equal risk.
- A calculation of the average number of turbines a bird is likely to encounter in a given flight through the site. This is based on the scattered configuration of turbines in the landscape and the total number of turbines proposed for the project.

1.2.2 Avoidance rate

Results are provided for various avoidance rates. Avoidance rate is the capacity for a bird to avoid a collision, whether that occurs due to a cognitive response on the part of a bird or not. Thus at the extremes of the rates applied, a 0.90 avoidance rate equates to one flight in 10 in which a bird takes no action to avoid a turbine and a 0.99 avoidance rate equates to one flight in 100 in which it does not avoid a turbine. Based on experience with a wide range of bird species, it is certain that virtually all species have high capacity to avoid collision with the static components of turbines. Avoidance rate for these components is thus consistently considered to be 0.999 in the modelling. Various avoidance rates are modelled for the dynamic turbine components because it is not certain how adept various species may be at evading collision with the moving rotor. For this reason, results are provided for 0.90, 0.95, 0.98 and 0.99 avoidance rates for the dynamic components (moving rotor) of turbines.

It should be noted that internationally there is very little empirical evidence for the actual avoidance rate for any bird species and for this reason it is prudent to provide a range of estimates that are considered to be reasonable. The evidence that is available suggests that avoidance capacity is species-specific and that the great majority of birds have very high avoidance capability that is higher than 0.98. Nonetheless, the avoidance rate of some large raptors in Australia appears to be between 0.93 and 0.95 (Smales et al. 2013; Smales 2017).

1.2.3 Result metrics – number of flights at risk vs number of collisions

Generally, the model's results are expressed as the number of flights at risk of collision per annum for each species. This is a relative measure that permits us to compare risk rates associated with various turbines or turbine configurations. It does not necessarily equate to the number of collisions that might occur because we do not know how many individual birds of each species use the site and may thus be at risk. The difference between flights at risk of collision and number of actual collisions can be simply explained by way of an example. If there are just two individuals of a given species occupying the wind farm, they may make multiple flights that could result in collisions, however the maximum number of fatalities that could occur is two. As can be seen from this example, the number of actual collisions can be no greater than the number of flights at risk, and if the site-population is small but the birds fly actively within the site, the number of collisions will always be considerably lower than the number of flights at risk.

In cases where a good estimate of the site-population for particular species can be made, the model permits that to be incorporated to provide results expressed as an annual estimate of collisions.

Existing knowledge of the population dynamics for most of the species at the Hills of Gold site, is not sufficient to allow an estimate to be made for their site-populations. However, for two resident raptors, an estimate of their possible site-populations has been made and the model has been run to provide a projection of results for them as an annual estimate of collisions.

The model cannot forecast the frequency of collisions around the predicted annual average and it is important to recognize that the number of any actual collisions that might occur can be expected to vary from year to year in a distribution around the average.

All results are provided to two significant figures, however they represent annual 'average' results and, of course actual bird fatalities will always be measured in numbers of individuals and the average results of modelling must represent a distribution that can be expected to vary from year-to-year around the mean.

2. Preliminary evaluation of turbine options

An array of 70 wind turbines is proposed for the Hills of Gold Wind Farm. At present the project is considering options for three different models of turbine (Vestas 5.6, GE 5.5, SGRE 6). The three turbines differ in various aspects that may affect the collision risk they pose to birds in flight. The differences include rotor-swept area, rotor-sweep height above the ground and rotor speed. As a consequence, the risk to various species of birds will differ between them in response to the documented data for flight heights.

The Biosis turbine collision risk model was initially applied to a single species (Wedge-tailed Eagle) for each of the three turbines with a view to providing a preliminary consideration of how they might differ and to determine which turbine might represent a 'worst-case' collision risk. Wedge-tailed Eagle was chosen for this purpose because it had the greatest number of flights recorded at the site that were within rotor-swept height for all three turbines. An avoidance rate of 0.95 was used (see below and Appendix 1). The size of the population of Wedge-tailed Eagles at risk for the project was determined as set out under *Raptor populations at-risk*, below.

Results of the preliminary assessment of the three turbines are shown in Table 1.

Table 1 Comparison of three turbine models for a configuration of 70 of each turbine. Results show projected annual collision mortalities of Wedge-tailed Eagles at 0.95 avoidance rate.

Turbine model	Projected annual collision mortalities of Wedge-tailed Eagles at 0.95 avoidance rate
Vestas 5.6	3.71
GE 5.5	2.90
SGRE 6	3.23

On the basis of the preliminary evaluation it was determined that the Vestas 5.6 turbine represents the likely 'worst-case' collision risk for birds at the proposed Hills of Gold Wind Farm. While it has a slightly smaller rotor-swept area than the SGRE 6 turbine, it has a greater rotor speed and that can factor significantly in collision risk for birds.

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3. Model inputs and assumptions

The Biosis collision risk model requires a range of numeric inputs, to quantify the number of turbines, key dimensions of turbines, and to estimate bird utilisation characteristics, including the number of flights within and outside of rotor swept height for species to be included in the model.

3.1 Wind farm and turbine parameters

The collision risk model requires input values for 36 turbine parameters that include number and layout of turbines and multiple aspects of turbine dimensions and geometry.

Following the results of the preliminary evaluation, the collision risk model was run for the Vestas 5.6 turbine.

Key parameters used in this modelling are:

- Number of turbines: 70
- Turbine type: based on Vestas 5.6
- Turbine tower height: 139 m
- Rotor diameter: 162 m
- Rotational speed: 12.1 rpm

The rotor-swept area is 17331.5 m^2. The 162 metres diameter blades have a length of 81 metres, resulting in rotor swept height between 58 and 220 metres above the ground.

The landscape configuration of the proposed Hills of Gold Wind Farm is essentially a linear row of turbines. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, a bird has a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that a bird is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The collision risk model has a built-in function to account for this difference whereby the turbine array can have any setting from 100% of turbines fully clustered to 0% in which turbines are entirely linearly configured. Given the slight sinuosity of the ridge-top array, this factor was set to 5%.

3.2 Bird species data

Following the results of the preliminary evaluation, the collision risk model was run for all species for which there were any flights recorded at rotor-swept height for the Vestas 5.6 turbine. That included all flights documented from between 58 and 220 metres above the ground.

A total of 51 species of birds were recorded during investigations of the Hills of Gold site. While all of them may have capacity to fly at rotor swept height, 18 species were recorded doing so, and thus have data available for use in the model. They are listed in Table 3, below.

White-breasted Woodswallow is the only one of the modelled species that is known to be present seasonally as its population migrates to inland and northern Australia during the winter. It was modelled as being present at the site for nine months per annum.

With the exception of two species of raptors (Section 3.2.1), it is not feasible to estimate the site-population sizes of the species modelled. As a consequence, model results for those 16 species are expressed as the

number of flights at risk of collision per annum. The resident raptors, Nankeen Kestrel and Wedge-tailed Eagle, tend to occupy territories that remain stable over periods of several years and, because they are apex predators they occur at relatively low densities. In light of published studies for those species, Biosis undertook a process to estimate the sizes of their potential populations for the site. For those two species it was thus possible to run the model to provide results expressed as annual estimate of collisions.

3.2.1 Estimating site-populations for raptors

Information was collated from published sources to ascertain the likely number of Wedge-tailed Eagles and Nankeen Kestrels that might occupy the site and thus be at some risk of turbine collision. Brown Goshawk was recorded once only and is not considered further. There are a number of relevant studies of Wedge-tailed Eagle, but less for Nankeen Kestrel. Information for the latter was drawn from data collated in Marchant and Higgins (1993). The population dynamics of neither species has been studied at the Hills of Gold Wind Farm site.

The first item of information relates to average home-range size or documented spacing between home-ranges and to the number of birds that might occupy a given home-range. The second requires an understanding of the likely number of flying birds that might occupy a given territory. For the two species in question, published data indicates that they function as territorial pairs that usually attempt to raise one brood per annum. For the purposes of considering collision risk, the number of birds occupying a territory thus includes the adult pair and the average number of their offspring that fledge.

Wedge-tailed Eagle

Cherriman (2007) provided an overview of studies, including his own, that have investigated the size of Wedge-tailed Eagle territories in temperate regions. Territory sizes in studies near Perth (Cherriman 2007); at two other sites in the south-east of Western Australia (Ridpath and Brooker 1987); near Canberra in south-eastern Australia (Leopold and Wolfe 1970); and, in South Australia (Rowe et al. 2017) were all between 31 km² and 42 km². Foster and Wallis (2010) studied the species west of Melbourne and recorded nearest-neighbour distances averaged 4.7 kilometres. In a study in western NSW, Sharp et al. (2001) found the mean distance to nearest neighbour between Wedge-tailed Eagle nests was in the order of 1 pair per 3–9 km^2. They noted this was considerably higher than that noted in other semi-arid zone studies (~1 pair per 40–48 km^2).

Using a conservative mean Wedge-tailed Eagle territory size of 30 km², the average diameter of a territory would be slightly greater than 12 kilometres. As a consequence, we have based the modelling exercise for Wedge-tailed Eagles on the assumption that the 26 kilometre linear array of the proposed wind farm may intersect with three territories, occupied by six adult birds.

Cherriman (2013) reported that breeding productivity (number of chicks fledged) was 0.73 young per pair, across 15 occupied territory-years. Debus et al. (2007) recorded very similar results with 10 young produced in 12 pair-years, equating to 0.8 young fledged per pair per year. On the basis of those studies, we have conservatively assumed that, on average, three pairs will be accompanied by a total of three flying juveniles, bringing the average site-population of Wedge-tailed Eagles to a total of 9. Hence we have modelled for this number of birds as being at potential risk of collision.

During field investigations of the site, Biosis staff documented one instance each in which three, four and five Wedge-tailed Eagles were observed simultaneously.

Nankeen Kestrel

Near Armidale, NSW, one pair of Nankeen Kestrels occupied at least 200 hectares (2 km^2) (Genelly 1978) and active nests were recorded approximately 1 kilometre apart (Baker-Gabb 1985). Near Mildura, Victoria, 12 pairs were documented from an area with a 10 kilometre radius (i.e. approx. 314 km^2), and 25 nests averaged

1-3.6 kilometre apart equating to 1 pair per 5.4 km² (Baker-Gabb 1984). At Millewa, Victoria, Campbell (1986) reported an average of 1 active pair per 5.3 km² [all references in Marchant and Higgins (1993)].

Using a conservative mean Nankeen Kestrel territory size of 5.3 km², the average diameter of a territory would be approximately 2.6 kilometre . As a consequence, we have based the modelling exercise for Nankeen Kestrels on the assumption that the 26 kilometre linear array of the proposed wind farm may intersect with 10 territories, occupied by 20 adult birds.

Baker-Gabb (1984) reported a mean number of 1.3 fledglings per territorial pair. On the basis of that study, we have assumed that, on average, 10 pairs will be accompanied by a total of 13 flying juveniles, bringing the average site-population of Nankeen Kestrels to a total of 33 and we have modelled for this number of birds as being at potential risk of collision.

4. Model results

4.1 Raptors

Collision risk model results for Nankeen Kestrel and Wedge-tailed Eagle are shown in Table 2. As discussed earlier, informed assumptions have been made for the possible site-population sizes of these two species, and results for them are provided here expressed as projected numbers of annual average collisions. Results are provided for four potential avoidance rates.

Experience with these two species at wind energy facilities in south-eastern Australia demonstrates that both Nankeen Kestrels and Wedge-tailed Eagles collide with wind turbines (Moloney et al. 2019). For Wedge-tailed Eagles there is some published empirical data (Smales et al. 2013) and more recent unpublished data for actual mortalities available to validate the outputs of the Biosis collision risk model. That evidence suggests that the model's projections accurately equate to avoidance capacity of between 0.90 and 0.95. As with any forward-projection modelling, the accuracy of the results presented here for the proposed Hills of Gold Wind Farm, will depend upon the precision of all assumptions used for the modelling process.

Table 2 Collision risk model results for 70 x Vestas 5.6 turbines for two raptors at Hills of Gold Wind Farm site

Common name	Scientific name	Dynamic rotor avoidance rate			
		0.90	0.95	0.98	0.99
Nankeen Kestrel	*Falco cenchroides*	0.36	0.20	0.10	0.07
Wedge-tailed Eagle	*Aquila audax*	5.86	3.71	1.77	0.98

4.2 Other species

Collision risk model results for all 18 species of birds that were documented flying within rotor-swept height of the Vestas 5.6 turbines as proposed for Hills of Gold Wind Farm, are shown in Table 3. As discussed earlier in the report, information about the possible site-population sizes of 16 of these species is not available, and results for them are provided here expressed as projected numbers of annual flights that may be at risk of turbine collisions. Results are provided for four potential avoidance rates.

Fewer than 20 flights were recorded during the total of all point count field observations for the species shaded grey in Table 3. In cases such as these where the sample size of flights is low, it is possible that the model results may be less reliable than they are for species that were recorded more frequently. If the low number of observations for those species indicates that they occur relatively infrequently, or make few flights, that may still indicate that their risk is relatively low. We include them here for completeness, but under the caveat that the model's estimates for them may be less certain than the results for species with a greater number of records.

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Table 3 Results for 70 x Vestas 5.6 turbines for 18 species of birds recorded within RSH at Hills of Gold Wind Farm site

Common name	Scientific name	Dynamic rotor avoidance rate			
		0.90	0.95	0.98	0.99
Brown Goshawk	*Accipiter fasciatus*	0.24	0.12	0.05	0.03
Galah	*Cacatua roseicapilla*	0.34	0.17	0.07	0.04
Nankeen Kestrel	*Falco cenchroides*	0.36	0.20	0.10	0.07
White-browed Treecreeper	*Climacteris affinis*	1.08	0.54	0.22	0.11
Australian Magpie	*Gymnorhina tibicen*	1.07	0.61	0.33	0.24
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	3.27	1.64	0.67	0.34
Laughing Kookaburra	*Dacelo novaeguineae*	0.73	0.38	0.16	0.09
Red Wattlebird	*Anthochaera carunculata*	0.59	0.38	0.25	0.21
Spotted Pardalote	*Pardalotus punctatus*	1.03	0.52	0.21	0.11
Common Starling	*Sturnus vulgaris*	0.30	0.16	0.08	0.05
Rainbow Lorikeet	*Trichoglossus haematodus*	0.52	0.26	0.11	0.06
Crimson Rosella	*Platycercus elegans*	0.62	0.35	0.20	0.14
Little Wattlebird	*Anthochaera chrysoptera*	1.70	0.87	0.36	0.20
Pied Currawong	*Strepera graculina*	1.99	1.02	0.43	0.24
White-breasted Woodswallow	*Artamus leucorynchus*	1.67	0.84	0.35	0.18
Australian Raven	*Corvus coronoides*	4.02	2.04	0.86	0.46
Sulphur-crested Cockatoo	*Cacatua galerita*	3.95	2.01	0.84	0.45
Wedge-tailed Eagle	*Aquila audax*	9.46	4.78	1.97	1.03

5. Conclusion

A total of 51 species of birds were recorded during investigations of the Hills of Gold site. While all of them may have capacity to fly at rotor-swept height, 18 species were recorded doing so and the Biosis turbine collision risk model was run for them. The modelling was undertaken for 70 x Vestas 5.6 turbines after preliminary assessment suggested that this turbine is likely to represent a greater collision risk than two other types of turbines under consideration for operational use by the project.

None of the species involved are listed within any category of threat status under New South Wales or Commonwealth legislation.

Informed assumptions were able to be developed and employed for the potential site-population sizes of Nankeen Kestrels and Wedge-tailed Eagles and this permitted the model to provide projections expressed as average numbers of potential collisions per annum for those two species. Depending upon avoidance capacity and all other assumptions used for Nankeen Kestrels the model returned a likely range of between 0.36 and 0.07 collisions for that species per annum. Under the same caveats for Wedge-tailed Eagles, the likely range was between 5.86 and 0.98 collisions per annum. Empirical evidence from some wind farms in south-eastern Australia suggest that avoidance capacity for this species at those sites has been between 0.90 and 0.95.

For 16 other species, of birds collision risk modelling provided results expressed as average numbers of their flights that might be at risk of turbine collisions. For nine of those species the model indicates that they might make between one and four flights per annum that would be at some risk of collision assuming their collision avoidance capacity was no greater than 0.90. This is considered to be a very low avoidance rate and most birds appear to avoid turbine collisions at a significantly higher rate than that. On the basis of the bird utilization data collected for these birds at the site, and other assumptions entailed in the modelling, it is reasonable to conclude that the number of actual collisions that might occur per annum for all of these species would be lower than the number of their flights-at-risk.

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Appendix 1

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Wind Energy and Wildlife Conservation

A Description of the Biosis Model to Assess Risk of Bird Collisions With Wind Turbines

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ABSTRACT We describe the model of Biosis Propriety Limited for quantifying potential risk to birds of collisions with wind turbines. The description follows the sequence of the model's processes from input parameters, through modules of the model itself. Aspects of the model that differentiate it from similar models are the primary focus of the description. These include its capacity to evaluate risk for multi-directional flights by its calculation of a mean presented area of a turbine; its use of bird flight data to determine annual flux of movements; a mathematical solution to a typical number of turbines that might be encountered in a given bird flight; capacity to assess wind-farm configurations ranging from turbines scattered in the landscape to linear rows of turbines; and the option of assigning different avoidance rates to structural elements of turbines that pose more or less risk. We also integrate estimates of the population of birds at risk with data for numbers of their flights to predict a number of individual birds that are at risk of collision. Our model has been widely applied in assessments of potential wind-energy developments in Australia. We provide a case history of the model's application to 2 eagle species and its performance relative to empirical experience of collisions by those species. © 2013 The Wildlife Society.

KEY WORDS bird, collision, model, risk, turbine, wind energy.

A number of mathematical models have been developed for the purposes of either describing the interaction of a bird with a wind turbine or to predict the risks of bird collisions with turbines (Tucker 1996*a*, *b*; Podolsky 2003, 2005; Bolker et al. 2006; Band et al. 2007). Tucker (1996*a*, *b*) and Band et al. (2007) detailed their models in the peer-reviewed literature. The collision risk model developed by Biosis Propriety Limited has been widely used to assess wind-energy developments in Australia since 2002, but it has not previously been described in detail. Given high levels of interest in effects of wind turbines on fauna, we believe it is important for the model to be accessible.

Our model provides a predicted number of collisions between turbines and a local or migrating population of birds. It has the potential to be modified to accommodate Monte-Carlo simulation, although at its core it uses a deterministic approach. It is modular by design, and allows various customizations, depending upon the unique configuration of the wind facility and characteristics of the taxa modeled.

The initial calculation involves species-specific parameters for speed and size of birds and specifications of the turbine, including its dimensions and rotational speed of its blades. Using these parameters, we derive the mean area of turbine presented to a bird in flight. This allows the model to accommodate flight approaches from any potential direction. Alternatively, unidirectional flights can be modeled by using the relevant turbine surface area presented to birds approaching from a given direction.

Data for bird flights are collected at the wind-farm site according to a specific and consistent field methodology. These data are used to determine the flux (density) of bird flights. When combined with turbine specifications, this yields the probability of collision during a single flight–turbine interaction. The density flux approach has not been used for this application previously.

The number of movements at risk of collision with one turbine is then scaled according to a typical number of turbines that a bird might encounter in a given flight. This is further refined by a metric for the capacity of the particular species to avoid collisions. Where a population census or estimate is available for the number of birds that may be at risk, a further deduction is used to attribute the number of flights-at-risk to individuals, and hence provide a final model output as the number of individuals at risk of collisions. The ability to transform from flights-at-risk to individuals-at-risk has been uniquely developed and applied as a routine component of our model.

DESCRIPTION OF THE MODEL

The model requires data for input parameters and, using these, functions in a sequence of modules (Fig. 1).

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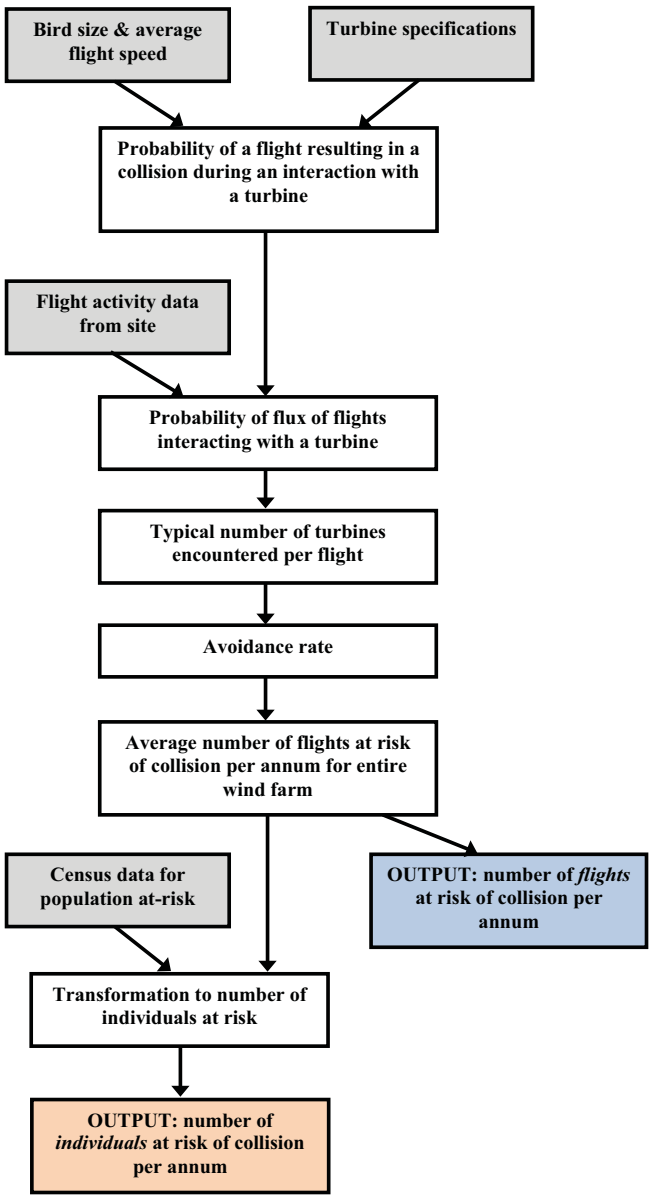

Figure 1. Overview of the collision risk model that quantifies risk to birds of colliding with wind turbines, showing input parameters (gray boxes), modules, and sequence.

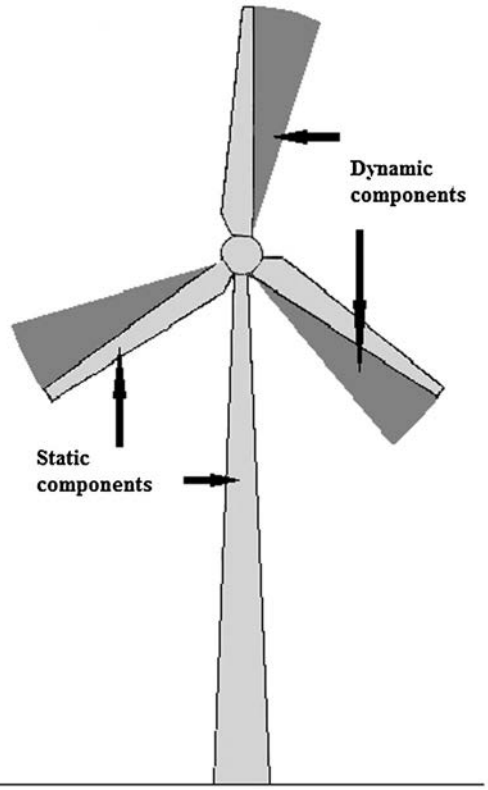

Figure 2. Schematic indication of the static and dynamic components of a wind turbine that may be encountered by a flying bird. The dynamic component is the area swept by rotor blades during the time that a bird of a particular species would take to pass through the rotor-swept zone.

Model Inputs

Turbine parameters.—The primary risk faced by a flying bird, whether it may strike or be struck by a turbine, is that the machine presents a potential obstacle in its path. Ultimately this equates to the surface area of the turbine presented to the bird from whatever its angle of approach. Other models, such as probably Band et al. (2007), use individualistic representations of birds. Our model uses a projection of the presented area onto all possible flight angles. For this reason, multiple dimensions of turbine components and rotor speed for the particular type of turbine are used as input values to the risk model. Turbine specifications are as provided by the machine's manufacturer.

The modeled wind turbine consists of 2 fundamental components representing potentially different risks. We refer to these as the static and dynamic components (Fig. 2). The static areas of a turbine include all surfaces of the entire machine comprising a tower, which in current turbines is a simple taper with known base and top diameters; a rectangular nacelle housing the generator; a hemi-spherical hub; and rotor blades that taper in 2 planes. The dynamic component is the area swept by the leading edges of rotor blades during the time that a bird would take to pass through the rotor-swept zone.

Size and flight speed of birds.—For each taxon, the model requires values for the total length of the bird in flight, from bill tip to tip of the tail or outstretched legs, and the average speed of the species' flights. We obtained bird lengths either from museum specimens or from standard ornithological texts.

Accurate determinations of bird flight speeds can be complex and difficult to obtain (Videler 2005, Pennycuick 2008) and published data are not available for most species. However, published radar studies (e.g., Bruderer 1995, Bruderer and Boldt 2001) provide ranges of flight speeds for a variety of species, including congenerics with similar morphologies and ecological traits to a number of species we have assessed. Use of radar to collect bird flight data at the wind-farm site may provide flight speeds for species of interest. We consider that average ground speed (as opposed to air speed) is appropriate for modeling of multidirectional movements of birds.

Bird flight data.—The model requires data from the wind-farm site for the number of flights made by species of interest within a measured time and volume of airspace. Movement data may be obtained from fixed-time point counts using a methodology adapted from Reynolds et al. (1980), incorporating an effective detection range (Buckland et al. 1993). It may be collected by human observers or by using horizontal and vertical radar combined with call recording or visual species identification (e.g., Gauthreaux and Belser 2003, Desholm et al. 2006). Data represent the number of flights that birds make within a cylinder of airspace that is centered horizontally on the observer and the height of which is the maximum reached by rotor blades of the turbines. The data collection regime is designed with the aim of providing a representative sample of flight activity across the local range of diel, seasonal, and other environmental variables.

Model Modules

Probability of a single flight interacting with a turbine.—In some situations, such as during highly directional migratory passage, the presented area of turbines is determined from the angle of the birds' flight relative to the compass orientation of turbines. However, for the great majority of species (including temporary or permanent residents at an on-shore wind farm) this does not apply, and flights can be expected to approach turbines from any direction. For this situation, all dimensions of the turbine contribute to the area with which a flying bird might collide and the model uses a simple integration to determine a mean presented area. This represents a substantial advance over other collision risk models that depend on the assumption of a specific angle of approach as a bird encounters a turbine (e.g., Tucker 1996*a*, *b*; Bolker et al. 2006; Band et al. 2007).

We calculate the area presented by the static components of a turbine using a conservative assumption that none of them overlap or obscure any others. The area of each component is calculated individually, and these are then summed to determine a total static area for the turbine. Static areas are calculated from the simple length × width dimensions of all components visible by line of sight. These are then projected onto an arbitrary approach direction (effectively scaling by the cosine of the approach angle). For example, viewed directly from one side, only the side panel of the nacelle is visible. However, approached from 45° to the turbine, both the front and side panels are visible, and are thus scaled by $\cos(45) \varrho 1/\sqrt{2}$ to match that particular angle of view.

We calculate the dynamic area, swept during the movement of blades, from the dimensions of the stationary blades and the distance they travel at their average speed during the time taken by a bird to fly through the rotor-swept area. We assume that all flights involve forward movement, so the swept-area is derived from the length and speed of the particular species of bird, in combination with the thickness of the sweeping blade.

Each rotor blade is tapered in 2 planes. Thus the thickness of the blades, used to determine the time taken for a bird to cross through the swept area, is actually a function of the point in the rotor radius at which an individual bird's flight intersects the swept area. This presents a complication that we overcome by defining an effective blade, which is a simple rectangular cross-section that sweeps out precisely the same volume of space as the physical blade. In doing so, we calculate a constant thickness of blade that accounts for the fact that the thinner tips actually sweep far more space than the thicker base of the blade. This ensures also that our flux calculation is not compromised by introduction of a spatial variation at odds with other aspects of the model.

A further input parameter is the percentage of time per annum when rotors are not turning due to inappropriate wind speeds and routine turbine maintenance. Prior to commissioning of a wind farm, wind speed data are usually gathered and the expected percentage of downtime due to inappropriate wind speeds is determined. During downtime periods the rotor simply stops turning; and so risks associated with dynamic components only are reduced by this percentage of time, while all static components of the turbine remain as potential obstacles to flying birds.

Combining all presented areas of the turbine.—Modeling for multidirectional bird movements requires no dependence on approach angles nor on complexities of interactions between flight direction and wind direction. We thus reduce the turbine to its mean presented area. This is solved by the equation

$$\frac{1}{\pi}\int_0^{\pi} A(\theta)\,\mathrm{d}\theta$$

where A is the presented area of the turbine as a function of approach angle θ. We solve this numerically using a trapezoidal integrator (Press et al. 1992).

Probability of multiple flights interacting with a turbine.—Because counts of bird flights have been made across the wind-farm site and there is no obligatory relationship between point-count locations and particular sites proposed for turbines, we combine the data collected from all point counts. This provides a measure of flight activity, which is assumed to be constant across the site. Thus the field data reduce to a single ratio value for the subject species, which is the sum of all flights documented during all counts divided by the total time of observations. This equates to a maximum likelihood estimation of the mean of an assumed Poisson distribution.

To calculate a number of flights at risk of collision, we first reduce documented bird movements (M) to a measure of flux (F) using the equation

$$F = \frac{M}{T_{\mathrm{obs}} A_{\mathrm{obs}}}$$

where T_{obs} is the combined total time of all point counts and A_{obs} is the area of the vertical plane dissecting the observation cylinder. This flux is a measure of bird movements per time per square meter of vertical airspace. The third dimension, volume of airspace, is redundant (or tacit) due to the

assumption that, unless involved in a collision, flight paths do not end arbitrarily in space.

We next multiply activity measure by the number of minutes in which the species is active during the 24-hour diel period, T, and the total presented area of the turbine, A. For year-round resident species, the "active minutes" are calculated for the entire year, while for seasonal or migratory species, they are calculated for the portion of the year that the species is present at the site. This then gives a measure of risk to the bird movements, $M_{\text{risk}} = \text{FTA}$.

Because the flight data are a measure of movements by the species in question and do not discriminate the number of individuals making the movements, the measure (M_{risk}) quantifies the total movements-at-risk for the species and does not reflect risk to individual birds.

To determine a risk rate from total of recorded movements-at-risk, it is necessary to extrapolate to a total number of expected bird movements per annum, M_{yearly}. We calculate this from the flight data, extrapolating the movements to a yearly total through the equation

$$M_{\text{yearly}} = M \frac{T_{\text{yearly}}}{T_{\text{obs}}}$$

We then deduce a probability of flights at risk of collision as $M_{\text{risk}}/M_{\text{yearly}}$. Note that T_{year} is the total time in a year, and not the diel activity period of the species, which has already been factored into the calculation of movements at risk.

The resultant value is now a probability of flights being at risk of collision with a single turbine. To this point, no account is taken of the bird's own ability to avert a collision. This is modified later through use of an avoidance factor.

Estimating number of turbines encountered per flight.—Every turbine is presumed to represent some risk for birds, so the total number of turbines proposed for the wind farm is an input to the model. Turbine layout of modern wind farms is primarily determined by the wind resource and turbines are micro-sited accordingly. Consequently, the machines are usually scattered on the landscape. Older wind farms had turbines arrayed in rows, and occasional modern facilities may be linear where they follow a single topographic feature.

To account for the number of turbines with which a single flight might interact, it would be necessary either to know precisely the route of every flight or to make informed assumptions about flight paths. The manner in which turbines are arrayed in the landscape is important to ascertain a typical number of turbines that a bird might encounter in a given flight. This number differs according to whether turbines are in a scattered array or a single row, and these require different calculations.

For a row of turbines, the likely number of encounters can be visualized by considering a row of N turbines in plan view and a flight path at angle Φ to the row. A flight directly along the line of turbines (Φ') will interact with all N turbines. As the angle of flight relative to the row increases toward 90°, flight paths have potential to interact with fewer turbines until an angle (Φ'') is reached at which the path has potential to interact with a maximum of one turbine.

For a single row of turbines, we define the piecewise smooth function, which gives the number of turbines for a given angle of crossing with,

$$n_{\text{interaction}} = \begin{cases} N, & \text{if } \theta \le \phi\prime \\ \cot(\theta), & \text{if } \phi' < \theta \le \phi'' \\ 1, & \text{if } \phi'' < \theta \le \frac{\pi}{2} \end{cases}$$

This gives us an expected number of interactions as

$$\langle n_{\text{interaction}} \rangle = \frac{2}{\pi} \left[N \arctan\left(\frac{1}{N}\right) + \frac{\pi}{4} - \ln\left(\sqrt{2}\sin\left(\arctan\left(\frac{1}{N}\right)\right)\right)\right]$$

For scattered turbine arrays it is not realistic to assume that a bird will encounter all turbines in the wind farm in a given flight. We assume each flight has potential to cross between any 2 points on the outer edges of the farm. Given the size of most on-shore wind farms, this is a reasonable assumption for typical species of concern, such as raptors. When multiple flight paths are drawn randomly across the plan view of a wind farm, some paths may be circuitous and have potential to encounter many turbines, while others will pass through a small portion of the site and have potential to encounter relatively few turbines.

To deduce an average number of turbines likely to be encountered by any flight we use a topological, non-affine mapping technique. This spatial transformation can be illustrated as follows: if we were to throw a lasso around the perimeter of the site and shorten it to its minimum, we would find that all the turbines had collected in a circle. A straight flight path through this "lassoed" site is mathematically equivalent to a random walk across the unconstrained layout. The average of all flight paths crossing the center of this remapped farm will intersect with $\sqrt{N}$ turbines (where N is the total no. of turbines in the wind farm). This value is used in the model for the number of turbines that might be encountered per flight within a scattered turbine array.

For arrays that are neither entirely scattered nor linear, the model employs a simple weighted average of the values for fully scattered and entirely linear arrays.

Application of turbine avoidance capacity.—Birds have substantial ability to avoid obstacles; therefore, it is necessary to incorporate this capacity into the model. In common with other workers (Percival et al. 1999), we use "avoidance" in specific reference to behavior on the part of a bird that averts a potential collision with a turbine. The "avoidance rate" equates to the proportion of flights that might otherwise have involved interaction with a turbine but where the bird alters course and the flight does not result in a collision. For the purposes of the model it is of no consequence whether or not this is a result of a cognitive response by the bird to the presence of the turbine.

Turbine avoidance remains little-studied for any species, and empirical information about actual avoidance can be obtained for a given site only by studying the responses of birds in the presence of operational turbines (Chamberlain et al. 2006). One recent investigation has compared flight behaviors of 2 species of eagles in the presence of turbines at

2 operating wind farms with their behaviors at a site without turbines (Hull and Muir 2013).

Avoidance rate is incorporated into the model by scaling the movements at risk by $(1 - v)$, where v is a measure of the bird's ability to avoid objects. In this scenario, $v = 0$ corresponds to a blind, non-responsive projectile, and $v = 1$ represents a perfectly responsive bird able to avoid any object.

A novel feature of our model is its capacity to apply different avoidance values to the static and dynamic portions of a turbine. As noted by Martin (2011), birds are known to collide with both stationary and moving parts of turbines. This aspect of our model allows for differences in capacity of birds to detect and avoid the large, static components of modern turbines relative to their capacity to detect and avoid the small and fast-moving leading edges of rotor blades.

Size of population at risk.—When information about the size of the population at-risk is available, this can be factored directly into our model to provide results in the form of an expected number of individuals at risk of collision per annum. This is an important consideration because an input measured in terms of bird movements cannot provide an output in terms of individual birds. This aspect appears to have been largely overlooked by other workers, although Chamberlain et al. (2006) alluded to the use of a number of flights only, without incorporation of the number of individuals, as a potential issue in evaluation of collision estimates provided by the Band model (Band et al. 2007).

To deduce a predicted number of individual birds that are at risk of collision, a valid estimate is required of the number of individuals that may interact with turbines at the wind farm in the course of a year. If it is not feasible to obtain this for a species, then the output of the collision risk model will necessarily be the number of flights-at-risk per annum. Although this metric is not predictive of the number of individuals that might collide, it permits risk to be compared for various designs of a wind farm or between one facility and another. In rare cases, such as where there is a single migration passage through the site per annum, the number of movements may equate with the number of individual birds that are at risk. The great majority of risk modeling we have undertaken has been for raptors that are year-round residents. Due to their territoriality and relatively low densities, our studies at wind-farm sites have been able to ascertain the number of individuals using a site per annum, including both resident adults and juveniles, with a high level of confidence. For some other species, such as cranes (Gruidae), we have undertaken home-range studies to determine numbers present during the breeding season, and we have obtained local census data to estimate numbers of individuals that might encounter turbines during non-breeding seasons.

Given a population estimate, the number of flights at risk is attributed equally to the relevant number of individuals through the simple relation $M_{\text{individuals}} = \text{Yearly Movements}/\text{Population}$. We can then attribute individual mortality through

$$\text{mortality} = \text{Population}\left(1 - \frac{\text{Movements At Risk}}{\text{Yearly Movements}}\right)^{M_{\text{individuals}}}$$

MODEL VALIDATION

The model we describe here has been used to assess potential turbine collision risk for numerous species of birds for 23 commercial-scale wind farms proposed in Australia and one in Fiji. Eleven of these facilities have subsequently been built and are now operational. The model's projections have been used by regulatory authorities in determination of approval or modification to wind-farm designs for a range of species of concern. These include taxa as diverse as the orange-bellied parrot (*Neophema chrysogaster*), wedge-tailed eagle (*Aquila audax*), brolga (*Grus rubicunda*), and the large and readily observable Pacific fruit-bat (*Pteropus tonganus*) in Fiji.

The model's performance can be validated only when it can be compared with post-construction mortality data that are sufficient to permit calculation of an actual annual mortality rate and a 95% confidence interval for that rate. Conditions of regulatory approval for most wind farms that have been built to-date in Australia have varied considerably between state jurisdictions and over time. Generally they have not required rigorous investigation or public reporting of avian collisions that occur during operation. We have thus had limited opportunity to validate our model against empirical information for actual collisions. However, where these are available, we can compare the model's predicted average estimates with the measured confidence interval for actual mortalities to assess its predictive capacity. We present one such case study below.

Comparing the Model's Predictions With Empirical Data—A Case History

Substantial investigations have been undertaken at Bluff Point and Studland Bay wind farms in northwestern Tasmania entailing a number of studies of wedge-tailed eagle and white-bellied sea-eagle (*Haliaeetus leucogaster*). These have included utilization surveys designed to measure eagle activity before and after development of the wind farm; collision monitoring; eagle breeding success; eagle behaviors and movements relative to turbines and observers; and investigations and trials aimed at reduction of collisions (Hull et al. 2013). Commissioning of turbines began at Bluff Point Wind Farm in 2002 and at Studland Bay Wind Farm in 2007. Bluff Point Wind Farm consisted of 37 Vestas V66 turbines in a scattered array on an area of 1,524 ha. Studland Bay Wind Farm was situated 3 km south of Bluff Point and comprised 25 Vesta V90 turbines in a scattered array over an area of 1,410 ha. Both wind farms were close to the coast of northwestern Tasmania and resident white-bellied sea-eagles and Tasmanian subspecies of wedge-tailed eagle (*A. a. fleayi*) occurred at both sites.

Monitoring Eagle Flights

Movement data for both species were collected during point counts at Bluff Point Wind Farm site in 3 years prior to construction of turbines and in 4 years after they commenced operating. At Studland Bay, they were collected in 6 years prior to turbine construction and in 3 years after turbines commenced operation. As prescribed by regulatory authorities, point counts were undertaken in the austral autumn and spring. Ten replicate point counts were made in each season

at 18 locations per wind farm. There were 545 point counts undertaken at Bluff Point between 1999 and 2007 and 854 point counts at Studland Bay between 1999 and 2009.

Collision Risk Model Results

We used the model to estimate risk based on movement data collected prior to construction for populations of 6 wedge-tailed eagles and 4 white-bellied sea-eagles at-risk per annum at each of the 2 wind farms.

State regulatory authorities have required that the collision risk model be re-run with the accumulated sum of eagle movement data obtained during the entire period of both pre-construction and operation of the 2 wind farms spanning the period from 1999 to 2009 (Table 1). We modeled static avoidance rate at 99% in all cases.

Documented Eagle Collisions

Carcass monitoring surveys were conducted at the Bluff Point and Studland Bay wind farms since they commenced operating. Fences to exclude mammalian scavengers were maintained at 27% of turbines across the 2 sites. All turbines, both fenced and unfenced, were searched routinely within a 100-m radius of the tower base. Search frequency was initially informed by trials to determine rates of loss to scavengers and of observers' capacity to detect carcasses. Since 2007, searches were carried out twice weekly during periods that may have represented higher risk to the species (i.e., eagle display period Jun–Aug, inclusive; and eagle fledging period mid-Dec–Feb, inclusive) and fortnightly outside these periods (Hull et al. 2013). Assessment of the extent of undetected eagle collisions (Hydro Tasmania 2012; Hull et al. 2013) concluded that it is unlikely that significant numbers of eagle carcasses were missed because they are conspicuous; the search zone around turbines was adequate to detect eagle carcasses where they will fall after colliding with turbines (Hull and Muir 2010); personnel on site had capacity to detect carcasses that may have been moved from the formal search zones; eagle carcasses in vegetation were found not to decompose readily and, even when scavenged, remains were identifiable; avian scavengers did not remove all evidence of carcasses and, although mammalian scavengers could remove carcasses, this was controlled at the subset of fenced turbines; survey intensity was informed by predetermined scavenger removal rates; and, although a small number of eagles survived collision with a turbine, in all documented cases such birds were unable to fly and are likely to have been detected because both scavenger exclusion and farm fences prevented them from leaving the site.

Table 1. Modeled mean annual turbine collision estimates for 2 eagle species based on movement data collected over the span of pre-construction and operation of 2 wind farms in northwestern Tasmania, Australia, from 1999 to 2009. Estimates are shown for 4 potential dynamic avoidance rates. Static avoidance rate was modeled at 99% in all cases

	White-bellied sea-eagle		Wedge-tailed eagle	
Dynamic avoidance rate (%)	Bluff Point	Studland Bay	Bluff Point	Studland Bay
90	0.9	0.8	2.7	1.9
95	0.5	0.4	1.5	1.1
98	0.2	0.2	0.7	0.5
99	0.1	0.1	0.4	0.3

Comparison of Collision Risk Model Estimates With Actual Mortality Rates

Given constraints of statistically low collision numbers, the model's estimates of annual collisions, based on the combined total of movement data from pre-construction and operation of the 2 wind farms from 1999 until 2009 (Table 1), compare well with actual mortality of the 2 eagle species at both wind farms (Table 2). The model's estimate of the number of wedge-tailed eagle collisions per annum at Bluff Point at a 95% avoidance rate was 1.5, which is the same as the mean number of documented mortalities per annum. Estimates provided for this case by model iterations for 90% and 95% avoidance rates fell within the 95% confidence interval of measured mortality rates. The model's estimates for number of collisions at a 95% avoidance rate for white-bellied sea-eagles at Bluff Point (0.5) and for wedge-tailed eagles at Studland Bay (1.1; Table 1) also closely approximated the mean numbers of documented mortalities per annum for the 2 species (0.4 and 1.0, respectively; Table 2). For those cases, the model's estimates for the range of avoidance rates between 90% and 99% fell within the 95% confidence interval of measured mortality rates. No white-bellied sea-eagle collisions have yet been reported from Studland Bay so, to date, the model's estimates are higher than actual experience for that species there.

MANAGEMENT IMPLICATIONS

We consider that there are 2 different, although not mutually exclusive, applications for modeling of bird collision risks at prospective wind farms. These are to provide projections of long-term effects of a particular wind-energy facility on key bird species; and to determine relative risks for key species that are associated with different wind-farm sites, different portions of large wind farms, and different types of turbines and/or turbine configurations.

In many respects, we consider the latter use of collision risk modeling is the most important contribution it offers. This application provides a tool for planning of wind farms to avoid, reduce, or mitigate potential risks to birds. The model we describe here has now been used in such an iterative manner for a number of prospective sites to evaluate relative risks to key species posed by different types, sizes, numbers, and layouts of turbines.

The integration in our model of data for numbers of bird flights with numbers of birds in the population at-risk is key to the accurate prediction of potential numbers of collisions. This aspect appears not to have been adequately considered previously but has real implications to the appropriate determination of actual risks posed by a wind farm. Our model's use of bird flight data to determine annual flux of movements; a mathematical solution to the typical number of turbines that might be encountered in a bird flight; capacity to assess wind-farm configurations ranging from turbines scattered in the landscape to linear rows of turbines; and the option of assigning different avoidance rates to components

Table 2. Average annual mortality rate and variance for 2 eagle species based on carcasses detected at 2 wind farms in northwestern Tasmania, Australia

	White-bellied sea-eagle		Wedge-tailed eagle	
Wind farm	**Mean annual mortality**	**Annual variance (95% CI)**	**Mean annual mortality**	**Annual variance (95% CI)**
Bluff Point 2002–2012	0.4	0.1–1.0	1.5	0.8–2.6
Studland Bay 2007–2012	0.0	0.0–0.7	1.0	0.3–2.2

of turbines that pose more or less risk, all represent refinements designed to improve the predictive capacity of turbine collision risk modeling.

In the cases outlined here, where long-term mortality data sets have permitted validation of the model's collision estimates at given avoidance rates, the two have closely approximated each other. We will seek further opportunities to compare the results of our model with empirical mortality information from operating wind farms, with a view to wider application of the model.

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The model described here is the property of Biosis Propriety Limited, an environmental consultancy business incorporated in Australia. It is used commercially by Biosis Propriety Limited.

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Appendix E Serious and irreversible impact assessments

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SAII assessment for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland

White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box Gum Woodland) is a CEEC listed under the BC Act and EPBC Act. The vegetation community has an open woodland or open forest structure and often contains a high diversity of groundcover species. Its distribution is strongly associated with more fertile soils on lower elevations across the known range in Queensland, New South Wales and Victoria. The geographic range of Box Gum Woodland is quite broad, ranging from the Queensland border in the north, to the Victorian border in the south. In NSW, occurs in the following bioregions NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina.

Over much of its range, the CEEC has been subject to extensive clearing and modification for agriculture and grazing, so it often occurs as derived native grasslands with no overstorey. It now mostly occurs as fragmented, isolated and modified fragments. Key historical and current threats to this CEEC include clearing for agriculture and urban development.

There are four PCTs within the development footprint that align with the floristic description of this TEC, including:

- PCT 433 - White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, Brigalow Belt South Bioregion.
- PCT434 - White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern Brigalow Belt South Bioregion
- PCT 492 - Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion.
- PCT 599- Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion.

The CEEC is listed in the BioNet Threatened Biodiversity Data Collection (TBDC) as an entity at risk of SAII based on the following principles (DPIE 2019):

- Principle 1: an ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.
- Principle 2: an ecological community that is observed, inferred or reasonably suspected to be severely degraded or disturbed.

Given the absence of definitive impact thresholds stated for the community, the potential for a SAII will be determined by the consent authority, guided by the additional assessment provided below.

Impacts to Box Gum Woodland in the context of this SAII assessment are mapped on Figure 29.

1. Impacts to the CEEC and the action and measures taken to avoid the direct and indirect impact on the CEEC at risk of an SAII.

It has been conservatively assumed that all condition states of the above listed PCTs support the required floristic diversity to represent the CEEC. Within the development footprint, there is a total of 6.07 hectares of Box Gum Woodland, which has been considered to meet the listing requirements of both the EPBC Act TEC and the BC Act.

The CEEC was found to occur along the transmission line corridor, mainly to the west of the wind farm, with a small area in the central portion of the development site downslope (and north) of the wind farm itself. Furthermore the CEEC was found to occur at the far northern end of the access track servicing the central

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portion of the transmission line, and within two areas requiring upgrades for the transport route including just east of Nundle, and at Devils Elbow (Figure 9).

The patches of Box Gum Woodland within the development footprint are predominantly located in the Nandewar Bioregion (5.54 hectares), with a small area (0.53 hectares) located in the NSW North Coast Bioregion.

Actions and measures to avoid direct impacts

Throughout the development of the project layout, design decisions have been implemented to avoid impacts to Box Gum Woodland. This has included early biodiversity surveys, prior to development of the preferred corridor.

A preliminary biodiversity assessment (Arup 2019) was undertaken prior to the development of the wind farm layout and the selection of the preferred transmission line corridor. This preliminary assessment highlighted areas of key ecological concern and allowed for avoidance of these areas during the wind farm concept design. During the wind farm layout design, workshops were held between project ecologists, civil engineers and wind modellers to further optimise layout options and ensure impacts to the areas of mapped Box Gum Woodland.

During the design development phase, a wider landscape was reviewed for potential transmission line corridor and seven potential transmission line routes were identified to understand visual impact and willingness to reach land agreements. Desktop and field validated vegetation and habitat maps were reviewed and transmission line options assessed for likely impacts to significant biodiversity features, with a focus on minimising impacts to TECs. A desktop assessment was undertaken to identify the potential impacts to native vegetation communities for each of the seven options using the State Vegetation Type Mapping for the alignments.

Following the review of each of these seven options two preferred routes were selected and an optimisation consisting of a 200 metre corridor was undertaken to adjust the routes to minimise further impact around mapped PCTs and TECs. The transmission line corridor was then further refined to a single option a 60 metre wide impact areas was determined, resulting in impacts to 31.4 hectares of exotic grassland, and 53.5 hectares of native vegetation, of which 3.1 hectares comprises Box Gum Woodland CEEC. This level of impact includes those areas determined as impacted by AECOM (2021) where the vegetation occurs within valleys spanned by the overhead lines (refer section 7.3 for more detail).

Impacts to Box Gum Woodland also occur along the transport route where upgrades are required to allow delivery of turbine components to site. Impacts to the CEEC at Devils Elbow occur to vegetation that would not be considered the typical grassy woodland form of the CEEC, with PCT 492 in this area present on thinner rockier soils, with a relatively high shrubby understorey cover. However, floristically the vegetation matches BC Act requirements well (based on data collected from three BAM plots), and the PCT is noted as 'Equivalent' to the CEEC in the BioNet Vegetation Classification Database. As such, the vegetation in this area has been conservative assessed as representing Box Gum Woodland CEEC.

Design of roadworks required to bypass the hairpin turns at Devils Elbow have been refined significantly since the exhibited BDAR (refer Plate 1 above). Impacts assessed in that location have been reduced from the removal of approximately 17 hectares of native vegetation, including approximately 6 hectares of Box Gum Woodland CEEC (as presented in the exhibited BDAR), to 2.5 hectares of impact to Box Gum Woodland (PCT 492) in the current amended BDAR. Previously exhibited impacts considered a number of design options of which only one was intended to be constructed. The final route selected presented the lowest impact option and was further refined to avoid impacts. Furthermore, it should be noted that actual impacts are considered likely to be almost half of that current assessed at Devils Elbow following detailed design of project

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components. The current impact footprint assesses impact over a width of between 30 to 60 metres, with the expected final design only requiring a 14.5 metre average total width.

Overall design refinements undertaken since the exhibited BDAR have resulted in a reduction of assessed impact to Box Gum Woodland CEEC from 13.3 hectares to 6.07 hectares.

Furthermore the current transmission line development footprint considers a conservative 'worst case' clearing footprint for the transmission line easement, assessing complete clearing within the areas of the 60 metre easement not spanned by the overhead wires (AECOM 2021).

Planning for the construction of the transmission line corridor has also been completed as part of the impact assessment. This has included consideration for the placement of access tracks into the main transmission line corridor. Existing road infrastructure and farm tracks have been prioritised to provide the required access during construction and operation. By utilising pre-existing infrastructure, the Project has avoided and minimised impacts to sensitive ecological areas, including areas of Box Gum Woodland.

Actions and measures to avoid indirect impacts

As outlined above, the current transmission line development footprint considers a conservative 'worst case' clearing footprint for the transmission line easement, assessing complete clearing within the areas of the 60 metre easement not spanned by the overhead wires (AECOM 2021). Actual impacts, as determined to occur by the AECOM (2021) (Appendix I) will likely be smaller than, and contained entirely within, the 60 metre wide development footprint. This detailed investigation has shown that impacts to native vegetation can be avoided along the transmission line due to spanning and implementation of a construction methodology that allows vegetation in gullies to be completed avoided, and that these areas will not be subject to ongoing indirect impacts from the overhead wires. Impacts to over 1 kilometre of Box Gum Woodland CEEC (PCT 492) has been confirmed as avoided as a result.

Opportunities to complete revegetation works using species characteristic of Box Gum Woodland have been committed to in Section 8.9 of this BDAR, and the current concept design assumes that a large portion of the transmission line corridor can be subject to revegetation works using native species. Options to plant trees, shrubs and groundcovers will be explored where appropriate safety and operational constraints allow taller vegetation to be established. Where this is not possible, such as locations underneath the transmission line where suitable clearance is required, opportunities to plant groundcover species that occur in Box Gum Woodland will be included in revegetation species mixes. Revegetation of road batters associated with Devils Elbow upgrade works will ensure only Box Gum Woodland characteristic species are used. With all revegetation seed / plantings sourced to ensure appropriate local provenance.

Additional indirect impacts associated with construction will be managed through preparation and implementation of a Biodiversity Management Plan that will highlight ecologically sensitive areas, including areas Box Gum Woodland CEEC, and ensure these areas are maintained as no-go zones, ensure current condition of retained areas are maintained and improved, and no indirect impacts associated with water, materials storage, access etc occur and ongoing weed control will occur.

2a. Evidence of reduction in geographic distribution, as the current total geographic extent of the TEC in NSW and the estimated reduction in geographic extent of the TEC since 1970 (not including impacts of the proposal). (SAII Principle 1)

Species and ecological communities that have undergone large reductions or are likely to undergo large reductions in the future are considered to be at greater risk of extinction than those that have undergone or are likely to undergo smaller reductions (NSW TSSC 2018).

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To be considered under this principle, the ecological community should have been observed, estimated, inferred, or reasonably suspected to have undergone, or be projected to undergo, a very large reduction in distribution (DPIE 2019).

The Final Determination for the listing of Box Gum Woodland as a CEEC under the BC Act states the community undergone "a very large reduction in geographic distribution" evidenced by the community having been extensively cleared throughout its range, and remnants typically are small, isolated, highly fragmented, that occur in predominantly cleared landscapes and exhibit a highly modified understorey (TSSC 2006). Based on a compilation of available maps depicting the current extent of the community at the national scale, TSSC (2006) estimated that less than 5% of the original distribution remained (NSW TSSC 2020a).

The NSW Threatened Species Scientific Committee (TSSC) Conservation Assessment of Box Gum Woodland (NSW TSSC 2020b) presents indicative estimates of the historical decline in geographic distribution compiled by the Commonwealth TSSC (2006) for state jurisdictions from sub-jurisdictional vegetation maps. The total reduction in NSW is stated as being approximately 93% of the pre-1750 distribution of the community (with 250,729 hectares remaining from a historical area of 3,717,366 hectares). It is noted that there are uncertainties around the pre-1750 distribution of the community, however the plausible ranges for variants of the community estimated to have been most extensively distributed in NSW suggest that these have almost certainly been reduced to less than 10% of their pre-1750 distribution (NSW TSSC 2020b).

Data is not available on the community's reduction in geographic extent since 1970 (i.e. over the last 50 years), however NSW TSC (2020b) states there is evidence that clearing of Box Gum Woodland CEEC is ongoing and has increased in recent years. During the period 2009 – 2016 it is noted that:

- An average of 395 ha of Grassy Woodland (sensu Keith 2004, of which Box Gm Woodland CEEC is a major component) was lost annually across NSW to agriculture-related activities (cropping, conversion to pasture and thinning)
- A further 155 ha per annum of Grassy Woodland is lost due to infrastructure developments (NSW DPIE 2019).
- Losses due to agriculture rose during the period 2016-2017 to 654 ha (166% of the average over the preceding seven years) and to 1,344 ha (340%) for the period 2017-2018.
- Losses attributable to infrastructure rose to 216 ha (138% of the 2009-2016 average) and 589 ha (378% of the 2009-2016 average), respectively (NSW DPIE 2019).

It should be noted that these figures include other forms of grassy woodland communities, and impacts to Box Gum Woodland CEEC only form a sub-component of these impacted figures, however the data illustrates ongoing pressures and an expected ongoing reduction in geographic extent of the TEC since 1970.

2b. Extent of reduction in ecological function for the TEC using evidence that describes the degree of environmental degradation or disruption to biotic processes, as indicated by i. change in community structure, ii. change in species composition, iii. disruption of ecological processes, iv. invasion and establishment of exotic species, v. degradation of habitat, and vi. fragmentation of habitat. (SAII Principle 2)

Reduction in ecological function relates to the IUCN principle of "very small population size" which for ecological communities means communities have very high levels of either environmental degradation or disruption of biotic processes, and interactions have an increased risk of failure to sustain their characteristic native species assemblages (Bland et al. 2016).

Ecological communities that are considered to have a very large degree of environmental degradation or disruption of biotic processes or interactions are those with:

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- ≥90% extent and severity where the disruption or impacts are measured since 1970.
- ≥80% extent and severity where the disruption or impacts are over a 50-year period, either in the past, future, or any part of the past, present and future (as per (Bland et al. 2016). (DPIE 2019).

Box Gum Woodland CEEC is listed as being Data Deficient for an assessment of environmental degradation of ecological community by NSW TSSC (2020a), however it is listed in the same document as being subject to very large disruption of biotic processes or interactions.

NSW TSSC (2020a) states that Box Gum Woodland CEEC is subject to a number of threatening processes that have negatively impacted upon biotic processes and interactions throughout its range and are likely to cause continuing decline in the future. An almost complete conversion of the community to agricultural production has occurred which invariably includes the removal and/or thinned of the tree canopy resulting in op-down pressures on the ecosystem, with follow-on grazing of domestic stock being the most widespread activity. The impacts of grazing vary depending on the historical grazing regime (timing, intensity, continuity), methods employed to improve pasture (fertilizer application, augmentation with exotic or native species) and the extent of associated impacts on soil structure and biota (soil erosion, compaction).

Grazing has also been shown to lead to a reduction in understorey species diversity and richness due to the loss of native species that are both highly palatable and intolerant of grazing by domestic stock, with many previously widespread species now confined to the least disturbed remnants NSW TSSC (2020a). Shifts in the dominance of pasture species have also been observed as grazing intensity increases and is attributed to differential palatability and resilience to grazing among species, and the reduction of native plant cover by grazing presents opportunities for the invasion of the community by exotic plant species NSW TSSC (2020a).

NSW TSSC (2020b) also states that Box Gum Woodland CEEC is subject to a number of other threatening processes associated with fragmentation, increased soil salinity, inappropriate fire regimes, and reduced recruitment of tree species.

2c. Evidence of restricted geographic distribution, based on the TEC's geographic range in NSW based on i. extent of occurrence, ii. area of occurrence and iii. number of threat-define locations. (SAII Principle 3)

The geographic distribution of ecological communities is defined by the area of occupancy, sensu (Bland et al. 2016). Ecological communities with a very limited geographic distribution have an area of occupancy of less than or equal to two 10 x 10 km grid cells (200 km2) or an extent of occurrence of ≤1,000 km2, sensu (Bland et al. 2016), and one of the following:

- An observed or inferred continuing decline in:
  - A measure of spatial extent appropriate to the ecological community.
  - A measure of environmental quality appropriate to characteristic biota of the ecological community.
  - A measure of disruption to biotic interactions appropriate to the characteristic biota of the ecological community.
- Observed or inferred threatening processes that are likely to cause continuing declines in geographic distribution, environmental quality or biotic interactions within the next 20 years.
- An ecological community that exists at one location (DPIE 2019).

NSW TSSC (2020a) states that the geographic distribution of Box Gum Woodland CEEC is not restricted.

The best estimate of the extent of occurrence (EOO) is 702,800 km2, based on a minimum convex polygon enclosing likely occurrences of the community, the method of assessment recommended by (Bland et al. 2016). The best estimate of the area of occupancy (AOO) is 151,100 km2 based on 10 x 10 km grid cells (with a

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minimum of 1% occupied by the community), the scale recommended for assessing AOO by (Bland et al. 2016). The best estimates of EEO and AOO derive from a compilation of maps from multiple sources. Not all of the areas occupied by the community are covered by maps of appropriate scale and accuracy. Therefore, the values for EOO and AOO quoted above may underestimate the true values.

2d. Evidence that the TEC is unlikely to respond to management.(SAII Principle 4)

This principle encompasses two components, firstly whether there are any particular traits of the community which limits its' response to management, and secondly whether there are any key threatening processes affecting the community which cannot be effectively managed (DPIE 2019).

The Commonwealth TSSC (2006) states that Box Gum Woodland CEEC has suffered a severe decline in extent and condition, and remaining areas are generally small and highly fragmented, and that the key threats to the survival of the ecological community include clearing, grazing and weed invasion. Other threats include salinity, nutrient enrichment, altered fire regimes and the effects of fragmentation.

The priority recovery and threat abatement actions required for the listed ecological community include:

- protection of remnants of the listed ecological community through the development of conservation agreements and covenants;
- protection of remnants from weeds, particularly Coolatai Grass, by preventing soil disturbance in and around remnants, and the speedy eradication of any newinvasion;
- avoid the use of fertilisers in or nearremnants
- avoid soil disturbance in or near remnants, such as ripping planting lines and road grading;
- in very small derived grassland sites, avoid planting trees as they may reduce the floral diversity through competition for light, nutrients and water;
- planting and other rehabilitation-focused disturbance should focus on the edges of patches, expanding them, rather than within the patches;
- expansion and connection of existing remnants;
- exclusion of continuous grazing from remnants is important, coupled with weed management and control;
- use strategic grazing (incorporating rest at appropriate times) in areas still containing a diverse native understorey;
- burning or slashing if native tussock grasses have built up to a high level, to open inter- tussock spaces for tree seedlings, forbs and shrubs to establish; and,

Further information on recovery actions and conservation measures are detailed in the *National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (DECC 2009). Furthermore the TBDC lists 10 management actions to aid the threat abatement and recovery of the CEEC.

Based on the existence of a national recovery plan providing a guidance as to the management of the CEEC, the community is not considered to be unlikely to respond to management.

3. Where the TBDC indicates data is 'unknown' or 'data deficient' for a TEC, the assessor must record this in the BDAR or BCAR.

Not applicable.

4a. The impact on the geographic extent of the TEC, by estimating the total area of the TEC to be impacted by the proposal.

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The majority of the impacted area of Box Gum Woodland TEC within the development footprint have been calculated based on a worst case clearing footprint requirement for the transmission line corridor. This corridor has been calculated for a maximum clearing footprint that is 60 metre wide. This width of corridor is unlikely be required, and is considered to be the maximum width is sufficient to capture any indirect impacts to adjacent retained areas of Box Gum Woodland CEEC.

A summary of the area of direct and indirect impact assessed as total loss, with PCTs and the measured vegetation integrity score is provided in the below table.

PCT and condition class	Area (ha)	Vegetation integrity score*
433 - Moderate	0.01	99.9
434 – Low	0.01	99.9
492 – High	2.60	93.0
492 – Moderate	0.55	93.0
492 – Low	0.58	60.3
492 – DNG	0.89	59.9
599 – High	0.36	99.9
599 – Moderate	0.09	99.9
599 – Low	0.97	99.9

* The vegetation integrity scores provided in the above table are artificially inflated due to the use of benchmark values to compensate for a reduced number of vegetation integrity plots in the following vegetation zones *433 – Moderate, 434 – Low, 492 – DNG, 599 – High, 599 – Moderate, 599 – Low* (refer Section 4.1 for more detail).

Approximately 41 % of the impacts to Box Gum Woodland (2.47 hectares) as a result of the project will occur on areas of DNG or that have been assessed as occurring in Low condition.

The construction and operation of the 330kV transmission line or section of open road built to the required Australian Standards is unlikely to result in changes to any abiotic factors that are critical to the long term survival of Box Gum Woodland in areas adjacent to the development footprint. The construction of the transmission line will not require substantial earthworks that could impact on surface water or groundwater flow patterns. The current design has also allowed for several access tracks into the transmission line corridor to limit the need for substantial earthworks along the length of the alignment to enable construction. Earthworks and design of the roadway constructed to bypass Devils Elbow will ensure that existing environmental processes are not substantially altered or negatively impacted by the construction.

The impacts to Box Gum Woodland associated with the project are confirmed to generally low condition vegetation within a fragmented landscape associated with the transmission line and its access racks, and to high condition vegetation within larger patches of intact vegetation associated with road upgrades. Neither will result in clearing of vegetation unique to the locality, or to species locally common when compared to elsewhere in the development footprint or broader locality. As such the project is not considered likely to cause a substantial change in the species composition of an occurrence of Box Gum Woodland such that it would continue to decline.

The project is unlikely to result in substantial additional impacts to characteristic and functionally important species beyond these areas that has been assessed as being lost during construction. Opportunities to

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include characteristic trees, shrubs and groundcover species from the Box Gum Woodland TEC will be included as part of revegetation works following construction.

The proposed development will not directly lead to altered fire regimes in areas of adjacent retained Box Gum Woodland. Recommendations to implement a suitable fire regime to manage biodiversity and fuel load may be required in areas of retained Box Gum Woodland adjacent to the transmission line corridor.

As outlined above impacts to Box Gum Woodland associated with the project are confirmed to be generally low condition vegetation within a fragmented landscape associated with the transmission line and its access racks, and to high condition vegetation within larger patches of intact vegetation associated with road upgrades.

Box Gum Woodland present along the transmission line and in the surrounding landscape largely occurs as fragmented and isolated patches in an over-cleared landscape. The construction and operation of the transmission line will not result in negative ongoing impacts to the CEEC in the landscape, nor will it increase existing pressures associated with fragmentation, isolation and edge effects.

Box Gum Woodland along Barry Road mainly occurs on the edges of the extent of the CEEC, and within larger patches of intact grassy and shrub/grass woodland. The construction and operation of the new roadways may result in an increase in edge effects where the new road will occur through an existing patch of intact vegetation, however it is not expected that sources of negative impacts such as weed encroachment will increase above the levels that already existing in the landscape. The vegetation currently exists in in high condition away from the immediate roadside edges and there is no reason to expect this would change into the future.

Based on the above additional indirect impacts to Box Gum Woodland are not expected to be substantial or significant as a result of the project and therefore only the direct impacts are considered in the calculation of the project's impacts on the geographic extent of the TEC.

As outlined above, the NSW (2020b) states the current geographic extent of Box Gum Woodland as being estimated as 250,729 hectares. The project will remove a total of 6.07 hectares of Box Gum Woodland, or approximately 0.002% of the extant area of the community.

4b. The extent that the proposed impacts are likely to contribute to further environmental degradation or the disruption of biotic processes of the TEC by i. estimating the size of any remaining, but now isolated, areas of the TEC; including areas of the TEC within 500m of the development footprint or equivalent area for other types of proposals.

Patches of potential Box Gum Woodland CEEC present in the wider landscape surrounding the project area occurs in an already highly fragmented state. GIS was used to determine the range and average size of mapped (Biosis 2021, DPIE 2019, DPIE 2015) occurrences of PCTs representative of Box Gum Woodland CEEC within a 500 metre buffer of the development footprint. The results of which are provided below both for those patches intersected by the development footprint (i.e. subject to vegetation removal) and those patches not intersected by the development footprint (i.e. not directly impact by the project). It should be noted that only the broad components of the development footprint proximal to impacted Box Gum Woodland have been included in these calculations, i.e. large areas of the transport route, where no Box Gum Woodland is impacted, have been excluded.

Mapped areas of known and potential Box Gum Woodland within 500m not directly impacted:

- Size range: <0.001ha to 305 ha
- Average size: 6.69 ha
- Median: 1.23 ha

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- Total no. mapped patches (dissolved Box Gum Woodland PCT polygons): 197

Mapped areas of known and potential Box Gum Woodland within 500m directly impacted:

- Size range: 2.81 ha to 164 ha
- Average size: 29.99 ha
- Median: 6.52 ha
- Total no. mapped patches: 8

It can be seen that there are a large number of mapped known an potential Box Gum Woodland patches within 500 metres of the development footprint, ranging from <0.001 hectares to >300 hectares in area. Patches directly impacted by the project are generally lager with a larger minimum size, average size and median size, than those patches not impacted by the project. This mainly relates to larger patches of PCT 492 mapped within the intact vegetation to the north and east of the subject land. The project is not expected to result in impacts that will substantially increase fragmentation, and/or increase perimeter to area ratios of retained patches of known and potential Box Gum Woodland vegetation based on both the generally large patch sizes of impacted patches and high level of variation in patch sizes within 500 metres of the development footprint.

ii. describing the impacts on connectivity and fragmentation of the remaining areas of TEC measured by:

- ***distance between isolated areas of the TEC, presented as the average***
- ***distance if the remnant is retained AND the average distance if the remnant is removed as proposed, and***
- ***estimated maximum dispersal distance for native flora species characteristic of the TEC, and***
- ***other information relevant to describing the impact on connectivity and fragmentation, such as the area to perimeter ratio for remaining areas of the TEC as a result of the development***

GIS was used to undertake a nearest neighbour analysis of mapped (DPIE 2019, DPIE 2015) occurrences of potential Box Gum Woodland CEEC prior to and post vegetation removal to determine the distance between impacted areas of the CEEC before and after the proposed development. The average and median distance between mapped occurrences of potential Box Gum Woodland CEEC within a 500 m buffer of the impact area, include:

- An average before development separation distance of 75.6 m
- An average after development separation distance of 85.3 m
- A median before development separation distance of 20.11 m
- A median after development separation distance of 15.06 m.

As can be seen from the above calculations the proposed vegetation removal will result in an increase of the average separation distance between patches of known and potential Box Gum Woodland CEEC by approximately 10 meters, but will result in a decrease in the median separation distance by 5 metres. Furthermore it should be noted that the increase in mean separation distance stated above is being driven by the removal of one small patch (<0.1 hectares) of known Box Gum Woodland CEEC vegetation resulting in the increased isolation of another larger patch (approx. 3.29 hectares) of potential Box Gum Woodland CEEC vegetation, such that the patch of the CECC nearest the larger retained patch post development is over 2.9 kilometres away. If that outlier is excluded from the 'post-clearing' dataset, the development also results in a decrease of mean separation distance from 75.6 metres prior to development to 71.7 metres after development.

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These decreases in mean and median separation distance are the result of the very large study area and 500 metre buffer considered in this analysis that supports larger and well separated patches of potential Box Gum Woodland CEEC vegetation the majority of which are not directly impacted by the project, the effect of the relatively narrow vegetation clearing within the development footprint creating new patches separated by between 5 and up to 60 metres, and the generally isolated nature of the majority of the impacted Box Gum Woodland CEEC polygons within the development footprint.

Native flora species characteristic of the CEEC include a range trees, shrubs, grasses, forbs and other groundcover species, the majority of which are dispersed via wind or animal vectors, with some species primary method of dispersal likely to be via non-flying insects such as ants. The expected changes to average separation distance between patches of retained known and potential Box gum Woodland CEEC within 500 m of the impact area are not expected to result in a significant or substantial impediment to the dispersal of native species between these patches, in an already highly fragmented landscape.

It is noted in EPBC Act conservation advice documents that allowances can be made for "breaks" of up to 30 metres between areas of MNES habitat, and that such breaks, which may be the result of watercourses, tracks, paths, roads, etc., do not significantly alter the overall functionality of the ecological community, or habitat (CoA 2020). As such, breaks in connectivity caused by the development footprint, of between 5 and 30 metres are not considered to be substantial in nature, which include all impacts, outside the proposed Devils Elbow upgrade, where assessed impacts include a worst case scenario of up to 60 metres of clearing.

Box Gum Woodland occurs within the development footprint in association with the transmission line corridor, transmission line access tracks and road upgraded along Barry Road outside Nundle and at Devils elbow.

Along the transmission line and its access tracks the CEEC occurs in an already highly fragmented landscape, with the impacted patches of the CEEC, and the patches mapped in the surrounding landscape largely occurring as isolated patches of vegetation in an over-cleared landscape. Some larger patches of potential CEEC also occur on steeper slopes in more intact vegetation where the CEEC is associated with PCT 488 Silvertop Stringybark - Yellow Box +/- Nortons Box grassy woodland on basalt hills, however these areas are mainly south of the development footprint and on the southern side of the ridgeline. Impacts associated with the construction and operation of the project's transmission line (and associated access tracks) will not result in fragmentation of any substantial patches of the CEEC, nor will it increase fragmentation in the landscape.

Near Nundle, a small isolated patch of Box Gum Woodland will be impacted by the required transport route upgrade works to allow for wind turbine components to be transported to the site. This impact will occur to a single Blakelys Red Gum tree present on the road side in low condition, and within a landscape of scattered paddock trees, and retained vegetation near creeks. This impact will not fragment or increase fragmentation of the CEEC in this location.

More significant road upgrades works are required further east along Barry Road, at Devils Elbow, where the double hairpin turns must be bypassed to allow for turbine components to reach the site. Box Gum Woodland in this location exists not in its more typical grassy woodland form but on thinner rockier soils with a shrubbier understorey, as PCT 492 Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest. It does however, align well with the floristic and condition requirements for listing as the CEEC.

Minor clearing of the CEEC is required at the eastern extent of the works area on road edges to widen the corners, and as such no fragmentation impacts will occur in this area. However to bypass the Devils Elbow corners, clearing will occur over approximately 700 metres, between 30 to 60 metres in width, up the ridgeline through a patch of intact vegetation. This will result in the fragmentation of an approximately 5.5 hectare patch of vegetation to the north, that will no longer be part of the large contiguous patch of vegetation, and will be surrounded on all side by roads (approximately 10 to 15 m wide). This vegetation was

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mapped as PCT 541 Silvertop Stringybark - Rough-barked Apple grassy open forest during ground assessment haul route impacts and is noted as having the upper stratum dominated by Silvertop Stringybark and Rough-barked Apple. It is considered likely that this vegetation supports occasional Yellow Box, moving downslope from the adjacent PCT 492 (Box Gum Woodland CEEC), but the vegetation to the north is considered unlikely to represent the CEEC. Indirect impacts to this fragmented patch of retained vegetation (PCT 541) will be managed through best practice road drainage designs, ensuring current hydrological patterns are maintained a close as possible to the system. Impacts to PCT 492 in this location occur along a ridgeline on the northern edge of a large mapped patch of the PCT, and as such fragmentation impacts are not expected to occur.

It is therefore considered that the project will not fragment or increase fragmentation of Box Gum Woodland CEEC.

iii. describing the condition of the TEC according to the vegetation integrity score for the relevant vegetation zone(s) (Section 4.3). The assessor must also include the relevant composition, structure and function condition scores for each vegetation zone.

Box Gum Woodland occurs as four separate PCTs across nine vegetation zones. The relevant composition, structure and function condition scores are provided below.

PCT and condition class	Comp. score	Struc. score	Func. score	VI score	Comments
433 - Moderate	99.7	100	100	99.9	Condition of PCT 433 has been assumed to be benchmark due to a shortfall in collection of BAM plot data. The actual condition of the vegetation is 'moderate' being subject to historical clearing and ongoing agricultural processes.
433 – Low	99.7	100	100	99.9	Condition of PCT 433 has been assumed to be benchmark due to a shortfall in collection of BAM plot data. The actual condition of the vegetation is 'low' being subject to a high level of historical clearing and ongoing agricultural processes.
492 – High	100	80.9	99.5	93.0	Condition of PCT 492 has been assumed where a shortfall in in collection of BAM plot data has occurred. This has increased the attribute and VI scores for each condition state, with the exception of PCT 492 Low. The actual condition of the vegetation ranges from 'high' to 'DNG' depending on the level of historical clearing, ongoing agricultural processes and edge affectedness.
492 – Moderate	98.4	99.7	81.9	93.0	
492 – Low	68.4	60	53.5	60.3	
492 – DNG	75	57.2	50	59.9	
599 – High	99.7	100	100	99.9	Condition of PCT 599 has been assumed to be benchmark due to a shortfall in collection of BAM plot data. The actual condition of the vegetation ranges from 'high' to 'low' depending on the level of historical clearing, ongoing agricultural processes and edge affectedness.
599 – Moderate	99.7	100	100	99.9	
599 – Low	99.7	100	100	99.9	

No specific measures are proposed to contribute to the recovery of Box Gum Woodland in the IBRA subregion, with the exception of the goal of seeking local offsets in the form of Biodiversity Stewardship Sites established in the local area.

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It cannot be guaranteed that any Biodiversity Stewardship Sites that are established will directly benefit Box Gum Woodland however rehabilitation of native vegetation in the locality is likely to provide indirect benefits to Box Gum Woodland in the locality.

The project's proposed offset strategy of targeting local properties for the establishment of Biodiversity Stewardship Sites provides potential opportunities for strategic enhancement of local habitat connectivity. Such enhancements could occur along the southern side of the ridgeline between Ben Halls Gap Nature Reserve and Crawney Pass National Park, and over Crawney Mountain to Wallabadah Nature Reserve, linking the three conservation areas. This enhancement of local connectivity can be achieved through the in-perpetuity conservation agreements being pursued over a number of properties along the ridge line, which will improve the biodiversity values on the land and increase habitat connectivity. Connectivity enhancements realised in this strategic location will not only offset direct impacts resulting from the project, but also allow for potential indirect impacts associated with disruption of habitat connectivity to be mitigated against and offset through the establishment of a managed corridor linking local conservation reserves and high-quality habitats.

Areas of the transmission line alignment and road batters surrounding the future bypass of Devils Elbow will also be subject to revegetation works, with species characteristic of Box Gum Woodland to be included in plant species mixes where appropriate. This will have an indirect benefit to Box Gum Woodland, mainly along the transmission line, through increasing propagative material and decreasing area available for colonisation by existing species in some more degraded areas.

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Large Bent-winged Bat SAII assessment in accordance with the BAM (2017) methodology

Large Bent-winged Bat is a member of the Miniopteridae family. The species occurs along the east coast of Australia from Cape York in northern Queensland to Castlemaine in Victoria, east of the Great Dividing Range (Churchill 2008). It is listed as Vulnerable under the BC Act.

Large Bent-winged Bat utilises a range of habitats including rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, *Melaleuca* spp. dominated forests, and open grasslands. The species typically forages for moths and flying insects above the forest canopy, in open grassy areas it will forage a few metres off the ground (Churchill 2008).

Large Bent-winged Bat is considered a species credit species under the BAM, specifically in relation to the species' breeding habitat. This breeding habitat is defined in the Atlas of NSW Wildlife (DPIE 2021) as any:

'Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records with microhabitat code "IC - in cave;" observation type code "E nest-roost;" with numbers of individuals >500 or from the scientific literature'.

Impacts to these breeding habitat features, and the area within a 100 metre radius buffer around an accurate GPS point location centred on the cave / feature entrance, are what are considered to be potentially serious and irreversible for the species (DPIE 2021). Such areas were previously located within the development footprint, requiring the undertaking of an SAII assessment. However, amendments to the project design, as outlined in Table 1, have since resulted in these areas being successfully avoided. Whilst no longer required, this SAII has still been included and updated due to the importance of the species.

(a) The action and measures taken to avoid the direct and indirect impacts on the potential entity for an SAII.

Actions and measures to avoid direct impacts

A preliminary biodiversity assessment (Arup 2019) was undertaken prior to the development of the wind farm layout and the selection of the preferred transmission line corridor. This preliminary assessment highlighted areas of key ecological concern and allowed for avoidance of these areas during the wind farm concept design. During the wind farm layout design, workshops were held between project ecologists, civil engineers and wind modellers to further optimise layout options and ensure impacts to the areas of highest potential Large Bent-winged Bat breeding areas were avoided or minimised. These workshops resulted in the removal of turbines from areas of steep and rocky terrain located within 100 metres of areas of steep slopes considered to potentially support cave bat roosting/breeding opportunities. A total of 8 turbines were removed during these workshops, down to 70 turbines from a maximum of 78, which contributed to an approximately 30 % reduction in clearing extents.

Existing road infrastructure and farm tracks have been prioritised to provide the required access during construction and operation. By utilising pre-existing infrastructure the Project has avoided and minimised impacts to sensitive ecological areas, including potential microbat breeding habitat and the surrounding native vegetation that supports these habitats.

Two high potential cave bat roosting/breeding habitats were identified within the previous development footprint (as described in Section 5.4.2). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 partially occurred within the 100 metre buffer zone surrounding one of the high potential cave bat roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8 % of the overall buffer zone). The removal of the WP27 as part of project design (Table 1) means that this impact has been successfully avoided.

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Actions and measures to avoid indirect impacts

Indirect impacts to Large Bent-winged Bat associated with the project operation phase primarily involve potential collision and possibly barotrauma risks associated with the wind turbine blades during the operational phase of the project. In designing the wind farm layout the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma.

Prior to design amendments there would have been some incursion into the air space above the 100 metre radius buffers surrounding two identified breeding/roosting habitats in the vicinity of WP27 and WP50. This overlap extended over 8,100 square metres (7.5 %) of the 108,465 square metre buffer applied to the WP27 habitat, and over 470 square metres (0.3 %) of the 168,036 square metre buffer applied to the WP50 habitat, when considered on the horizontal plane. Distances between the tip of turbine blades and the top of canopy were considered as part of the wind farm design to ensure that ample vertical buffers were provided for foraging microbats and other avian fauna. A buffer distance above the canopy (estimated to be 23.5 metres high) surrounding WP27 and WP50 of approximately 36.67 metres and 43.35 metres was allowed.

As the two identified high potential roosting/breeding habitats consisted of rocky outcrop and cliffline habitats, buffer distances between tip of the WP27 and WP50 turbine blades and the nearby potential microbat habitats were calculated at ground level in accordance with TIN051 (Natural England 2009). A distance of approximately 91 metres occurs between the tips of the WP27 turbine blades and the nearby potential microbat roosting/breeding habitat, and a distance of approximately 139 metres occurred between the tips of the WP50 turbines blades and the potential microbat roosting/breeding habitat in that vicinity. WP50 therefore exceeded the BAM 100 metres radius buffer (DPIE 2021), whereas WP27 only intruded within the first 9 metres of this buffer. However, as outlined in Table 1, the removal of WP27 and relocation of WP50 means impacts to the identified breeding/roosting habitats and surrounding buffer areas has been successfully avoided.

Section 5.4.2 of this BDAR outlines the potential for collision mortality for the Large Bent-winged Bat, as well as other threatened and more common bats, which were recorded by acoustic detectors mounted on met masts at approximately 60 metres above the ground. In terms of the Large Bent-winged Bat, although there are no direct impacts to the potential roosting/breeding habitats within the development footprint, this species is migratory and are a fast-flying species that often forage above canopy height and may fly with RSH. Therefore, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years).

Construction related indirect impacts include light, noise, and vibration. These impacts will be managed during construction to minimise impacts to nocturnal fauna. They also will not occur within the 100 metre buffer zone of the two high potential bat roosts. An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to monitor any potential bat mortality and to continually assess the assumptions of this impact assessment. Furthermore, this will include detailed and stringent mitigation measures for high risk turbines and adaptive management strategies for moderate and low risk turbines.

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Additional mitigation measures are recommended for inclusion in the CEMP that will further reduce the potential for impact to the species. These are provided in Section 8.9 of the BDAR.

(b) The size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification.

Historical records for the species are located approximately 5 kilometres south-west of the wind farm development footprint. This includes one survey event in 2003 at Timor Caves, a known non-breeding roost location for the species (NPWS 2011), where approximately 2,000 individuals were recorded. A second survey event undertaken in 2008, slightly west of the first event, utilising anabat recording devices and seven separate detection events were recorded (DPIE 2021). Ultrasonic detectors were deployed at Timor Caves, as part of the current assessment, for three nights in March 2020, however the species was not recorded by this survey.

The species was recorded during the targeted surveys supporting the current assessment. These surveys were conducted from February 2020 to May 2020 and included deployment of units at ground-level as well as deployment on three meteorological masts at heights of 2 metres, c.30 metres and c.60 metres. Additional acoustic/ultrasonic survey was also undertaken in spring 2019 between 19 – 21 November 2019 (three nights) Across the 24 deployed ultrasonic detector units deployed in 2020 and the three nights of spring surveys in 2019, the total mean call for the species per night was 10.3 calls, indicating individuals of the species were utilising areas within the development footprint on most nights.

Due to the rural location of the assessment area, where historical survey coverage is lower, the overall size of the local population is unknown. This assessment considers the local population to include all individuals within 100 kilometres of the development footprint, which is based on a balance between the maximum overnight foraging distance of 65 kilometres (Churchill 2008), and the several hundred kilometre distances the species is known to travel between maternity and non-breeding roosts (Hoye & Hall 2008).

Within the development footprint, the impacts that were previously considered potentially serious and irreversible for the local population were restricted to two high potential roosting/breeding locations that were detected within the proximity of proposed turbines WP27 and WP50 (as described in Section 8.3). Due to the avoidance measures that have been employed (Table 1), there are now no direct impacts to these sites.

There are also indirect impacts associated with project construction and operation including collision mortality and possibly barotrauma, as well as noise, light and vibrations. In terms of the Large Bent-winged Bat, this species is migratory and are a fast-flying species that often forage above canopy height and may fly within RSH. Therefore, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). These will be minimised through the avoidance measure outlined in under question (a) above.

As direct impacts to the identified high potential roosting/breeding locations have been avoided, impacts to the local population as a result of the Project are primarily associated with loss of native vegetation that provides foraging habitat at the individual level, potential turbine strike and possibly barotrauma, and possible interruptions to habitat connectivity. Assessment of these indirect impacts has been provided in Section 8.3 of this BDAR.

(c) The extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact.

The SAII threshold specified for Large Bent-winged Bat within the Atlas of New South Wales is 'breeding habitat to be identified by survey'. This threshold does not provide a numerical value for the species that would assist a decision-maker in determining the level of impact above which a serious and irreversible impact may occur for this species. As such the extent to which the proposed impacts may exceed a threshold

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target for the species cannot be calculated. The general notes provided for the species state that any impact on breeding habitat could be considered potentially serious and irreversible (DPIE 2021).

Two high potential roosting/breeding habitat locations were previously identified within the vicinity of the development footprint (refer Figure 15). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 partially occurred within the 100 metre buffer zone surrounding one of the high potential cave bat roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8 % of the overall buffer zone). Road infrastructure supporting turbine pad WP50 was also located within 5 metres of a cave bat roosting/breeding habitat buffer. Due to avoidance measures adopted by the project (outlined in Table 1), these impacts have now been successfully avoided.

A geomorphological assessment of the assessment area was also commissioned which found that the landscape within and surrounding the development footprint was formed by a range of volcanic activity resulting in a basalt lithology (Environmental Geosurveys Pty Ltd 2021). The extent to which potential microbat habitat is present and suitable is a function initially of lithology and rock structure modified over time by geological and environmental processes. The assessment found that whilst the basalt lithology present at the development footprint may support opportunities for microbat roosts, no substantial caves were likely to be present, and that no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another (Environmental Geosurveys Pty Ltd 2021).

Given the avoidance measures adopted by the project (Table 1) mean that there are now no direct impacts to identified cave bat breeding habitat, the project is considered unlikely to result in a serious and irreversible impacts for the species.

(d) The likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to:

> ***(i) An estimate of the change in habitat available to the local population as a result of the proposed development.***
>
> ***(ii) The proposed loss, modification, destruction or isolation of the available habitat used by the local population.***
>
> ***(iii) Modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.***

Approximately 2.54 million hectares of native vegetation occurs within a 100 kilometre buffer zone surrounding the development footprint. This represents the available foraging habitat available with the range of the local population, as defined in question (b). Only 132.43 hectares of native vegetation occurs within the development footprint, a tiny fraction of the vegetation within the locality. Of this vegetation approximately 37.92 hectares (28.6 %) is in high condition providing good habitat values for foraging native fauna, including Large Bent-winged Bat. This foraging habitat would be modified as a result of the Project.

Two high potential roosting/breeding sites for Large Bent-winged Bat have been identified adjacent to the development footprint. No direct impacts are proposed for these habitats. As such there will be no reduction in the availability of breeding habitat for Large Bent-winged Bat. Similarly, there will be no direct impact to important species 'life cycle' processes as no habitats that support these processes are being directly impacted.

The project will also result in indirect impacts during construction and afterward during operation of the wind farm. During construction these indirect impacts will consist of increased traffic, noise and light during the

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project construction. These impacts will be managed during construction to reduce impacts to nocturnal fauna and will cease once construction is completed. Restriction of works to outside of breeding season within the vicinity of the two high potential roosting/breeding habitats is recommended for inclusion within the CEMP's mitigation measures which will further reduce scale of construction related indirect impacts.

There are also indirect impacts associated with the operations phase where collision and possibly barotrauma risks associated with the wind turbine blades could occur, as well as potential impacts to habitat connectivity. These impacts are discussed further in Sections 8.3 and 8.5 of the BDAR, however these impacts will not significantly change the availability of habitat in the locality. In terms of the Large Bent-winged Bat, although there are no direct impacts to the potential roosting/breeding habitats within the development footprint, this species is migratory and are a fast-flying species that often forage above canopy height and may fly with RSH. Therefore, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to monitor any bat mortality and to continually assess the assumptions of this impact assessment and enable adaptive management measures to be implemented if required to reduce measured impacts.

(e) The likely impact on the ecology of the local population. At a minimum, address the following:

- For fauna:
  - Breeding

Maternity roosts for Large Bent-winged Bat are uncommon with 12 roosts known throughout the species' range (Hoye & Hall 2008). These colonies are reportedly large, ranging from 100 to 150,000 individuals (DPIE 2021), with one study estimating established colonies ranging from 15,000 to 200,000 Bent-winged Bats (prior to the split into subspecies) (Dwyer & Hamilton-Smith 1965).

Within NSW the Saving Our Species program has identified seven priority management sites across the state, none of which occur within the same IBRA subregion as the development footprint (DPIE 2015). The closest of these is a volcanic cave in the Mount Kaputar National Park, north of Tamworth, approximately 135 kilometres to the north-west of the development footprint. A second priority area is located at Willi Caves, approximately 140 kilometres to the north-east of the development footprint. Both of these areas are known maternity roosts for the species (DPIE 2015, Dwyer 1966). However, individuals recorded within the assessment area, and those likely to utilise Timor Caves as a non-breeding roost are expected to utilise the maternity roost at Kanangra-Boyd NP, due it's similarities to the assessment area in terms of topography and climatic conditions, rather than the northerly hotter/driers, and sub-tropical sites.

Within this area there are many potential roosting and breeding habitats for the species with over 80 caves identified in the Timor Caves karst system alone (Rutledge 2008). A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale (Environmental Geosurveys Pty Ltd 2021). Finally the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently

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there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021) which may also provide potential roosting habitat to the local population.

Adjacent to the development footprint there are two identified high potential roosting/breeding sites. This is comparatively few when placed in context of the similar habitat available within the locality and broader region. There are also no direct impacts proposed to either of these potential habitat locations or their surrounding buffer areas. The avoidance and minimisation for reducing indirect impacts during operation of the wind farm are discussed in question (a) above. Finally, the actual likelihood of the two potential breeding sites being a new and previously undiscovered breeding location for the species is considered to be very low. As such, the Project is unlikely to result in impacts to breeding habitat for Large Bent-winged Bat.

- Foraging

Large Bent-winged Bat uses a broad range of habitats including rainforests, wet and dry sclerophyll forests and vine thicket. The species hunts in timbered areas, catching beetles, moths and flies above the canopy trees (Churchill 2008, DPIE 2021). Approximately 2.54 million hectares of native vegetation occurs within a 100 kilometre buffer zone surrounding the development footprint. This represents the available foraging habitat available with the 100 kilometre range of the local population, as defined in question (b). Only 132.43 hectares of native vegetation occurs within the development footprint, a tiny fraction of the vegetation within the locality. Of this vegetation approximately 37.92 hectares (28.6 %) is in high condition providing good habitat values for foraging native fauna, including Large Bent-winged Bat. This foraging habitat would be modified as a result of the Project.

Vegetation within the development footprint is connected to surrounding vegetation in all directions, and across the 100 kilometre area surrounding the development footprint there is approximately 85 % coverage of native vegetation. This includes large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests. These areas represent prime foraging habitat for the species and are all within two kilometres of various locations along the development footprint. Given the species has been known to travel up to 65 kilometres in a single night to access foraging habitat (Churchill 2008), all of these foraging habitats would be easily accessible individuals within the local population. The removal of native vegetation as part of the proposed works is therefore not considered to have a significant impact on the foraging ecology of Large Bent-winged Bat.

- Roosting

Large Bent-winged Bat primarily roosts in caves however the species is also known to utilise derelict mines, storm-water tunnels, buildings and other man-made structures (DPIE 2021). Bionet records for Large Bent-winged Bat occur within the locality and the species was also detected as part of the targeted acoustic surveys undertaken as part of this assessment. A known non-breeding roost for the species also occurs in the locality at Timor Caves (NPWS 2011), located approximately 5 kilometres to the south-west of the development footprint.

Within the locality there are many potential roosting and breeding habitats for the species with over 80 caves identified in the Timor Caves karst system alone (Rutledge 2008). A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality

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of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale (Environmental Geosurveys Pty Ltd 2021). Finally the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021) which may also provide potential roosting habitat to the local population.

There are two high potential roosting habitats located adjacent to the development footprint. As a result of avoidance measures adopted by the project (Table 1), there are no direct impacts to either of these features or the surrounding buffer areas. Given the underlying geology outlined by the geomorphological report (Environmental Geosurveys Pty Ltd 2021), there are likely to be numerous cracks and crevices along ridgelines within the broader locality that may be used as overnight roosts by individuals or small groups of Large Bent-winged Bats. Given the high potential for similar habitat across the locality, the Project is not expected to significantly alter the availability of these crack/crevice overnight roosting habitats.

- Dispersal or movement pathways

Large Bent-winged Bat is a highly mobile species, with some individuals documented dispersing up to three hundred kilometres from known maternity caves (DPIE 2021). While it is assumed that connected vegetation is preferred by the species for movement, the existence of many records of the species within urbanised areas, and its utilisation of man-made structures as roosting sites, suggests that the species does not rely on specialised dispersal or movement habitat.

Furthermore, in designing the wind farm layout the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma.

Given the local population is most likely to be utilising the known important non-breeding roosting habitats afforded by Timor Caves (NPWS 2011), and then travelling further south to the known maternity roost in the Kanangra-Boyd NP, it is unlikely that individuals would be making multiple north-south movements at turbine blade height over the linear wind farm footprint. Such north-south movement are more likely to be associated with foraging flights which would be conducted at canopy level, out of turbine blade range (see Section 7.2 for details regarding turbine blade buffers). The layout also retains areas of preferred foraging habitat in steeper areas of terrain, with more densely vegetated gullies preserved. Overall, although collision mortality is unlikely and may occur only during some circumstances, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(f) A description of the extent to which the local population will become fragmented or isolated as a result of the proposed development.

Large Bent-winged Bat is a highly mobile species, capable of traversing and surviving in highly urbanised environments with hundreds of observations recorded across metropolitan areas, including Sydney, one of the most urbanised regions in the country. The species also utilises man-made structures such as culverts,

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bridges, buildings and derelict mines as roosting sites. Given the transient nature of the species, the high level of native vegetation connection across the region, and the high level of potential roosting locations, the project is not expected to result in significant amount of landscape fragmentation that would result in the local population becoming isolated. Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(g) The relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range.

Large Bent-winged Bat is distributed along the east coast of Australia from Cape York in northern Queensland to Castlemaine in Victoria, east of the Great Dividing Range (Churchill 2008). The occurrence of Large Bent-winged Bat is contiguous across its range within NSW, as evidenced by Bionet records for the species. Records are more isolated towards the southern and western edges of its distribution, however, the assessment area occurs well within the range of the species and is not considered to be at the limit of its range. Seven priority areas have been identified for the species as part of the Saving Our Species program (DPIE 2015).

The closest priority area to the Project is located north of Tamworth, in the Mount Kaputar National Park, approximately 135 kilometres to the north-west. Willi Caves, another priority area, occurs approximately 140 kilometres to the north-east (DPIE 2015, Dwyer 1966). In addition to these priority areas, a known non-breeding roost for the species occurs at Timor Caves, approximately 5 kilometres south-west of the development footprint (NPWS 2011). The species is known to travel up to several hundred kilometres between maternity and non-breeding roosts (Hoye & Hall 2008, DPIE 2021), with one study detailing 194 movement records from banded individuals in excess of 160 kilometres (Wilson 2003). Given the highly mobile nature of the species it is likely that individuals recorded within the development footprint would be dispersing through to other areas including the maternity roost at Kanangra-Boyd NP, due it's similarities to the assessment area in terms of topography and climatic conditions, rather than the northerly hotter/driers, and sub-tropical sites at Mount Kaputar and Willi Caves. The impacts associated with the Project will not impact on the ability for these interactions to occur.

(h) The extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population

The potential threats to Large Bent-winged Bat, as identified in the species profile included in the Bionet Atlas of NSW (DPIE 2021), are addressed below in Table 97.

Table 97 Potential threats to Large Bent-winged Bat

Threat	Relevance to proposed works
Disturbance by recreational cavers and general public accessing caves and adjacent areas particularly during winter or breeding	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and, due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features As such there will be no significant impacts to breeding habitat for Large Bent-winged Bat as a result of the Project. Mitigation measures to control indirect impacts (noise, light and vibration) during construction will further ensure no impacts to the species, as will recommendations to avoid undertaking works in the proximity of these habitat features during breeding season.

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Threat	Relevance to proposed works
Loss of high productivity foraging habitat	The proposed works include impacts to 132.43 hectares of native vegetation from the development footprint. However, only 37.92 hectares of this vegetation is considered high quality and potential foraging habitat for the species. Approximately 2.54 million hectares of native vegetation occurs within a 100 kilometre buffer zone surrounding the development footprint. This represents the available foraging habitat available with the range of the local population, as defined in question (b). There are also large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which all occur within foraging distance of the development footprint. As such the Project is considered unlikely to significantly reduce the availability of high productivity foraging habitat for the local population of Large Bent-winged Bat.
Introduction of exotic pathogens, particularly White-nose fungus.	There have been no cases of White-nose fungus recorded in Australia (DAWE 2019). It is unlikely that the proposed development would result in the fungus being spread to microbats due to its non-detection within Australia.
Cave entrances being blocked for human health and safety reasons, or vegetation (particularly blackberries) encroaching on and blocking cave entrances	There are two high potential roosting sites located within the vicinity of the development footprint. No direct impacts are proposed to either of these locations. As such the Project is unlikely to result in these locations becoming inaccessible to Large Bent-winged Bat individuals.
Hazard reduction and wildfire fires during the breeding season.	The risk of fire as a result of sparks from machinery during proposed works is unlikely but could increase the risk of fire occurring nearby potential roost sites. This risk will be managed by implementing appropriate mitigation measures such as spark dampeners, water spraying or the close proximity of fire-fighting gear such as extinguishers as necessary within the Project's CEMP.
Predation by feral cats	The project does not substantially alter the environment in such a way that the numbers of feral cats within the locality are likely to increase. As such the project is unlikely to result in exacerbation of this threatening process upon Large Bent-winged Bat.

(i) An estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion.

The following information has been gathered from BioNet Atlas records as well as scientific literature and government reports.

New South Wales

A total of 6,234 BioNet Atlas records for Large Bent-winged Bat exist across NSW (DPIE 2021). These records continuously across its range along the coastal region of NSW from the border with Queensland in the north down to the southern border of NSW with Victoria. Records exist within the following IBRA regions within NSW:

- Australian Alps
- Brigalow Belt South

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- Nandewar
- New England Tablelands
- NSW North Coast
- NSW South Western Slopes
- South East Corner
- South Eastern Highlands
- South Eastern Queensland
- Sydney Basin

Low numbers of records also occur within the Cobar Peneplain (3 records) and Riverina (1 record) IBRA regions.

The Saving Our Species strategy (DPIE 2015) for this species has identified seven priority management sites within NSW occurring in the following areas:

- Kwiamble in the Inverell LGA.
- Mount Kaputar in the Narrabri LGA.
- Willi Willi Cave in the Kempsey LGA.
- Yessabah in the Kempsey LGA.
- Church Cave in the Yass Valley LGA.
- Drum Cave in the Goulburn Mulwaree LGA.
- Dip Cave in the Yass Valley LGA.

A total of 1,229 (20 %) of the historical sightings occur within the NSW reserve system spread across 181 national parks, nature reserves and conservation areas.

Nandewar – Peel IBRA sub-region

A total of 372 records for Large Bent-winged Bat occur within the Nandewar IBRA region, 326 within the Peel IBRA sub-region. Of these only a single record from the Peel sub-region occurs within the NSW reserve system, located in the Serpentine Ridge CCA Zone 1 National Park.

New England Tablelands – Walcha Plateau IBRA sub-region

A total of 128 records for Large Bent-winged Bat occur within the New England Tablelands IBRA region, 10 within the Walcha Plateau sub-region. Of these, four records from the Walcha Plateau sub-region occur within the NSW reserve system, located in the Curracabundi National Park and Oxley Wild Rivers National Park.

NSW North Coast – Tomalla IBRA sub-region

A total of 1,103 records for Large Bent-winged Bat occur within the NSW North Coast IBRA region, 26 within the Tomalla sub-region. Of these only a single record from the Tomalla sub-region occurs within the NSW reserve system, located within the Curracabundi National Park.

(j) The measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

The proposed works are not considered likely to have a substantial impact on Large Bent-winged Bat, and thus no measures have been proposed to contribute to the recovery of the species.

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Little Bent-winged Bat SAII assessment in accordance with the BAM (2017) methodology

Little Bent-winged Bat is a member of the Miniopteridae family (Churchill 2008). The species occurs along the east coast of Australia from northern Queensland to Albion Park south of Wollongong, and is listed as Vulnerable under the BC Act.

Little Bent-winged Bat uses a broad range of habitats including moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, *Melaleuca* spp. swamps, dense coastal forests and banksia scrub (Churchill 2008, DPIE 2019). Little Bent-winged bats prefer well-timbered areas where they feed primarily in the shrub and canopy layers. Their diet consists primarily of beetles, moths, flies and spiders (Churchill 2008).

Little Bent-winged Bat is considered a species credit species under the BAM, specifically in relation to the species' breeding habitat. This breeding habitat is defined in the Atlas of NSW Wildlife (DPIE 2021) as any:

'Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave'; observation type code 'E nest-roost'; with numbers of individuals >500; or from the scientific literature'.

Impacts to these breeding habitat features, and the area within a 100 metre radius buffer around an accurate GPS point location centred on the cave / feature entrance, are what are considered to be potentially serious and irreversible for the species (DPIE 2021). Such areas were previously located within the development footprint, requiring the undertaking of an SAII assessment. However, amendments to the project design, as outlined in Table 1, have since resulted in these areas being successfully avoided. Whilst no longer required, this SAII has still been included and updated due to the importance of the species.

(a) The action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII.

Actions and measures to avoid direct impacts

A preliminary biodiversity assessment (Arup 2019) was undertaken prior to the development of the wind farm layout and the selection of the preferred transmission line corridor. This preliminary assessment highlighted areas of key ecological concern and allowed for avoidance of these areas during the wind farm concept design. During the wind farm layout design, workshops were held between project ecologists, civil engineers and wind modellers to further optimise layout options and ensure impacts to the areas of highest potential Little Bent-winged Bat breeding areas were avoided or minimised. These workshops resulted in the removal of turbines from areas of steep and rocky terrain located within 100 metres of areas of steep slopes considered to potentially support cave bat roosting/breeding opportunities. A total of 8 turbines were removed during these workshops, down to 70 turbines from a maximum of 78, which contributed to an approximately 30 % reduction in clearing extents.

Existing road infrastructure and farm tracks have been prioritised to provide the required access during construction and operation. By utilising pre-existing infrastructure the Project has avoided and minimised impacts to sensitive ecological areas, including potential microbat breeding habitat and the surrounding native vegetation that supports these habitats.

Two high potential cave bat roosting/breeding habitats were identified within the previous development footprint (as described in Section 5.4.2). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 partially occurred within the 108,546 square metre (100 metre radius) buffer zone surrounding one of the high potential roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8 % of the overall buffer zone). The removal of the WP27 as part of project design (Table 1) means that this impact has been successfully avoided.

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Actions and measures to avoid indirect impacts

Indirect impacts to Little Bent-winged Bat associated with the project operation phase primarily involve potential collision and possibly barotrauma risks associated with the wind turbine blades during the operational phase of the project. In designing the wind farm layout the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma.

Prior to design amendments there would have been some incursion into the air space above the 100 metre radius buffers surrounding two identified breeding/roosting habitats in the vicinity of WP27 and WP50. This overlap extended over 8,100 square metres (7.5 %) of the 108,465 square metre buffer applied to the WP27 habitat, and over 470 square metres (0.3 %) of the 168,036 square metre buffer applied to the WP50 habitat, when considered on the horizontal plane. Distances between the tip of turbine blades and the top of canopy were considered as part of the wind farm design to ensure that ample vertical buffers were provided for foraging microbats and other avian fauna. A buffer distance above the canopy (estimated to be 23.5 metres high) surrounding WP27 and WP50 of approximately 36.67 metres and 43.35 metres was allowed.

As the two identified high potential roosting/breeding habitats consisted of rocky outcrop and cliffline habitats, buffer distances between tip of the WP27 and WP50 turbine blades and the nearby potential microbat habitats were calculated at ground level in accordance with TIN051 (Natural England 2009). A distance of approximately 91 metres occurs between the tips of the WP27 turbine blades and the nearby potential microbat roosting/breeding habitat, and a distance of approximately 139 metres occurred between the tips of the WP50 turbines blades and the potential microbat roosting/breeding habitat in that vicinity. WP50 therefore exceeded the BAM 100 metres radius buffer (DPIE 2021), whereas WP27 only intruded within the first 9 metres of this buffer. However, as outlined in Table 1, the removal of WP27 and relocation of WP50 means impacts to the identified breeding/roosting habitats and surrounding buffer areas has been successfully avoided.

Section 5.4.2 of this BDAR, outlines the potential for collision mortality for the Little Bent-winged Bat, as well as other threatened and more common bats, which were recorded by acoustic detectors mounted on met masts at approximately 60 metres above the ground. In terms of the Little Bent-winged Bat, although there are no direct impacts to the potential roosting/breeding habitats within the development footprint, this species is migratory and are a fast-flying species that often forage beneath or above canopy height and may fly within RSH. Therefore, although collision mortality is unlikely and may occur only during some circumstances, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years).

Construction related indirect impacts include light, noise, and vibration. These impacts will be managed during construction to minimise impacts to nocturnal fauna. They also will not occur within the 100 metre buffer zone of the two high potential bat roosts. An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to monitor any potential bat mortality and to continually assess the assumptions of this impact assessment. Furthermore, this will include detailed and stringent mitigation measures for high risk turbines and adaptive management strategies for moderate and low risk turbines

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Additional mitigation measures are recommended for inclusion in the CEMP that will further reduce the potential for impact to the species.

(b) The size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification.

Two historical records for the species are located approximately 14 kilometres south-west of the wind farm development footprint. These records were based on ultrasonic recording that were made in December 2016 and December 2018 (DPIE 2021). The records occur within the Timor Caves locality, which is a known important non-breeding roost location for Large Bent-winged Bat, with which Little Bent-winged Bat is known to form mixed roosting colonies (NPWS 2011, Dwyer 1968).

The species was recorded during the targeted surveys supporting the current assessment. These surveys were conducted from February 2020 to May 2020 and included deployment of units at ground-level as well as deployment on three meteorological masts at heights of 2 metres, c.30 metres and c.60 metres. Additional acoustic/ultrasonic survey was also undertaken in spring 2019 between 19 – 21 November 2019 (three nights) Across the 24 deployed ultrasonic detector units deployed in 2020 and the three nights of spring surveys in 2019, the total mean call for the species per night was 2.6 calls, indicating a low activity within the development footprint on an infrequent basis.

Due to the rural location, where historical survey coverage is lower, the overall size of the local population is unknown. This assessment considers the local population to include all individuals within 100 kilometres of the development footprint, which is balance between the recorded maximum overnight distance of 28 kilometres (Dwyer 1968), and the over 200 kilometre distances the species is known to travel between maternity and non-breeding roost locations (Hoye & Hall 2008).

Within the development footprint the impacts that were previously considered potentially serious and irreversible for the local population were restricted to two high potential roosting/breeding locations that were detected within the proximity of proposed turbines WP27 and WP50 (as described in Section 8.3). Due to the avoidance measures that have been employed (Table 1), there are now no direct impacts to these sites.

There are also indirect impacts associated with project construction and operation including wind turbine strike and possibly barotrauma, as well as noise, light and vibrations. In terms of the Little Bent-winged Bat, this species is migratory and are a fast-flying species that often forage above canopy height and may fly within RSH. Therefore, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). These will be minimised through the avoidance measure outlined in under question (a) above.

As direct impacts to the identified high potential roosting/breeding locations have been avoided, impacts to the local population as a result of the Project are primarily associated with loss of native vegetation that provides foraging habitat at the individual level, potential turbine strike and possibly barotrauma, and possible interruptions to habitat connectivity. Assessment of these indirect impacts has been provided in Sections 8.3 and 8.5 of this BDAR.

(c) The extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact.

The SAII threshold specified for Little Bent-winged Bat within the Atlas of New South Wales is 'breeding habitat to be identified by survey'. This threshold does not provide a numerical value for the species that would assist a decision-maker in determining the level of impact above which a serious and irreversible impact may occur for this species. As such the extent to which the proposed impacts may exceed a threshold target for the species cannot be calculated. The general notes provided for the species state that any impact on breeding habitat could be considered potentially serious and irreversible (DPIE 2021).

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Two high potential roosting/breeding habitat locations were previously identified within the vicinity of the development footprint (refer Figure 15). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 partially occurred within the 100 metre buffer zone surrounding one of the high potential cave bat roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8 % of the overall buffer zone). Road infrastructure supporting turbine pad WP50 was also located within 5 metres of a cave bat roosting/breeding habitat buffer. Due to avoidance measures adopted by the project (outlined in Table 1), these impacts have now been successfully avoided.

A geomorphological assessment of the assessment area was also commissioned which found that the landscape within and surrounding the development footprint was formed by a range of volcanic activity resulting in a basalt lithology (Environmental Geosurveys Pty Ltd 2021). The extent to which potential microbat habitat is present and suitable is a function initially of lithology and rock structure modified over time by geological and environmental processes. The assessment found that whilst the basalt lithology present at the development footprint may support opportunities for microbat roosts, no substantial caves were likely to be present, and that no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another (Environmental Geosurveys Pty Ltd 2021).

Given the avoidance measures adopted by the project (Table 1) mean that there are now no direct impacts to identified cave bat breeding habitat, the project is considered unlikely to result in a serious and irreversible impacts for the species.

(d) The likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to:

> ***(i) An estimate of the change in habitat available to the local population as a result of the proposed development.***
>
> ***(ii) The proposed loss, modification, destruction or isolation of the available habitat used by the local population***
>
> ***(iii) Modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.***

Approximately 2.54 million hectares of native vegetation occurs within a 100 kilometre buffer zone surrounding the development footprint. This represents the available foraging habitat available with the range of the local population, as defined in question (b). Only 132.43 hectares of native vegetation occurs within the development footprint, a tiny fraction of the vegetation within the locality. Of this vegetation approximately 37.92 hectares (28.6 %) is in high condition providing good habitat values for foraging native fauna, including Little Bent-winged Bat. This foraging habitat would be modified as a result of the Project.

Two high potential roosting/breeding sites for Little Bent-winged Bat have been identified adjacent to the development footprint. No direct impacts are proposed for these habitats. As such there will be no direct impact to important species 'life cycle' processes as no habitats that support these processes are being directly impacted.

The project will also result in indirect impacts during construction and afterward during operation of the wind farm. During construction these indirect impacts will consist of increased traffic, noise and light during the project construction. These impacts will be managed during construction to reduce impacts to nocturnal fauna and will cease once construction is completed. Restriction of works to outside of breeding season within the vicinity of the two high potential roosting/breeding habitats is recommended for inclusion within the CEMP's mitigation measures which will further reduce scale of construction related indirect impacts.

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There are also indirect impacts associated with the operations phase where collision and possibly barotrauma risks associated with the wind turbine blades could occur, as well as potential impacts to habitat connectivity. These impacts are discussed further in Section 8.5 of the BDAR, however these impacts will not significantly change the availability of habitat in the locality. In terms of the Little Bent-winged Bat, although there are no direct impacts to the potential roosting/breeding habitats within the development footprint, this species is migratory and are a fast-flying species that often forage above canopy height and may fly with RSH. Therefore, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to monitor any bat mortality and to continually assess the assumptions of this impact assessment and enable adaptive management measures to be implemented if required to reduce measured impacts.

(e) The likely impact on the ecology of the local population. At a minimum, address the following:

- For fauna:
  - Breeding

Maternity roosts for Little Bent-winged Bat are rare with only five documented nursery sites within Australia (DPIE 2021). The species maternity roosts are documented as being large, with groups of 3,000 to 4,000 individuals, with the largest known maternity colony at Mt Etna in central Queensland consisting of over 100,000 individuals (Churchill 2008, Hoye & Hall 2008). The largest maternity colony in NSW co-occurs with a large maternity colony of Large Bent-winged Bat. This pattern of co-occurrence is repeated across several roost sites and it is thought that the smaller species depends on the heat generated by the larger species to successfully rear its young (DPIE 2021, Dwyer 1968, Churchill 2008).

The Saving Our Species strategy for Little Bent-winged Bat has identified two priority management areas (one north of Newcastle and one in Byron Bay), as well one key management site, Willi Willi Cave in northern NSW, (DPIE 2015). Willi Willi Cave is the closets of these locations, at approximately 140 kilometres north-east of the development footprint (DPIE 2015). The Willi Willi Cave is an important maternity colony for the species and is a mixed colony of both Little Bent-winged Bat and Large Bent-winged Bat. The size of this colony was estimated over three years, from 1961-1963, with the average estimate being 4,069 Little Bent-winged Bat individuals. (Dwyer 1968).

Within this area there are many potential roosting and breeding habitats for the species with over 80 caves identified in the Timor Caves karst system alone (Rutledge 2008). A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale (Environmental Geosurveys Pty Ltd 2021). Finally the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021) which may also provide potential roosting habitat to the local population.

Adjacent to the development footprint there are two identified high potential roosting/breeding sites. This is comparatively few when placed in context of the similar habitat available within the locality and broader

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region. There are also no direct impacts proposed to either of these potential habitat locations or their surrounding buffer areas. The avoidance and minimisation for reducing indirect impacts during operation of the wind farm are discussed in question (a) above. Finally, the actual likelihood of the two potential breeding sites being a new and previously undiscovered breeding location for the species is considered to be very low. As such, the Project is unlikely to result in impacts to breeding habitat for Little Bent-winged Bat.

- Foraging

Little Bent-winged Bat uses a broad range of habitats including rainforests, wet and dry sclerophyll forests and vine thicket. The species hunts in timbered areas, catching beetles, moths and flies within the shrub and canopy layer (Churchill 2008, DPIE 2021). Approximately 2.54 million hectares of native vegetation occurs within a 100 kilometre buffer zone surrounding the development footprint. This represents the available foraging habitat available with the 100 kilometre range of the local population, as defined in question (b). Only 132.43 hectares of native vegetation occurs within the development footprint, a tiny fraction of the vegetation within the locality. Of this vegetation approximately 37.92 hectares (28.6 %) is in high condition providing good habitat values for foraging native fauna, including Little Bent-winged Bat. This foraging habitat would be modified as a result of the Project.

Vegetation within the development footprint is connected to surrounding vegetation in all directions, and across the 100 kilometre area surrounding the development footprint there is approximately 85 % coverage of native vegetation. This includes large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests. These areas represent prime foraging habitat for the species and are all within two kilometres of various locations along the development footprint. Given the species has been known to travel up to 65 kilometres in a single night to access foraging habitat (Churchill 2008), all of these foraging habitats would be easily accessible individuals within the local population. The removal of native vegetation as part of the proposed works is therefore not considered to have a significant impact on the foraging ecology of Little Bent-winged Bat.

- Roosting

Little Bent-winged Bat is known to roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and occasionally buildings (DPIE 2021). Bionet records for Little Bent-winged Bat occur within the locality and the species was also detected as part of the acoustic surveys undertaken as part of this assessment, although at low levels. A known non-breeding roost for Large Bent-winged Bat also occurs in the locality at Timor Caves (NPWS 2011), located approximately 5 kilometres to the south-west of the development footprint. Given Little Bent-winged Bat is known to co-occur and share roost sites with Large Bent-winged Bat (Dwyer 1968, DPIE 2021), it is likely that the Timor Caves site is also utilised by Little Bent-winged Bat.

Within the locality there are many potential roosting and breeding habitats for the species with over 80 caves identified in the Timor Caves karst system alone (Rutledge 2008). A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale

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(Environmental Geosurveys Pty Ltd 2021). Finally the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021) which may also provide potential roosting habitat to the local population.

There are two high potential roosting habitats located adjacent to the development footprint. As a result of avoidance measures adopted by the project (Table 1), there are no direct impacts to either of these features or the surrounding buffer areas. Given the underlying geology outlined by the geomorphological report (Environmental Geosurveys Pty Ltd 2021), there are likely to be numerous cracks and crevices along ridgelines within the broader locality that may be used as overnight roosts by individuals or small groups of Little Bent-winged Bats. Given the high potential for similar habitat across the locality, the Project is not expected to significantly alter the availability of these crack/crevice overnight roosting habitats.

- Dispersal or movement pathways

Little Bent-winged Bat is a highly mobile species, with some individuals documented as dispersing up to two hundred kilometres from known maternity caves (Hoye & Hall 2008). While it is assumed that connected vegetation is preferred by the species for movement, the existence of many records of the species within urbanised areas, and its utilisation of man-made structures as roosting sites, suggests that the species does not rely on specialised dispersal or movement habitat.

Furthermore, in designing the wind farm layout the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma.

Given the local population is most likely to be utilising the known important non-breeding roosting habitats afforded by Timor Caves (NPWS 2011), and then travelling further south to the known maternity roost in the Kanangra-Boyd NP, it is unlikely that individuals would be making multiple north-south movements at turbine blade height over the linear wind farm footprint. Such north-south movement are more likely to be associated with foraging flights which would be conducted at canopy level, out of turbine blade range (see Section 7.2 for details regarding turbine blade buffers). The layout also retains areas of preferred foraging habitat in steeper areas of terrain, with more densely vegetated gullies preserved. It is therefore unlikely that the Project will interfere in the dispersal of movement pathways of the species. Overall, although collision mortality is unlikely and may occur only during some circumstances, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(f) A description of the extent to which the local population will become fragmented or isolated as a result of the proposed development.

Little Bent-winged Bat is a highly mobile species, capable of traversing and surviving in highly urbanised environments with hundreds of observations recorded across metropolitan areas, including Sydney, one of the most urbanised regions in the country. The species also utilises man-made structures such as culverts, bridges, buildings and derelict mines as roosting sites. Given the transient nature of the species, the high level

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of native vegetation connection across the region, and the high level of potential roosting locations, the project is not expected to result in significant amount of landscape fragmentation that would result in the local population becoming isolated. Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(g) The relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range.

Little Bent-winged Bat is distributed along the east-coast of Australia, ranging from north of Batemans Bay up to Cape York in Queensland (DPIE 2021). The occurrence of Little Bent-winged Bat is contiguous across its range within NSW, as evidenced by Bionet records for the species. Records are more isolated towards the southern and western edges of its distribution, however, the assessment area occurs well within the range of the species and is not considered to be at the limit of its range. Two priority areas have been identified for the species as part of the Saving Our Species program, one north of Newcastle and one in Byron Bay), as well one key management site, Willi Willi Cave in northern NSW (DPIE 2015).

The closest of these sites is Willi Willi Cave, located approximately 140 kilometres to the north-east of the development footprint, which is an important maternity colony for the species (DPIE 2015, Dwyer 1968). In addition, an important non-breeding roost for the Large Bent-winged Bat occurs at Timor Caves, approximately 5 kilometres south-west of the development footprint (NPWS 2011). Given the Little Bent-winged Bat is known to form mixed roosting colonies with Large Bent-winged Bat, it is likely Timor Caves are also utilised by Little Bent-winged Bat. With the species being high mobile, known to travel over two hundred kilometres between maternity and over-wintering roosts (Hoye & Hall 2008), it is likely that individuals recorded within the development footprint would be dispersing through to other areas including the Willi Willi Cave maternity roost, and the Timor Caves non-breeding roost. The impacts associated with the Project will not impact on the ability for these interactions to occur.

(h) The extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population.

The potential threats to Little Bent-winged Bat, as identified in the species profile included in the Bionet Atlas of NSW (DPIE 2021), are addressed below in Table 98.

Table 98 Potential threats to Little Bent-winged Bat

Threat	Relevance to proposed works
Disturbance of colonies, especially in nursery or hibernating caves.	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and, due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features. As such there will be no significant impacts to breeding habitat for Little Bent-winged Bat as a result of the Project. Mitigation measures to control indirect impacts (noise, light and vibration) during construction will further ensure no impacts to the species, as will recommendations to avoid undertaking works in the proximity of these habitat features during breeding season.
Destruction of caves that provide seasonal or potential roosting sites.	No direct impacts are proposed to either of the two high potential roosting/breeding locations. As there are no direct impacts these habitat features, there will be no destruction of potential roosting sites as a result of the Project.

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Threat	Relevance to proposed works
Changes to habitat, especially surrounding maternity/nursery caves and winter roosts.	The proposed works include impacts to 132.43 hectares of native vegetation from the development footprint. However, only 37.92 hectares of this vegetation is considered high quality and potential foraging habitat for the species. Approximately 2.54 million hectares of native vegetation occurs within a 100 kilometre buffer zone surrounding the development footprint. This represents the available foraging habitat available with the range of the local population, as defined in question (b). There are also large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which all occur within foraging distance of the development footprint. As such the Project is considered unlikely to significant alter the habitat of Little Bent-winged Bat surrounding maternity/nursery caves and winter roosts.
Pesticides on insects and in water consumed by bats bio accumulates, resulting in poisoning of individuals.	The project is not likely to substantially increase the levels of pesticides within the environment.
Predation from foxes, particularly around maternity caves, winter roosting and roosts within culverts, tunnels and under bridges.	Foxes are already present within the development footprint. The project does not substantially alter the environment such that the numbers of foxes within the locality are likely to increase. As such the project is unlikely to result in exacerbation of this threatening process upon Little Bent-winged Bat.
Predation from feral cats, particularly around maternity caves, winter roosts and roosts within culverts, tunnels and under bridges.	The project does not substantially alter the environment such that the numbers of feral cats within the locality are likely to increase. As such the project is unlikely to result in exacerbation of this threatening process upon Little Bent-winged Bat.
Introduction of exotic pathogens such as White-nose fungus.	There have been no cases of White-nose fungus recorded in Australia (DAWE 2019). It is unlikely that the proposed development would result in the fungus being spread to microbats due to its non-detection within Australia.
Hazard reduction and wildfire fires during the breeding season.	The risk of fire as a result of sparks from machinery during proposed works is unlikely but could increase the risk of fire occurring nearby potential roost sites. This risk will be managed by implementing appropriate mitigation measures such as spark dampeners, water spraying or the close proximity of fire-fighting gear such as extinguishers as necessary within the Project's CEMP.
Large scale wildfire or hazard reduction can impact on foraging resources.	The proposed works are unlikely to result in large-scale wildfire and do not involve hazard reduction practices. As such the impact of this threatening process is unlikely to be exacerbated by the proposed works.
Poor knowledge of reproductive success and population dynamics.	This threatening process will not be exacerbated by the proposed works. It is also unlikely that the proposed works will have an impact on the reproductive success of the species and local population dynamics given the scope of the impact and the lack of evidence of a known maternity roost being present in the development footprint
Destruction of caves that	No direct impacts are proposed to the two potential breeding/roosting habitats

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Threat	Relevance to proposed works
provide roosting sites.	within the development footprint. This threatening process will not be exacerbated by the Project.
Impacts from invasive flora and fauna.	Weeds occurring within the development footprint commonly occur across the locality. The current land use within the development footprint is agricultural with grazing cattle present that are likely already acting as vectors for the spreading of weeds. Measures to ensure adequate control of weeds and pathogens during construction will be detailed in the Project's CEMP. These measures will ensure weed material is properly managed such that there are no significant increases in weed densities that would lead to impacts to the potential Little Bent-winged Bat breeding habitat. The assessment area already supports several pest animal species including Red Fox Vulpes, Feral cats Felis catus and several species of deer. The CEMP will detail monitoring and management measures to ensure that the presence of such species does not increase due to proposed works. Such activities include improper disposal of rubbish that might attract pests. Overall, the impacts associated with the Project are unlikely to increase the presence of pest animal populations that might disturb potential Little Bent-winged Bat habitat.

(i) An estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion.

The following information has been gathered from BioNet Atlas records as well as scientific literature and government reports.

New South Wales

A total of 4,433 BioNet Atlas records for Little Bent-winged Bat exist across NSW (DPIE 2021). These records are generally contiguous along the east coast occurring from the Queensland border in the north, to Albion Park in the south, and up to 130 kilometres inland from the coast. Records occur within the following IBRA regions within NSW:

- New England Tablelands
- NSW North Coast
- South Eastern Queensland
- Sydney Basin

Low number of records also occur within the Nandewar (1 record), NSW South Western Slopes (1 record), South East Corner (2 records), and South Eastern Highlands (3 records).

The Saving our Species strategy for this species identifies two priority management areas and one priority management site (Willi Willi Cave) where management of important populations is underway. An estimated total of 23 % of the species' distribution occurs on reserves within the National Parks and Wildlife Service Estate (DPIE 2015). This is slightly higher than historical records suggest with 741 (16 %) sightings occurring within the NSW reserve system. These records occur within 138 national parks, nature reserves and conservation areas.

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Nandewar – Peel IBRA sub-region

One historical record for Little Bent-winged Bat occurs within the Nandewar IBRA region, in the Kaputar IBRA sub-region. No records exist with the Peel IBRA sub-region.

New England Tablelands – Walcha Plateau IBRA sub-region

A total of 22 records for Little Bent-winged Bat occur within the New England Tablelands IBRA region, however, only one of these occurs within the Walcha Plateau sub-region. This record occurs within the Oxley Wild Rivers National Park.

NSW North Coast – Tomalla IBRA sub-region

A total of 1,487 records for Little Bent-winged Bat occur within the NSW North Coast IBRA region, four within the Tomalla IBRA sub-region. None of the records from the Tomalla sub-region are associated with NSW reserves.

(j) The measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

The proposed works are not considered likely to have a substantial impact on Little Bent-winged Bat, and thus no measures have been proposed to contribute to the recovery of the species.

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Large-eared Pied Bat SAII assessment in accordance with the BAM (2017) methodology

Large-eared Pied Bat is a member of the Vespertilionidae family (Churchill 2008). The species is considered data-deficient and its current distribution is poorly known, however records for the species exist from Shoalwater Bay, north of Rockhampton, Queensland, through to Ulladulla in southern NSW (DAWE 2020, DPIE 2021a). The species is listed as Vulnerable under both the EPBC Act and BC Act. The species is commonly recorded from dry sclerophyll forests and woodlands however they do also occur in sub-alpine woodland as well as the edges of rainforest, wet sclerophyll forest, and *Callitris* sp. dominated forests, and areas with sandstone outcropping. (Churchill 2008).

Large-eared Pied Bat is considered a full species credit species under the BAM as it cannot be reliably predicted to occur on a site based on vegetation and other landscape features. Identified habitat constraints for the species include areas within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels (DPIE 2021b). The SAII threshold for the species specifically relates to potential breeding habitat and the presence of breeding habitat. The Atlas of NSW Wildlife identified these areas as follows:

Potential breeding habitat is PCTs associated with the species within 100m of rocky areas containing caves, or overhangs or crevices, cliffs or escarpments, or old mines, tunnels, culverts, derelict concrete buildings.

Such areas were previously located within the development footprint, requiring the undertaking of an SAII assessment. However, amendments to the project design, as outlined in Table 1, have since resulted in these areas being successfully avoided. Whilst no longer required, this SAII has still been included and updated due to the importance of the species. ***(a) The action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII.***

Actions and measures to avoid direct impacts

A preliminary biodiversity assessment (Arup 2019) was undertaken prior to the development of the wind farm layout and the selection of the preferred transmission line corridor. This preliminary assessment highlighted areas of key ecological concern and allowed for avoidance of these areas during the wind farm concept design. During the wind farm layout design, workshops were held between project ecologists, civil engineers and wind modellers to further optimise layout options and ensure impacts to the areas of highest potential Large-eared Pied Bat breeding areas were avoided or minimised. These workshops resulted in the removal of turbines from areas of steep and rocky terrain located within 100 metres of areas of steep slopes considered to potentially support cave bat roosting/breeding opportunities. A total of 8 turbines were removed during these workshops, down to 70 turbines from a maximum of 78, which contributed to an approximately 30% reduction in clearing extents.

Existing road infrastructure and farm tracks have been prioritised to provide the required access during construction and operation. By utilising pre-existing infrastructure, the Project has avoided and minimised impacts to sensitive ecological areas, including potential microbat breeding habitat and the surrounding native vegetation that supports these habitats.

Two high potential cave bat roosting/breeding habitats were identified within the previous development footprint (as described in Section 5.4.2). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 partially occurred within the 100 metre buffer zone surrounding one of the high potential cave bat roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8 % of the overall buffer zone). The removal of the WP27 as part of project design (Table 1) means that this impact has been successfully avoided.

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Actions and measures to avoid indirect impacts

Indirect impacts to Large-eared Pied Bat associated with the project operation phase primarily involve potential collision mortality and possibly barotrauma risks associated with the wind turbine blades during the operational phase of the project. In designing the wind farm layout the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma.

Prior to design amendments there would have been some incursion into the air space above the 100 metre radius buffers surrounding two identified breeding/roosting habitats in the vicinity of WP27 and WP50. This overlap extended over 8,100 square metres (7.5 %) of the 108,465 square metre buffer applied to the WP27 habitat, and over 470 square metres (0.3 %) of the 168,036 square metre buffer applied to the WP50 habitat, when considered on the horizontal plane. Distances between the tip of turbine blades and the top of canopy were considered as part of the wind farm design to ensure that ample vertical buffers were provided for foraging microbats and other avian fauna. A buffer distance above the canopy (estimated to be 23.5 metres high) surrounding WP27 and WP50 of approximately 36.67 metres and 43.35 metres respectively was allowed.

As the two identified high potential roosting/breeding habitats consisted of rocky outcrop and cliffline habitats, buffer distances between tip of the WP27 and WP50 turbine blades and the nearby potential microbat habitats were calculated at ground level in accordance with TIN051 (Natural England 2009). A distance of approximately 91 metres occurs between the tips of the WP27 turbine blades and the nearby potential microbat roosting/breeding habitat, and a distance of approximately 139 metres occurred between the tips of the WP50 turbines blades and the potential microbat roosting/breeding habitat in that vicinity. WP50 therefore exceeded the BAM 100 metres radius buffer (DPIE 2021b), whereas WP27 only intrudes within the first 9 metres of this buffer. However, as outlined in Table 1, the removal of WP27 and relocation of WP50 means impacts to the identified breeding/roosting habitats and surrounding buffer areas has been successfully avoided.

Section 5.4.2 of this BDAR, outlines the potential for collision mortality for the Large-eared Pied Bat, as well as other threatened and more common bats, which were recorded by acoustic detectors mounted on met masts at approximately 60 metres above the ground. In terms of the Large-eared Pied Bat, although there are no direct impacts to the potential roosting/breeding habitats within the development footprint, and although the likelihood of a collision is considered in highly unusual circumstances due to foraging and movement behaviour, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years).

Construction related indirect impacts include light, noise, and vibration. These impacts will be managed during construction to minimise impacts to nocturnal fauna. They also will not occur within the 100 metre buffer zone of the two high potential bat roosts. An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to monitor any potential bat mortality and to continually assess the assumptions of this impact assessment. Furthermore, this will include detailed and stringent mitigation measures for high risk turbines and adaptive management strategies for moderate and low risk turbines.

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Additional mitigation measures are recommended for inclusion in the CEMP that will further reduce the potential for impact to the species.

(b) The size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification.

The species appears to exist in a number of small populations throughout its known range with colonies seldom containing more than 50 individuals (DERM 2011). Historical records for the species occur approximately 14 kilometres south-west of the wind farm development footprint around the Timor Cave area (DPIE 2021b). These records were collected in December 2018 with acoustic recording devices.

The species was recorded during the targeted surveys supporting the current assessment. These surveys were conducted from February 2020 to May 2020 and included deployment of units at ground-level as well as deployment on three meteorological masts at heights of 2 metres, c.30 metres and c.60 metres. Additional acoustic/ultrasonic survey was also undertaken in spring 2019 between 19 – 21 November 2019 (three nights) across the 24 deployed ultrasonic detector units deployed in 2020 and the three nights of spring surveys in 2019, the total mean call for the species per night was 1.0 call, indicating a low level of activity within the development footprint on an infrequent basis.

Due to the rural location, where historical survey coverage is low, and a lack of existing scientific literature of the species' population biology, the overall size of the local population is unknown. As such, this assessment has utilised the available information regarding the roosting and foraging behaviour of the species to determine the likely local population relevant to, and potentially impacted by, the Project. Studies have shown that the species prefers roosting locations within 700 metres of foraging habitats, with the maximum distance travelled between a known roost and the edge of preferred foraging areas being 2.5 kilometres (Williams & Thomson 2018). This is supported by the 2 kilometre habitat constraint buffer required from rocky cliffline areas containing caves, overhangs, escarpments, outcrops, or crevices that represent potential habitat for the species in the Bionet Atlas of NSW (DPIE 2021b).

This assessment therefore assumes that the local population comprises, at a minimum, any individual bats foraging within the development footprint, as well as those present within a 2.5 kilometre buffer surrounding the development footprint. Furthermore, given the species proclivity to form small colonies (DERM 2011), the local population is considered likely to include individuals from multiple small over-lapping colonies, each occurring within a 2 – 2.5 kilometre distance of potential roosting habitat. Which, as the broader locality is rich in potential roosting habitat and foraging resources (Environmental Geosurveys Pty Ltd 2021), means there is potential for many small over-lapping colonies to exist over a large area, and all of these colonies together could be expected to form the local population.

Within the development footprint the impacts that were previously considered potentially serious and irreversible for the local population were restricted to two high potential roosting/breeding locations that have been detected within the proximity of proposed turbines WP27 and WP50 (as described in Section 8.3). Due to the avoidance measures that have been employed (Table 1), there are now no direct impacts to these sites.

There are also indirect impacts associated with project construction and operation including collision mortality and possibly barotrauma, as well as noise, light and vibrations. Although the likelihood of a collision is low due to foraging and movement behaviour, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). These will be minimised through the avoidance measure outlined in under question (a) above.

As direct impacts to the identified high potential roosting/breeding locations have been avoided, impacts to the local population as a result of the Project are primarily associated with loss of native vegetation that

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provides foraging habitat at the individual level, potential turbine strike and possibly barotrauma, and possible interruptions to habitat connectivity. Assessment of these indirect impacts has been provided in Sections 8.3 and 8.5 of this BDAR.

(c) The extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact.

The SAII threshold specified for Large-eared Pied Bat within the Atlas of New South Wales is 'breeding habitat to be identified by survey'. This threshold does not provide a numerical value for the species that would assist a decision-maker in determining the level of impact above which a serious and irreversible impact may occur for this species. As such the extent to which the proposed impacts may exceed a threshold target for the species cannot be calculated. The general notes for the species states that the SAII threshold is potential breeding habitat and presence of breeding individuals (DPIE 2021b).

Two high potential roosting/breeding habitat locations were previously identified within the vicinity of the development footprint (refer Figure 15). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 partially occurred within the 100 metre buffer zone surrounding one of the high potential cave bat roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8% of the overall buffer zone). Road infrastructure supporting turbine pad WP50 was also located within 5 metres of a cave bat roosting/breeding habitat buffer. Due to avoidance measures adopted by the project (outlined in Table 1), these impacts have now been successfully avoided.

A geomorphological assessment of the assessment area was also commissioned which found that the landscape within and surrounding the development footprint was formed by a range of volcanic activity resulting in a basalt lithology (Environmental Geosurveys Pty Ltd 2021). The extent to which potential microbat habitat is present and suitable is a function initially of lithology and rock structure modified over time by geological and environmental processes. The assessment found that whilst the basalt lithology present at the development footprint may support opportunities for microbat roosts, no substantial caves were likely to be present, and that no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another (Environmental Geosurveys Pty Ltd 2021).

Given the avoidance measures adopted by the project (Table 1) mean that there are now no direct impacts to identified cave bat breeding habitat, the project is considered unlikely to result in a serious and irreversible impacts for the species.

(d) The likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to:

> ***(i) An estimate of the change in habitat available to the local population as a result of the proposed development.***
>
> ***(ii) The proposed loss, modification, destruction or isolation of the available habitat used by the local population, and***
>
> ***(iii) Modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.***

A total of 28,033 hectares of native vegetation occurs within the 2.5 kilometre area surrounding the development footprint, with only 132.43 hectares of native vegetation (0.47 %) occurring within the development footprint. Of this vegetation approximately 37.92 hectares is in high condition providing good

habitat values for foraging native fauna, including Large-eared Pied Bat. This foraging habitat would be modified as a result of the Project.

Two high potential roosting/breeding sites for Large-eared Pied Bat have been identified adjacent to the development footprint. No direct impacts are proposed for these habitats. As such there will be no reduction in the availability of breeding habitat for Large-eared Pied Bat. Similarly, there will be no direct impact to important species 'life cycle' processes as no habitats that support these processes are being directly impacted.

The project will also result in indirect impacts during construction and afterward during operation of the wind farm. During construction these indirect impacts will consist of increased traffic, noise and light during the project construction. These impacts will be managed during construction to reduce impacts to nocturnal fauna and will cease once construction is completed. Restriction of works to outside of breeding season within the vicinity of the two high potential roosting/breeding habitats is recommended for inclusion within the CEMP's mitigation measures which will further reduce scale of construction related indirect impacts.

There are also indirect impacts associated with the operations phase where collision and possibly barotrauma risks associated with the wind turbine blades could occur, as well as potential impacts to habitat connectivity. These impacts are discussed further in Section 8.5 of the BDAR, however, these impacts will not significantly change the availability of habitat in the locality. Although the likelihood of a collision is low due to foraging and movement behaviour, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years). An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to assess any bat mortality and to continually assess the assumptions of this impact assessment and enable adaptive management measures to be implemented if required to reduce measured impacts.

(e) The likely impact on the ecology of the local population. At a minimum, address the following:

- For fauna:
  - Breeding

Large-eared Pied Bat utilises cave roosts almost exclusively for breeding. While individuals are known to utilise disused mine adits as roost sites, limited research suggests that the species requires a highly specific karst configuration (bell-shaped) with a dome roof that is deep enough to allow juvenile bats to learn to fly safely inside and with indentations in the roof to allow bats to cluster, as well as a specific microclimate (i.e. temperature of 15.5 – 18ºC and 51 – 76% relative humidity) for rearing young. The size of maternity roosts typically consist of between 15 and 40 adult females and their young, although one maternity cave north-west of Coonabarabran in central NSW has recorded approximately 40 adults accompanied by twin young for an estimate of around 110 individuals (Pennay 2008, DERM 2011, Churchill 2008, Dwyer 1966).

Known breeding locations are extremely limited within NSW. Five locations are known to have been used for breeding within NSW, including:

- A mine tunnel at Copeton that was used for breeding until flooded by dam waters in 1976 (Dwyer 1966).
- A sandstone cave near Coonabarabran, NSW (Pennay 2008).
- Capture of lactating females adjacent to sandstone cliffs in Ulan, NSW (Fly By Night 2005).
- Observations of small groups of females in a disused gold mine near Barraba, NSW (DERM 2011).
- Anecdotal observations of small groups of females and young bats in the sandstone Pilliga region, NSW (DERM 2011).

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The closest of these known breeding sites is the disused gold mine near Barraba, with the town of Barraba located approximately 145 kilometres away from the development footprint. The Saving Our Species strategy for this species is currently listed as data-deficient, with no priority management areas currently identified for the species (DPIE 2021a).

Within the locality of the assessment area there are many potential roosting and breeding habitats for the species. A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale (Environmental Geosurveys Pty Ltd 2021). Finally, the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021), which may also provide potential roosting habitat to the local population.

Adjacent to the development footprint there are two identified high potential roosting/breeding sites. This is comparatively few when placed in context of the similar habitat available within the locality and broader region. There are also no direct impacts proposed to either of these potential habitat locations or their surrounding buffer areas. The avoidance and minimisation for reducing indirect impacts during operation of the wind farm are discussed in question (a) above. As such, the Project is unlikely to result in impacts to breeding habitat for Large-eared Pied Bat.

- Foraging

Studies on the foraging behaviour of Large-eared Pied Bat in the western Blue Mountains found that the species preferred foraging areas consisted of sharp grassland-forest border in west-facing valleys with a creek or moist drainage gully and wet vegetation types within 700 metres of day roosts (Williams & Thomson 2018). A total of 28,033 hectares of native vegetation occurs within the 2.5 kilometre area surrounding the development footprint, with only 132.43 hectares of native vegetation (0.47 %) occurring within the development footprint. Of this vegetation approximately 37.92 hectares is in high condition providing good habitat values for foraging native fauna, including Large-eared Pied Bat. This foraging habitat would be modified as a result of the Project.

Vegetation within the development footprint is well connected to surrounding vegetation, with large patches of native vegetation occurring within the 2.5 kilometre area surrounding the development footprint. This includes large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests. These areas represent prime foraging habitat for the species and are all within two kilometres of various locations along the development footprint. Given the plentiful natural roosts that are likely to be available to individuals within 2.5 kilometres of the development footprint, due to the underlying geomorphology (Environmental Geosurveys Pty Ltd 2021), these foraging habitats would be easily accessible to individuals within the local population. The removal of native vegetation as part of the proposed works is therefore not considered to have a significant impact on the foraging ecology of Large-eared Pied Bat.

- Roosting

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Large-eared Pied Bat typically roosts in entrances of caves, crevices in cliffs, old mine workings and occasionally in the disused, bottle-shaped mud nests of the Fairy Martin *Petrochelidon ariel* (DPIE 2021b). Studies on the roosting behaviour of Large-eared Pied Bat in the western Blue Mountains found that crevices in vertical, sheer cliff faces were used exclusively for day roosts by males and females without offspring, with no individuals utilising tree roosts favoured by other microbat species (Williams & Thomson 2018, DERM 2011).

Within the locality there are many potential roosting and breeding habitats for the local population. A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale (Environmental Geosurveys Pty Ltd 2021). Finally the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021) which may also provide potential roosting habitat to the local population.

There are two high potential roosting habitats located adjacent to the development footprint. As a result of avoidance measures adopted by the project (Table 1), there are no direct impacts to either of these features or their surrounding buffer areas. Given the underlying geology outlined by the geomorphological report (Environmental Geosurveys Pty Ltd 2021), there are likely to be numerous cracks and crevices along ridgelines within the broader locality that may be used as overnight roosts by individuals or small groups of Large-eared Pied Bat. Given the high potential for similar habitat across the locality, the Project is not expected to significantly alter the availability of these crack/crevice overnight roosting habitats.

- Dispersal or movement pathways

Large-eared Pied Bat is a mobile species capable of dispersing across small breaks in habitats. In designing the wind farm layout, the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma. Although the likelihood of a collision is low due to foraging and movement behaviour, it is considered a moderate risk that repeated loss of individuals as a result of collision mortality may cause change to the local abundance of this species in the short term (up to 5 years).

Known maternity roosts of Large-eared Pied Bat maternity roosts are extremely limited, and the distance bats move from maternity roosts to non-breeding roosts has not been established but it likely to be less than 100 kilometres (DAWE 2020). It is therefore unlikely that individuals would be making multiple north-south movements at turbine blade height over the linear wind farm footprint for migratory purposes. Such north-

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south movement are more likely to be associated with foraging flights which would be conducted at canopy level, out of turbine blade range (see Section 7.2 for details regarding turbine blade buffers). The layout also retains areas of preferred foraging habitat in steeper areas of terrain, with more densely vegetated gullies preserved. It is therefore unlikely that the Project will interfere in the dispersal of movement pathways of the species. Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(f) A description of the extent to which the local population will become fragmented or isolated as a result of the proposed development.

Large-eared Pied Bat is a mobile species, capable of traversing small breaks in native vegetation, which also utilise man-made structures such as culverts, bridges, buildings and derelict mines as roosting sites. The geomorphology of the 2.5 kilometre area surrounding the development footprint has the potential to provide the species with numerous roosting habitats (Environmental Geosurveys Pty Ltd 2021). There are large tracts of intact native vegetation within and adjacent to these areas such as the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which are connected to the development footprint which would facilitate dispersal of the local population. The spacing between wind turbines within the development footprint is such that movement corridors have been conserved, allowing for migrating and foraging bats to pass through the landscape.

Given the transient nature of the species, the high level of native vegetation connection across the region, and the high level of potential roosting locations, the project is not expected to result in significant amount of landscape fragmentation that would result in the local population becoming isolated. Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(g) The relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range.

Large-eared Pied Bat is distributed along the east-coast of Australia, ranging from Shoalwater Bay, north of Rockhampton, Queensland, through to Ulladulla in southern NSW (DAWE 2020, DPIE 2021a). Whilst the range of the species is large, it has been suggested that the species is restricted within its range, and does not occur continuously (DAWE 2020). This may be due to the lack of available roosts throughout its range and has likely resulted in the populations of the species in north-east NSW and south-east Queensland, Shoalwater Bay and Blackdown Tablelands to become isolated from each other, with little interaction (DAWE 2020).

The Saving Our Species strategy for this species is currently listed as data-deficient, with no priority management areas currently identified for the species (DPIE 2021a). Known breeding locations are extremely limited within NSW. Five locations are known to have been used for breeding within NSW, including:

- A mine tunnel at Copeton which was used for breeding until flooded by dam waters in 1976 (Dwyer 1966).
- A sandstone cave near Coonabarabran, NSW (Pennay 2008).
- Capture of lactating females adjacent to sandstone cliffs in Ulan, NSW (Fly By Night 2005).
- Observations of small groups of females in a disused gold mine near Barraba, NSW (DERM 2011).
- Anecdotal observations of small groups of females and young bats in the sandstone Pilliga region, NSW (DERM 2011).

The closest of these known breeding sites is the disused gold mine near Barraba, with the town of Barraba located approximately 145 kilometres away from the development footprint.

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The dispersal capabilities of the species are poorly understood, as are the size of local populations within the locality. However, the surface geology of the 2.5 kilometre area surrounding the development footprint has the potential to provide small colonies that may be present within the area with numerous roosting habitats. There are also large tracts of intact native vegetation within and adjacent to these areas such as the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which are connected to the development footprint which would facilitate dispersal of individuals between these colonies

As consideration has been made with regards to the spacing of wind turbines, leading to preservation of movement corridors, it is unlikely that the movement of individuals between colonies would be significantly restricted by the proposed development. As such, the Project is unlikely to lead to a reduction in the pre-existing level of interactions that may be occurring between small, over-lapping colonies that may exist in the area that comprise the local population of the species.

(h) The extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population.

The potential threats to Large-eared Pied Bat, as identified in the species profile included in the Atlas of NSW Wildlife (DPIE 2021b), are addressed below in Table 99.

Table 99 Potential threats to Large-eared Pied Bat

Threat	Relevance to proposed works
Clearing and isolation of forest and woodland habitats near cliffs, caves and old mine workings for agriculture or development	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and, due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features. As such there will be no significant impacts to breeding habitat for Large-eared Pied Bat as a result of the Project. Mitigation measures to control indirect impacts (noise, light and vibration) during construction will further ensure no impacts to the species, as will recommendations to avoid undertaking works in the proximity of these habitat features during breeding season.
Loss of foraging habitat close to cliffs, caves and old mine workings for forestry activities and too-frequent burning, usually associated with grazing	The proposed works include impacts to 132.43 hectares of native vegetation from the development footprint. However, only 37.92 hectares of this vegetation is considered high quality and potential foraging habitat for the species. A total of 28,033 hectares of native vegetation occurs within the 2.5 kilometre area surrounding the development footprint, which, given the highly mobile nature of the species, is readily available to individuals as foraging habitat. There are also large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which all occur within foraging distance of the development footprint. As such the Project is considered unlikely to significantly reduce the availability of foraging habitat for the local population of Large-eared Pied Bat.
Damage to roosting and maternity sites from mining operations, and recreational caving activities	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features. As such there will be no significant impacts to breeding habitat for Large-eared Pied Bat as a result of the Project. Mitigation measures to control indirect impacts (noise, light and vibration) during construction

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Threat	Relevance to proposed works
	will further ensure no impacts to the species, as will recommendations to avoid undertaking works in the proximity of these habitat features during breeding season.
Use of pesticides	The project is not likely to substantially increase the levels of pesticides within the environment.
Disturbance to roosting areas by goats	The assessment area and surrounds likely support several pest animal species and it is highly likely that feral goats are already present within the area. The small-scale nature of works is unlikely to result in an increase in feral goat activity in the area or alter the existing disturbances to roosting sites that may already be exhibited by goats within the locality.
Insufficient understanding of habitat requirements	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features. Whilst the species is considered data-deficient, the lack of impacts to key habitats that support critical species life processes (i.e. breeding) means it is unlikely that the proposed impacts would have a significant impact on the population. The geomorphology assessment of the assessment area also found that whilst the basalt lithology present at the development footprint may support opportunities for microbat roosts, no substantial caves were likely to be present, and that no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another (Environmental Geosurveys Pty Ltd 2021).

(i) An estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion.

The following information has been gathered from BioNet Atlas records as well as scientific literature and government reports.

New South Wales

A total of 1,967 BioNet Atlas records for Large-eared Pied Bat exist across NSW (DPIE 2021b). The species is considered data-deficient and its current distribution is poorly known, however records for the species exist from Shoalwater Bay, north of Rockhampton, Queensland, through to Ulladulla in southern NSW (DAWE 2020, DPIE 2021a). Records exist within the following IBRA regions within NSW:

- Brigalow Belt South
- Nandewar
- NSW North Coast
- NSW South Western Slopes
- South Eastern Highlands
- South Eastern Queensland
- Sydney Basin

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Low numbers of records also occur within the Cobar Peneplian (3 records), New England Tablelands (1 record), and the South East Corner (4 records) IBRA region.

The Saving Our Species strategy for this species identifies that the species is currently data-deficient and additional survey and collection of ecological information is required. As such no priority management areas are identified (DPIE 2021a). A total of 453 (23%) of the historical sightings occurring within the NSW reserve system. These records occur within 63 national parks, nature reserves and conservation areas.

Nandewar – Peel IBRA sub-region

A total of 627 records for Large-eared Pied Bat occur within the Nandewar IBRA region, 618 within the Peel IBRA sub-region. Of these, six records from the Peel sub-region occurs within the NSW reserve system, located in the Boonalla CCA Zone 2 Aboriginal Area (1 record), Horton Falls CCA Zone 1 National Park (1 record), Mount Kaputar National Park (2 records), and the Woodsreef CCA Zone 3 State Conservation Area (2 records).

New England Tablelands – Walcha Plateau IBRA sub-region

A single record for Large-eared Pied Bat occurs within the New England Tablelands IBRA region. This record occurs outside of the Walcha Plateau sub-region.

NSW North Coast – Tomalla IBRA sub-region

A total of 19 records for Large-eared Pied Bat occur within the NSW North Coast IBRA region, four of which are within the Tomalla sub-region. None of the records from the Tomalla sub-region as associated with areas of land that are protected under the NSW reserve system.

(j) The measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

The proposed works are not considered likely to have a substantial impact on Large-eared Pied Bat, and thus no measures have been proposed to contribute to the recovery of the species.

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Eastern Cave Bat SAII asessment in accordance with the BAM (2017) methodology

The Eastern Cave Bat is a member of the Vespertilionidae family (Churchill 2008), with a range that extends from Cape York in northern Queensland down to at least the Sydney Basin in NSW (Law, Chidel, & Mong 2005). The species is listed as Vulnerable under both the EPBC Act and BC Act. Very little is known about the biology of the species, however, all records are in close proximity to sandstone or volcanic escarpments. They have been found inhabiting tropical moist woodland, as well as wet and dry sclerophyll forests. (Churchill 2008).

Eastern Cave Bat is considered a full species credit species under the BAM as it cannot be reliably predicted to occur on a site based on vegetation and other landscape features. Identified habitat constraints for the species include areas within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds (DPIE 2021a). The SAII threshold for the species specifically relates to potential breeding habitat and the presence of breeding habitat. The Atlas of NSW Wildlife identified these areas as follows:

Potential breeding habitat is PCTs associated with the species within 100m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within the potential habitat.

Such areas were previously located within the development footprint, requiring the undertaking of an SAII assessment. However, amendments to the project design, as outlined in Table 1, have since resulted in these areas being successfully avoided. Whilst no longer required, this SAII has still been included and updated due to the importance of the species.

(a) The action and measures taken to avoid the direct and indirect impact on the potential entity for an SAII.

Actions and measures to avoid direct impacts

A preliminary biodiversity assessment (Arup 2019) was undertaken prior to the development of the wind farm layout and the selection of the preferred transmission line corridor. This preliminary assessment highlighted areas of key ecological concern and allowed for avoidance of these areas during the wind farm concept design. During the wind farm layout design, workshops were held between project ecologists, civil engineers and wind modellers to further optimise layout options and ensure impacts to the areas of highest potential Eastern Cave Bat breeding areas were avoided or minimised. These workshops resulted in the removal of turbines from areas of steep and rocky terrain located within 100 metres of areas of steep slopes considered to potentially support cave bat roosting/breeding opportunities. A total of 8 turbines were removed during these workshops, down to 70 turbines from a maximum of 78, which contributed to an approximately 30% reduction in clearing extents.

Existing road infrastructure and farm tracks have been prioritised to provide the required access during construction and operation. By utilising pre-existing infrastructure, the Project has avoided and minimised impacts to sensitive ecological areas, including potential microbat breeding habitat and the surrounding native vegetation that supports these habitats.

Two high potential cave bat roosting/breeding habitats were identified within the previous development footprint (as described in Section 5.4.2). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 partially occurred within the 100 metre buffer zone surrounding one of the high potential cave bat roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8% of the overall buffer zone). The removal of the WP27 as part of project design (Table 1) means that this impact has been successfully avoided.

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Actions and measures to avoid indirect impacts

Indirect impacts to Eastern Cave Bat associated with the project operation phase primarily involve potential collision and possibly barotrauma risks associated with the wind turbine blades during the operational phase of the project. In designing the wind farm layout the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma.

Prior to design amendments there would have been some incursion into the air space above the 100 metre radius buffers surrounding two identified breeding/roosting habitats in the vicinity of WP27 and WP50. This overlap extended over 8,100 square metres (7.5%) of the 108,465 square metre buffer applied to the WP27 habitat, and over 470 square metres (0.3%) of the 168,036 square metre buffer applied to the WP50 habitat, when considered on the horizontal plane. Distances between the tip of turbine blades and the top of canopy were considered as part of the wind farm design to ensure that ample vertical buffers were provided for foraging microbats and other avian fauna. A buffer distance above the canopy (estimated to be 23.5 metres high) surrounding WP27 and WP50 of approximately 36.67 metres and 43.35 metres respectively was allowed.

As the two identified high potential roosting/breeding habitats consisted of rocky outcrop and cliffline habitats, buffer distances between tip of the WP27 and WP50 turbine blades and the nearby potential microbat habitats were calculated at ground level in accordance with TIN051 (Natural England 2009). A distance of approximately 91 metres occurs between the tips of the WP27 turbine blades and the nearby potential microbat roosting/breeding habitat, and a distance of approximately 139 metres occurred between the tips of the WP50 turbines blades and the potential microbat roosting/breeding habitat in that vicinity. WP50 therefore exceeded the BAM 100 metres radius buffer (DPIE 2021a), whereas WP27 only intrudes within the first 9 metres of this buffer. However, as outlined in Table 1, the removal of WP27 and relocation of WP50 means impacts to the identified breeding/roosting habitats and surrounding buffer areas has been successfully avoided.

Section 5.4.2 of this BDAR, outlines the potential for collision mortality for the Eastern Cave Bat, as well as other threatened and more common bats, which were recorded by acoustic detectors mounted on met masts at approximately 60 metres above the ground. In terms of the Eastern Cave Bat, it is not expected that impacts associated with potential blade strike would result in impacts significant enough to threaten the persistence of this species. It is considered that the likelihood of a collision event for the Eastern Cave Bat may occur only in unusual circumstances given the low level of relative activity at higher elevations due to foraging and movement behaviour (i.e. within the range of rotor blades), and the expected volume of commensurate habitat available in the landscape. Should collision mortality occur however, it is considered that the repeated loss of a small number of individuals would not be of concern to the viability of the local or broader population.

Construction related indirect impacts include light, noise, and vibration. These impacts will be managed during construction to minimise impacts to nocturnal fauna. They also will not occur within the 100 metre buffer zone of the two high potential bat roosts. An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to monitor any potential bat mortality and to continually assess the

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assumptions of this impact assessment. Furthermore, this will include detailed and stringent mitigation measures for high risk turbines and adaptive management strategies for moderate and low risk turbines.

Additional mitigation measures are recommended for inclusion in the CEMP that will further reduce the potential for impact to the species.

(b) The size of the local population directly and indirectly impacted by the development, clearing or biodiversity certification.

Historical records for the species occur approximately 10 kilometres west, and 24 kilometres south-west of the wind farm development footprint, around the Timor Cave area (DPIE 2021a). These records were collected in 2002 and 2005 respectively via acoustic recording devices.

The species was recorded during the targeted surveys supporting the current assessment. These surveys were conducted from February 2020 to May 2020 and included deployment of units at ground-level as well as deployment on three meteorological masts at heights of 2 metres, c.30 metres and c.60 metres. Additional acoustic/ultrasonic survey was also undertaken in spring 2019 between 19 – 21 November 2019 (three nights) Across the 24 deployed ultrasonic detector units deployed in 2020 and the three nights of spring surveys in 2019, the total mean call for the species per night was 0.6 calls, indicating a low level of activity within the development footprint on an infrequent basis.

Due to the rural location, where historical survey coverage is low, and a lack of existing scientific literature of the species' population biology, the overall size of the local population is unknown. As such, this assessment has utilised the available information regarding the roosting and foraging behaviour of the species to determine the likely local population relevant to, and potentially impacted by, the Project. Radio-tracking studies have shown that most movements of individuals between roost sites were within 1.5 kilometres, with the maximum measured distance between a roost sites by a single individual being 3.75 kilometres. Foraging range is typically small, with one individual observed foraging over five consecutive nights in an area of only 33 hectares (Law, Chidel, & Mong 2005, Churchill 2008). This is supported by the 2 kilometre habitat constraint buffer required from rocky cliffline areas containing caves, overhangs, escarpments, outcrops, or crevices that represent potential habitat for the species in the Bionet Atlas of NSW (DPIE 2021a).

This assessment therefore assumes that the local population comprises, at a minimum, any individual bats foraging within the development footprint, as well as those present within a 2.5 kilometre buffer surrounding the development footprint. The local population is considered likely to include individuals from multiple small over-lapping colonies, each occurring within a 2 – 2.5 kilometre distance of potential roosting habitat. Which, as the broader locality is rich in potential roosting habitat and foraging resources (Environmental Geosurveys Pty Ltd 2021), means there is potential for many small over-lapping colonies to exist over a large area, and all of these colonies together could be expected to form the local population.

Within the development footprint the impacts that were previously considered potentially serious and irreversible for the local population were restricted to two high potential roosting/breeding locations that have been detected within the proximity of proposed turbines WP27 and WP50 (as described in Section 8.3). Due to the avoidance measures that have been employed (Table 1), there are now no direct impacts to these sites.

There are also indirect impacts associated with project construction and operation including collision mortality and possibly barotrauma, as well as noise, light and vibrations. It is considered that the likelihood of a collision event for the Eastern Cave Bat may occur only in unusual circumstances given the low level of relative activity recorded for this species at higher elevations due to foraging and movement behaviour (i.e. within the range of rotor blades), and the expected volume of commensurate habitat available in the landscape. Should collision mortality occur however, it is considered that the repeated loss of a small number

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of individuals would not be of concern to the viability of the local or broader population. These will be minimised through the avoidance measure outlined in under question (a) above.

As direct impacts to the identified high potential roosting/breeding locations have been avoided, impacts to the local population as a result of the Project are primarily associated with loss of native vegetation that provides foraging habitat at the individual level, potential turbine strike and possibly barotrauma, and possible interruptions to habitat connectivity. Assessment of these indirect impacts has been provided in Sections 8.3 and 8.5 of this BDAR.

(c) The extent to which the impact exceeds any threshold for the potential entity that is specified in the Guidance to assist a decision-maker to determine a serious and irreversible impact.

The SAII threshold specified for Eastern Cave Bat within the Atlas of New South Wales is 'only for breeding habitat to be identified'. This threshold does not provide a numerical value for the species that would assist a decision-maker in determining the level of impact above which a serious and irreversible impact may occur for this species. As such the extent to which the proposed impacts may exceed a threshold target for the species cannot be calculated. The general notes for the species states that the SAII threshold is potential breeding habitat and presence of breeding individuals (DPIE 2021a).

Two high potential roosting/breeding habitat locations were previously identified within the vicinity of the development footprint (refer Figure 15). Whilst there were no direct impacts to these potential cave bat breeding habitats, the turbine pad associated with turbine WP27 does partially occurred within the 100 metre buffer zone surrounding one of the high potential cave bat roosting/breeding habitats. This would have resulted in the removal of approximately 2,000 square metres of native vegetation from this buffer zone (1.8% of the overall buffer zone). Road infrastructure supporting turbine pad WP50 was also located within 5 metres of a cave bat roosting/breeding habitat buffer. Due to avoidance measures adopted by the project (outlined in Table 1), these impacts have now been successfully avoided.

A geomorphological assessment of the assessment area was also commissioned which found that the landscape within and surrounding the development footprint was formed by a range of volcanic activity resulting in a basalt lithology (Environmental Geosurveys Pty Ltd 2021). The extent to which potential microbat habitat is present and suitable is a function initially of lithology and rock structure modified over time by geological and environmental processes. The assessment found that whilst the basalt lithology present at the development footprint may support opportunities for microbat roosts, no substantial caves were likely to be present, and that no data was found to suggest that the development footprint and immediate surrounds geomorphologically standout from the surrounding landscape in one way or another (Environmental Geosurveys Pty Ltd 2021).

Given the avoidance measures adopted by the project (Table 1) mean that there are now no direct impacts to identified cave bat breeding habitat, the project is considered unlikely to result in a serious and irreversible impacts for the species.

(d) The likely impact (including direct and indirect impacts) that the development, clearing or biodiversity certification will have on the habitat of the local population, including but not limited to:

> ***(i) An estimate of the change in habitat available to the local population as a result of the proposed development.***
>
> ***(ii) The proposed loss, modification, destruction or isolation of the available habitat used by the local population, and***
>
> ***(iii) Modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.***

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A total of 28,033 hectares of native vegetation occurs within the 2.5 kilometre area surrounding the development footprint, with only 132.43 hectares of native vegetation (0.47 %) occurring within the development footprint. Of this vegetation approximately 37.92 hectares is in high condition providing good habitat values for foraging native fauna, including Eastern Cave Bat. This foraging habitat would be modified as a result of the Project.

Two high potential roosting/breeding sites for Eastern Cave Bat have been identified adjacent to the development footprint. No direct impacts are proposed for these habitats. As such there will be no reduction in the availability of breeding habitat for Eastern Cave Bat. Similarly, there will be no direct impact to important species 'life cycle' processes as no habitats that support these processes are being directly impacted.

The project will also result in indirect impacts during construction and afterward during operation of the wind farm. During construction these indirect impacts will consist of increased traffic, noise and light during the project construction. These impacts will be managed during construction to reduce impacts to nocturnal fauna and will cease once construction is completed. Restriction of works to outside of breeding season within the vicinity of the two high potential roosting/breeding habitats is recommended for inclusion within the CEMP's mitigation measures which will further reduce scale of construction related indirect impacts.

There are also indirect impacts associated with the operations phase where collision mortality and possibly barotrauma risks associated with the wind turbine blades could occur, as well as potential impacts to habitat connectivity. These impacts are discussed further in Section 8.5 of the BDAR, however, these impacts will not significantly change the availability of habitat in the locality. It is considered that the likelihood of a collision event for the Eastern Cave Bat may occur only in unusual circumstances given the low level of relative activity recorded for this species at higher elevations due to foraging and movement behaviour (i.e. within the range of rotor blades), and the expected volume of commensurate habitat available in the landscape. Should collision mortality occur, however, it is considered that the repeated loss of a small number of individuals would not be of concern to the viability of the local or broader population. An Operational Bird and Bat Adaptive Management Plan will be prepared prior to construction to assess any bat mortality and to continually assess the assumptions of this impact assessment and enable adaptive management measures to be implemented if required to reduce measured impacts.

(e) The likely impact on the ecology of the local population. At a minimum, address the following:

- For fauna:
  - Breeding

The size and locations of maternity colonies for Eastern Cave Bat typically are poorly understood, however they appear to form small colonies of between 6-50 individuals. Larger colonies can form though with separate studies recording estimates of 240 and 500 individuals. A preference may be shown for sandstone caves with a rear dome, however, individuals have also formed a colony beneath corrugated iron roof where temperatures exceeded 40ºC, suggesting that buffering against extreme temperature may not be as important for this species. Roost fidelity is also low, and cave switching between successive years has been recorded (Law, Chidel, & Mong 2005, Churchill 2008, Parnaby et al. 2008, DPIE 2021a). The species has been assigned to the Landscape species management stream under the Saving Our Species strategy. No priority management areas are currently identified for the species. This may due to its roost switching behaviour leading to no single site being able to be accurately identified for direct management for the species (DPIE 2021b).

Within the locality of the assessment area there are many potential roosting and breeding habitats for the species. A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting

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sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale (Environmental Geosurveys Pty Ltd 2021). Finally the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021) which may also provide potential roosting habitat to the local population.

Adjacent to the development footprint there are two identified high potential roosting/breeding sites. This is comparatively few when placed in context of the similar habitat available within the locality and broader region. There are also no direct impacts proposed to either of these potential habitat locations or their surrounding buffer areas. The avoidance and minimisation for reducing indirect impacts during operation of the wind farm are discussed in question (a) above. As such, the Project is unlikely to result in impacts to breeding habitat for Eastern Cave Bat.

- Foraging

Studies on the movement and foraging behaviour of Eastern Cave Bat found that most distance were typically less than 1.5 kilometres, with a maximum distance of 3.75 kilometres observed by one individually travelling between roosts. The foraging area utilised by the species is also likely to be small and localised, with one individual foraging for five consecutive days of an area of only 33 hectares. Individuals are capable of dispersing over small breaks in the landscape, with individuals recorded covering a 500 metre gap over a cleared paddock (Law, Chidel, & Mong 2005).

A total of 28,033 hectares of native vegetation occurs within the 2.5 kilometre area surrounding the development footprint, with only 132.43 hectares of native vegetation (0.47 %) occurring within the development footprint. Of this vegetation approximately 37.92 hectares is in high condition providing good habitat values for foraging native fauna, including Eastern Cave Bat. This foraging habitat would be modified as a result of the Project.

Vegetation within the development footprint is well connected to surrounding vegetation, with large patches of native vegetation occurring within the 2.5 kilometre area surrounding the development footprint. This includes large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests. These areas represent prime foraging habitat for the species and are all within two kilometres of various locations along the development footprint. Given the plentiful natural roosts that are likely to be available to individuals within 2.5 kilometres of the development footprint, due to the underlying geomorphology (Environmental Geosurveys Pty Ltd 2021), these foraging habitats would be easily accessible to individuals within the local population. The removal of native vegetation as part of the proposed works is therefore not considered to have a significant impact on the foraging ecology of Eastern Cave Bat.

- Roosting

Eastern Cave Bat typically roosts in entrances of sandstone overhang caves, boulder piles, mines, road culverts occasionally in buildings, and in disused, bottle-shaped mud nests of the Fairy Martin *Petrochelidon ariel* beneath bridges and in culverts (Law, Chidel, & Mong 2005, Churchill 2008, Parnaby et al. 2008, Churchill 2008). Roost fidelity is low, even within a single season, with individuals regularly changing roosts, sometimes daily. These roosts are usually less than 1.5 kilometres part (Law, Chidel, & Mong 2005, Parnaby et al. 2008).

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Within the locality there are many potential roosting and breeding habitats for the local population. A geomorphological assessment of the assessment area found that there is diverse terrain and lithology and dynamic geomorphology within the locality that creates a high potential for microbat roosting sites across landscapes at all elevations, within the expected flight range of microbats that may be present within the assessment area (Environmental Geosurveys Pty Ltd 2021). The assessment notes that the assessment area lies in the southern margin of the New England Orogen, which comprises a complex geological history resulting in a wide range of rock types and structures in northeast NSW and southeast Queensland, with the diverse geology present in the landscape continuing to the north through the NSW North Coast, Nandewar and New England Tablelands bioregions (which together comprise much of the New England Orogen), thus habitats present in the locality of the project area are also likely to occur elsewhere within broader geological landscape, and therefore unlikely to form a substantial portion of the habitat available, or be significant at a bioregional scale (Environmental Geosurveys Pty Ltd 2021). Finally the nearby town of Nundle has a rich mining history, being settled in 1852 following the discovery of gold at "The Hanging Rock" and Swamp Creek, and consequently there are many (dozens) historic mines and unnamed pits in the region (AUSGIN 2021) which may also provide potential roosting habitat to the local population.

There are two high potential roosting habitats located adjacent to the development footprint. As a result of avoidance measures adopted by the project (Table 1), there are no direct impacts to either of these features or their surrounding buffer areas. Given the underlying geology outlined by the geomorphological report (Environmental Geosurveys Pty Ltd 2021), there are likely to be numerous cracks and crevices along ridgelines within the broader locality that may be used as overnight roosts by individuals or small groups of Eastern Cave Bat. Given the high potential for similar habitat across the locality, the Project is not expected to significantly alter the availability of these crack/crevice overnight roosting habitats.

- Dispersal or movement pathways

Eastern Cave Bat is a mobile species capable of dispersing across small breaks in habitats with individuals capable of crossing cleared paddocks of at least 500 metres. The species is known to move between roosting sites, sometimes daily, typically travelling less than 1.5 kilometres between these sites, however distances of up to 3.75 kilometres in a single night have been recorded (Law, Chidel, & Mong 2005).

In designing the wind farm layout the spacing of the turbines was considered to limit interactions with fauna and an essentially linear row of turbines was designed. This is different from most wind energy facilities in Australia in which turbines are scattered across a site. In the more usual scattered or 'clustered' array, microbats and avian fauna have a high probability of encountering multiple turbines in a given flight. The configuration of Hills of Gold turbines is such that an individual is likely to encounter multiple turbines only in the rare event that it flies directly along the row of turbines. The minimum spacing between two adjacent turbines along the development footprint is 270 metres (110 metres at turbine height) and the maximum distance between two adjacent turbines is 1,600 metres (1,400 metres at turbine height). The average range is 300 – 500 metres or 138 – 338 metres between turbines. These gaps provide movement corridors, allowing for migrating and foraging bats to pass through the landscape, reducing the chance of collision and possibly barotrauma. It is considered that the likelihood of a collision event for the Eastern Cave Bat may occur only in unusual circumstances given the low level of relative activity recorded for this species at higher elevations due to foraging and movement behaviour (i.e. within the range of rotor blades), and the expected volume of commensurate habitat available in the landscape. Should collision mortality occur however, it is considered that the repeated loss of a small number of individuals would not be of concern to the viability of the local or broader population.

North-south movements over the wind arm alignment are more likely to be associated with foraging flights which would be conducted at canopy level, out of turbine blade range (see Section 7.2 for details regarding turbine blade buffers). The layout also retains areas of preferred foraging habitat in steeper areas of terrain, with more densely vegetated gullies preserved. It is therefore unlikely that the Project will interfere in the

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dispersal of movement pathways of the species. Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(f) A description of the extent to which the local population will become fragmented or isolated as a result of the proposed development.

Eastern Cave Bat is a mobile species capable of dispersing across small breaks in habitats with individuals capable of crossing cleared paddocks of at least 500 metres. The species is known to move between roosting sites, sometimes daily, typically travelling less than 1.5 kilometres between these sites, however distances of up to 3.75 kilometres in a single night have been recorded (Law, Chidel, & Mong 2005). The species will also utilise man-made structures such as culverts, bridges, buildings and derelict mines as roosting sites. The surface geology of area 2.5 kilometre area surrounding the development footprint has the potential to provide the species with numerous roosting habitats (Environmental Geosurveys Pty Ltd 2021). There are large tracts of intact native vegetation within and adjacent to these areas such as the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which are connected to the development footprint which would facilitate dispersal of the local population. The spacing between wind turbines within the development footprint is such that movement corridors have been conserved, allowing for migrating and foraging bats to pass through the landscape.

Given the transient nature of the species, the high level of native vegetation connection across the region, and the high level of potential roosting locations, the project is not expected to result in significant amount of landscape fragmentation that would result in the local population becoming isolated. Impacts to habitat connectivity are further assessed in Section 8.5 of the BDAR.

(g) The relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range.

The ecology of Eastern Cave Bat is poorly understood, with the BioNet Atlas of NSW stating "very little is known about the biology of this uncommon species", whose threatening processes include insufficient understanding of species/community ecology (DPIE 2021a). The species is distributed along the east-coast of Australia, ranging from Cape York in northern Queensland down to at least the Sydney Basin in NSW, however it's extent south of Sydney is not fully understood (Law, Chidel, & Mong 2005, Parnaby et al. 2008).

The species has been assigned to the Landscape species management stream under the Saving Our Species strategy. No priority management areas are currently identified for the species. This may due to its roost switching behaviour leading to no single site being able to be accurately identified for direct management for the species (DPIE 2021b).

The full dispersal capabilities of the species are poorly understood, as are the size of local populations within the locality. However, the surface geology of the 2.5 kilometre area surrounding the development footprint has the potential to provide small colonies that may be present within the area with numerous roosting habitats. There are also large tracts of intact native vegetation within and adjacent to these areas such as the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which are connected to the development footprint which would facilitate dispersal of individuals between these colonies.

As consideration has been made with regards to the spacing of wind turbines, leading to preservation of movement corridors, it is unlikely that the movement of individuals between colonies would be significantly restricted by the proposed development. As such the Project is unlikely to lead to a reduction in the pre-existing level of interactions that may be occurring between small, over-lapping colonies that may exist in the area that comprise the local population of the species.

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(h) The extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population.

The potential threats to Eastern Cave Bat, as identified in the species profile included in the Atlas of NSW Wildlife (DPIE 2021a), are addressed below in Table 100.

Table 100 Potential threats to Eastern Cave Bat

Threat	Relevance to proposed works
Clearing and isolation of dry eucalypt forest and woodland, particularly about cliffs and other areas containing suitable roosting and maternity sites, mainly as a result of agricultural and residential development.	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and, due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features. As such there will be no significant impacts to breeding habitat for Eastern Cave Bat as a result of the Project. Mitigation measures to control indirect impacts (noise, light and vibration) during construction will further ensure no impacts to the species, as will recommendations to avoid undertaking works in the proximity of these habitat features during breeding season.
Loss of suitable feeding habitat near roosting and maternity sites as a result of modifications from timber harvesting and inappropriate fire regimes usually associated with grazing.	The proposed works include impacts to 132.43 hectares of native vegetation from the development footprint. However, only 37.92 hectares of this vegetation is considered high quality and potential foraging habitat for the species. A total of 28,033 hectares of native vegetation occurs within the 2.5 kilometre area surrounding the development footprint, which, given the highly mobile nature of the species, is readily available to individuals as foraging habitat. There are also large tracts of intact native vegetation within the Ben Halls Gap National Park, Crawney Pass National Park, Wallabadah Nature Reserve and the Nundle and Hanging Rock State Forests which all occur within foraging distance of the development footprint. As such the Project is considered unlikely to significantly reduce the availability of foraging habitat for the local population of Eastern Cave Bat. The Project is unlikely to result in changes to timber harvesting, fire regimes or grazing pressures such that a significant impact to Eastern Cave Bat would occur.
Pesticides and herbicides may reduce the availability of invertebrates, or result in the accumulation of toxic residues in individuals' fat stores.	The project is not likely to substantially increase the levels of pesticides within the environment.
Damage to roosting and maternity sites from mining operations, and recreational activities such as caving.	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features. As such there will be no significant impacts to breeding habitat for Eastern Cave Bat as a result of the Project. Mitigation measures to control indirect impacts (noise, light and vibration) during construction will further ensure no impacts to the species, as will recommendations to avoid undertaking works in the proximity of these habitat features during breeding season.
There is a strong likelihood that unrecorded populations	Targeted anabat survey and cave habitat inspections have been undertaken to support the current assessment. These surveys successfully detected the presence

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Threat	Relevance to proposed works
could be unintentionally affected by land management actions.	of the species within the locality as well as two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and only 2,000 square metres (1.8%) of native vegetation will be removed from the 108,546 square metre (100 metre radius) buffer zone applied to the high potential roosting/breeding habitat adjacent to turbine WP27. As such it is unlikely that an unrecorded population would be unintentionally affected by the Project.
Probable predation by cats and foxes.	The project does not substantially alter the environment in such a way that the numbers of feral cats and foxes within the locality are likely to increase. As such the project is unlikely to result in exacerbation of this threatening process upon Eastern Cave Bat.
Very little is known about the ecology, behaviour and habitat requirements.	Only two high potential roosting/breeding habitats occur adjacent to the development footprint. No direct impacts are proposed to either of these locations and due to avoidance measure adopted by the project, there are now no impacts within the buffer areas of these features. Whilst the species is considered data-deficient, the lack of impacts to key habitats that support critical species life processes (i.e. breeding) means is unlikely that the proposed impacts would have a significant impact on the population.

(i) An estimate of the area, or number of populations and size of populations that is in the reserve system in NSW, the IBRA region and the IBRA subregion.

The following information has been gathered from BioNet Atlas records as well as scientific literature and government reports.

New South Wales

A total of 616 BioNet Atlas records for Eastern Cave Bat exist across NSW (DPIE 2021a). The species range extends from Cape York in northern Queensland down to at least the Sydney Basin in NSW (Law, Chidel, & Mong 2005). Records exist within the following IBRA regions within NSW:

- Brigalow Belt South
- Nandewar
- New England Tablelands
- NSW North Coast
- South Eastern Highlands
- South Eastern Queensland
- Sydney Basin

Low numbers of records also occur within the Cobar Peneplian (2 records) IBRA region.

The Saving Our Species strategy for this species is at the landscape level as no single site can be accurately identified to direct management for the species. As such no priority management areas are identified (DPIE 2021b). A total of 107 (17%) of the historical sightings occurring within the NSW reserve system. These records occur within 34 national parks, nature reserves and conservation areas.

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Nandewar – Peel IBRA sub-region

A total of 50 records for Eastern Cave Bat occur within the Nandewar IBRA region, 25 within the Peel IBRA sub-region. Of these a single record from the Peel sub-region occurs within the NSW reserve system, located in the Wallabadah CCA Zone 1 National Park.

New England Tablelands – Walcha Plateau IBRA sub-region

A total of 18 records for Eastern Cave Bat occur within the New England Tablelands IBRA region. None of these occur within the Walcha Plateau IBRA sub-region.

NSW North Coast – Tomalla IBRA sub-region

A total of 100 records for Eastern Cave Bat occur within the NSW North Coast IBRA region. None of these occur within the Tomalla IBRA sub-region.

(j) The measure/s proposed to contribute to the recovery of the species in the IBRA subregion.

The proposed works are not considered likely to have a substantial impact on Eastern Cave Bat, and thus no measures have been proposed to contribute to the recovery of the species.

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Appendix F Geomorphology, ecology and potential microbat roosting habitat (Environmental Geosurveys Pty Ltd)

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HILLS OF GOLD WIND FARM

GEOMORPHOLOGY AND GEOLOGY

&

POTENTIAL MICROBAT ROOSTING HABITAT

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Prepared by: ENVIRONMENTAL GEOSURVEYS Pty Ltd (Neville Rosengren)

Prepared for: BIOSIS Pty Ltd.

VERSION 2: April 2021

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1 INTRODUCTION

1.1 Scope and Purpose

This short report was prepared in response to a letter brief (e-mail March # 2021) from Callan Wharfe (Senior Ecologist, Biosis Pty Ltd) for a desktop assessment of the geology and geomorphology at and enclosing the proposed Hills of Gold Wind Farm (HGWF) in the Mount Royal and Liverpool Ranges 60 km south-east of Tamworth in northeast New South Wales (Figure 1).

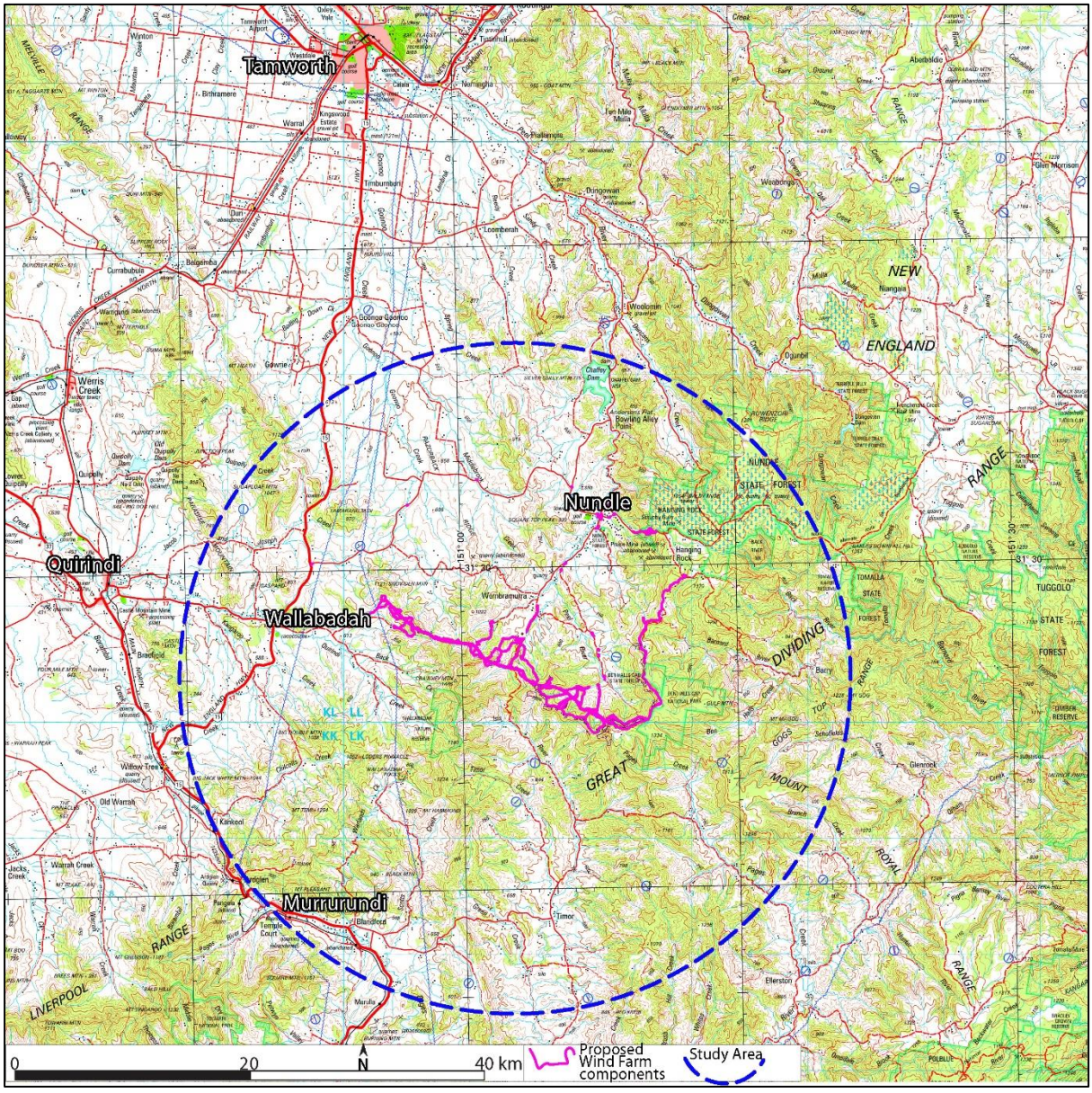

Figure 1. Location of proposed wind farm and extended study area. Base map part of Tamworth 1:250,000 Topographical Map. (Map Source: Geoscience Australia).

The purpose of the report—as requested in the letter brief—is to provide an opinion on the likelihood of the geology and landform of the area as potential microbat roosting habitat. Such habitat are cavities large enough to provide bat colony roosting space and with external access dimensions sufficient to allow flight entry and exit. The cavities may be

inherent as *in situ* attributes of the geology or produced by subaerial and subsurface weathering and denudation (erosion), including rock piles accumulated from landslides or other mass movement processes. Habitat created by human activities such as mining and quarry sites may also provide habitat.

1.2 Study Area

The study area includes precinct of the proposed HOGWF (turbines, transmission lines, roads and tracks), and a region extending approximately 30 km beyond these (Figure 1). The HOGWF turbines will be located on ridges and spurs from east of Crawney Pass to the south of Hanging Rock (Figure 2). Associated components will extend north and west of the turbine field.

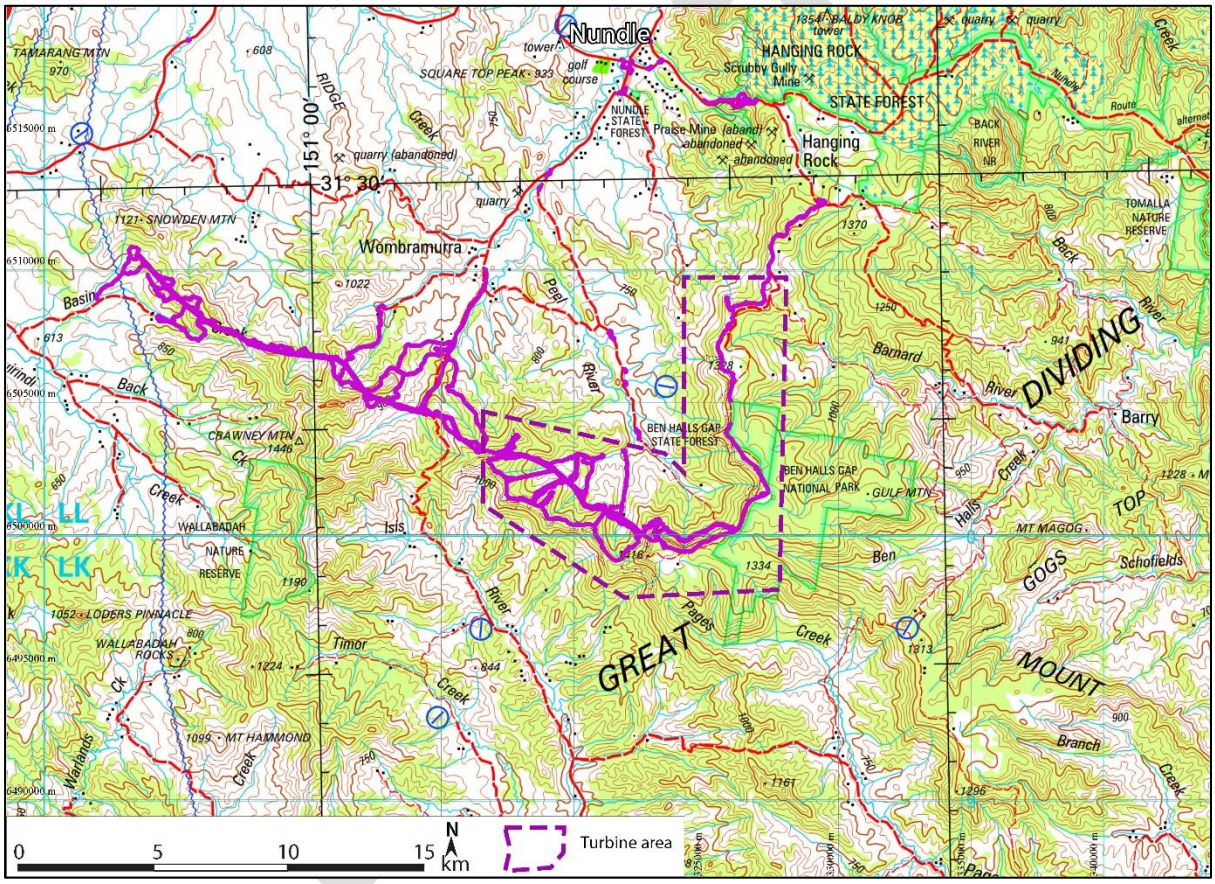

Figure 2. Topography and location of components of proposed wind farm. Base map part of Tamworth 1:250,000 Topographical Map. (Map Source: Geoscience Australia).

1.3 Methodology

This report was prepared from literature, spatial data (topography, geology) and aerial photography. Topographic data (Point Cloud LiDAR) and orthophoto imagery supplied by Someva and Biosis Pty Ltd, was supplemented by data downloaded from Geoscience Australia, Geological Survey of New South Wales, the SIX Maps mapping tool, and other products from Spatial Services New South Wales.

The GIS data was displayed on Global Mapper V22.1 LiDAR module. A DEM of the immediate study area (turbines and access tracks) was constructed from LiDAR Keypoints files with a drape of the orthophotograph and overlay of New South Wales digital Seamless Geology 2020. DEMs of turbine locations were created from LiDAR point cloud files. Combinations of slope shading and elevation shading at screen scales between 1:500 and 1:1,000 were used to identify potential habitat based on photo-interpretation of rock outcrop and scree slopes.

To provide context for potential habitat surrounding the proposed HOGWF site by identifying areas of outcrop, a DEM with 30 km buffer from the turbine sites was constructed from 5 metre LiDAR data obtained from Geoscience Australia ELVIS portal. An overlay of aerial photography of this envelope was accessed via Global Mapper allowing display of the DEM, photography, and geology. This image was viewed at screen scale approximately 1:4,000. Initially areas of slope >20^{o} were identified on the DEM and then the photograph layer displayed to discern visible outcrop. These were outlined and the layer exported and displayed in Figure 8 in the report. Areas of steep slope where outcrop was possible—but ground could not be seen due to tree cover or shadow—were also selected as potential habitat.

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2 GEOLOGY AND GEOMORPHOLOGY

2.1 Context: New England Orogen

The study area lies in the southern margin of the New England Orogen (NEO) the youngest and easternmost of the eastern Australian Tasmanides[1]. The geological history of the NEO is complex resulting in a wide range of rock types and structures in northeast New South Wales and southeast Queensland. The basement rocks of the NEO developed from the Cambrian—540 million years ago (Ma) to the Carboniferous—320 Ma, and over time have been altered by multiple episodes of deformation and igneous intrusions, and further sedimentation during the Permian (300 Ma) to (Triassic-Jurassic 250 to 16 Ma) prior to the break-up of Gondwana (Scheibner 1976) (Figure 3).

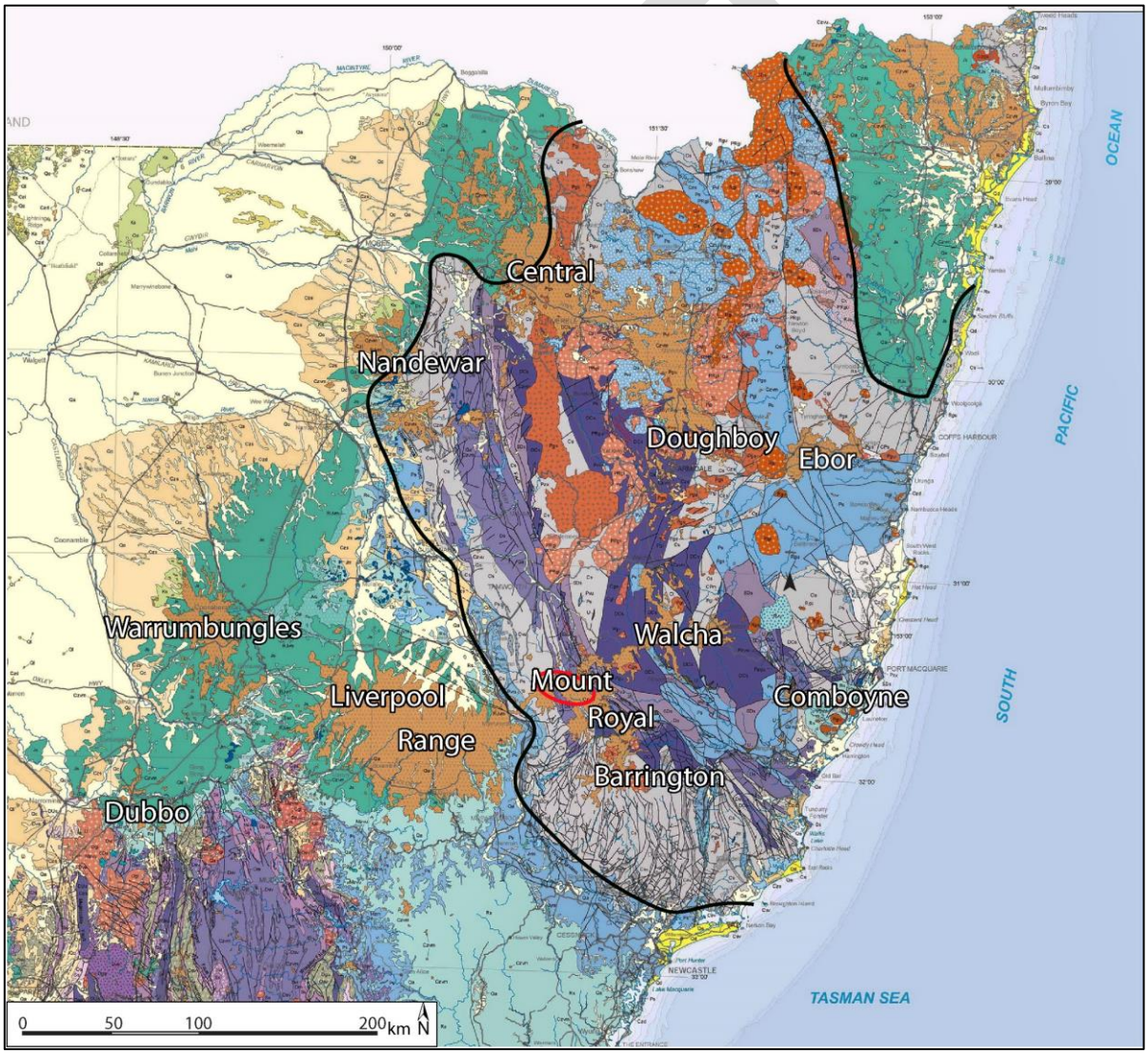

Figure 3. Surface geology and volcanic provinces of the New England Orogen (heavy black line) in northeast New South Wales. Proposed HOGWF shown as red ellipse at Mount Royal. (Province names after Kutson *et al. (1989)* From: Surface Geology of New South Wales 1:1 500 000, Planning Industry and Environment NSW 2009).

[1] The Tasmanides are geological units that form the basement rocks of eastern Australia. The New England Orogen is also referred to as the New England Fold Belt.

The exposed basement geology includes stratified silicic and calcareous sedimentary beds, granitoids and interbedded volcanics previously subjected to and altered by metamorphism, large-scale folding and faulting (Rosenbaum *et al.* 2005). Widespread volcanism in the Cenozoic covered much of the surface of the NEO, but the areal extent of volcanics has been reduced by denudation.

2.2 Cenozoic and Mesozoic Volcanics

Across much of the NEO the basement rocks are unconformably overlain by late Mesozoic and Cenozoic volcanic rocks (less than 80 Ma). Extensive remnants of eruption points (the volcano) and lava flows are conspicuous features of the modern landscape of northeast New South Wales (Figure 3, Figure 4).

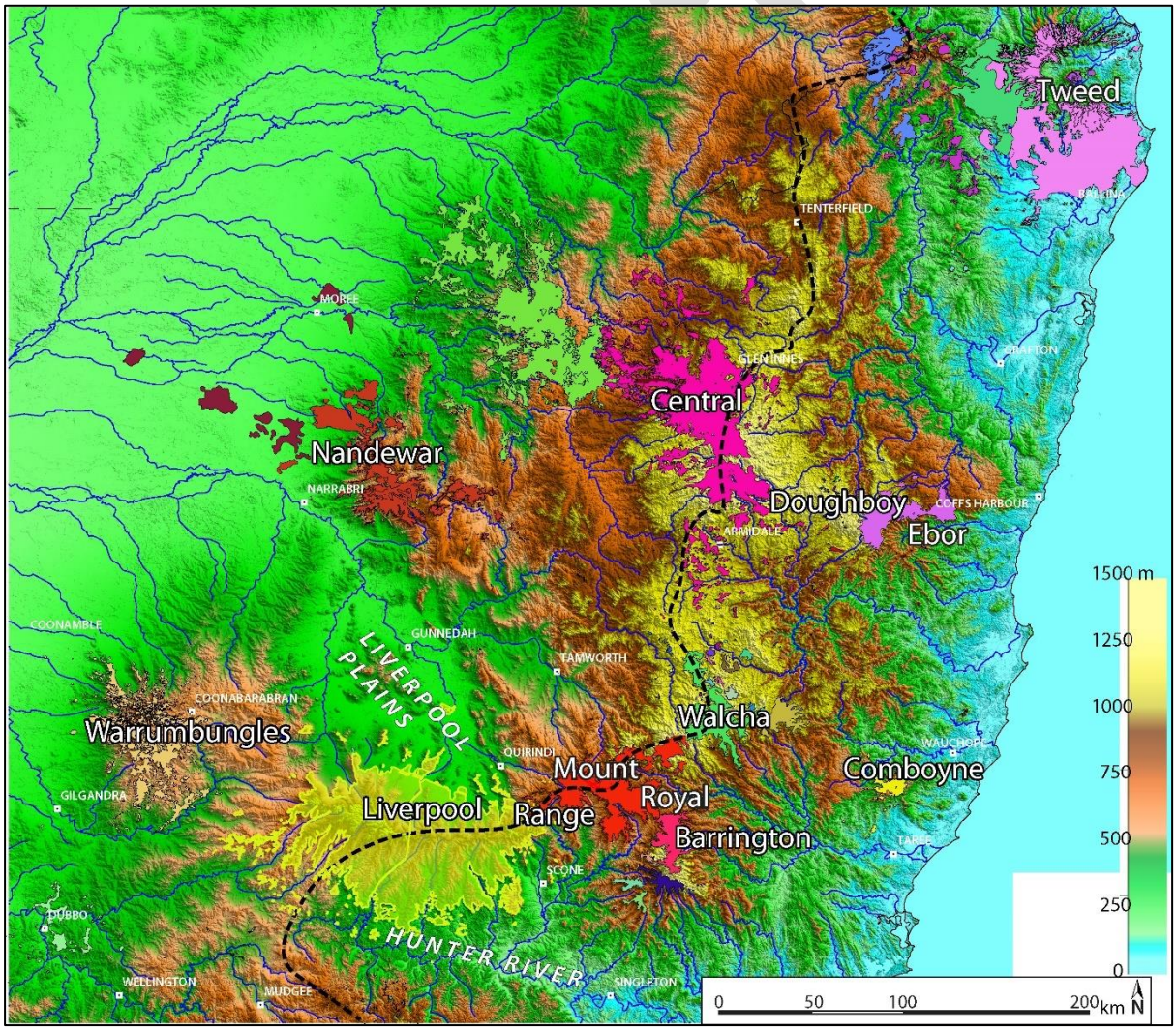

Figure 4. Digital elevation model northeast NSW showing Cenozoic volcanic provinces and position of the Great Divide (broken black line). (Volcanic province names from Knutson et al. (1989) and Seamless Geology NSW 2018. Base map 1 sec DEM: Geoscience Australia 2013).

Volcanoes are classified according to a range of overlapping characteristics including 1, *eruption source*—localised vents and fissures or numerous widespread eruption locations; 2, *eruption styles*—effusive with coherent lava flows or explosive with fragmental-

pyroclastic deposits; 3, *geochemistry*—fraction of silica that determines mineralogy; 4*, spatial and temporal distribution*—the extent, duration and the continuity of eruptions; 5, *geomorphic representation*—position in present landscape and preservation of initial volcanic characteristics.

Wilkinson (1969) grouped the volcanic rocks of north-eastern NSW into eight geographical provinces and recognised the petrographic (compositional) associations that occurred in some of these. Later studies, supported by radiometric dating (Wellman and McDougall 1974a, 1974b) refined the distinction based on geochemical affinity and age, and defined eleven volcanic provinces ranging from 70 Ma to 12 Ma. Recent mapping (Colquhoun *et al.* 2020) extends this to 12 provinces (Figure 3, Figure 4).

Wellman and McDougall (1974) and Knutson (in Johnson 1989) further classified the volcanic provinces into central volcanoes and lava fields. *Central volcanoes* are large single vent or clusters of close-spaced vents with frequent basaltic and felsic (higher silica) lava flows building a thick pile referred to as a shield volcano up to 100 km across. The Tweed, Warrumbungle, Nandewar, Ebor, Comboyne, Liverpool and Barrington provinces were identified as central (shield) volcanoes. Paine (1983) showed the Barrington Tops shield volcano to be at least 400 m thick and consist of 20 lava flows. *Lava fields* are provinces with eruptions from a diffuse pipe and dyke swarm producing generally thin lava flows, but in places with lava piles hundreds of metres thick. Wellman and McDougall (1974a) identified the Central Province is as a lava field.

2.3 Volcanic Terrain

The original lava thickness was determined by the lava viscosity, rate of effusion and pre-volcanic relief, with greatest thickness adjacent to the eruption point and in now-buried valleys and depressions. The thickness and distribution to-day is a function of denudation and tectonic history. Three groups of terrain occur across the volcanic provinces: planar surfaces, basalt margins, sub-basaltic (exhumed) terrain.

Planar surfaces are the undulating plains formed on the denuded surfaces of lava flows. The surface is the product of weathering and erosion over millions of years and does not represent the original post-eruptive landform materials or morphology. Much of the volcanic terrain occurs along the Great Divide—a continuous topographically variable watershed in the Eastern Uplands of Australia—commonly referred to as the Great Dividing Range. The Great Divide trends north-south along the northern New England Fold Belt to 60 km south of Walcha where it turns southwest and west as the Liverpool Range headwater

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tributaries of the Hunter River and Peel River with ridge and plateau summits rising to over 1400 metres (Figure 4). As the volcanism preceded and accompanied the uplift of much of the Eastern Uplands of Australia, volcanic rocks occur at a range of elevations, in places as broad elevated plateau and elongated ridges on the crest and flanks of the Great Divide.

Basalt margins are now the eroded edges of the original lava flows and are either continuous enclosures of the largest lava bodies across or adjacent to the Great Divide or outlying detached remnants—typically as hill capping. The basalt is geologically unconformable with the underlying older rocks and the base is commonly marked by a defined slope change or escarpment with locally precipitous slopes.

Sub-basaltic terrain surfaces are defined by the range in elevations of the basalt base contact with pre-volcanic rock. For example, a granite outcrop along the Main Divide at Morrisons Gap at an elevation of 1,260 m ASL is surrounded by basalt that has a base elevation around 900 m ASL in Nundle Creek, illustrating around 300 m of local relief. Paine (1983) mapped a series of bedrock benches occurring as plateau surfaces or flattened ridge crests at the base of the basalt around Barrington volcano, demonstrating pre-volcanic relief of about 1,000 m.

Weathering profiles are locally preserved in the buried-exhumed basement rocks. The basement rocks are exposed as narrow zones striking north-north-east locally defining strike ridges and valley alignment and spacing. There is variable rock outcrop and locally thick accumulations of colluvial rock debris.

2.3.1 Walcha, Mount Royal Range, Liverpool Range, Barrington Volcanic Provinces

The Walcha, Mount Royal Range, Liverpool Range and Barrington volcanic provinces are a geographically continuous surface of volcanic rocks extending 150 km south and west of Walcha and bracketing the Main Divide (Figure 5). Wellman and McDougall (1974), and Schön (1989) showed the Liverpool Range Volcanics Province as all the Liverpool Ranges south and west of Whites Sugarloaf to west of Murrurundi to Coolah Tops (Figure 6). The most recent geological mapping (Colquhoun *et al.* 2020) separates the Liverpool Range volcanics to be only west of Murrurundi—Liverpool East Basalt and Liverpool West Basalt—and recognises a new volcanic sub-province—Mount Royal Volcanics—as all the volcanics south of Whites Sugarloaf along the Main Divide to Crawney Mountain and the high southwest Liverpool Range ridge of Lagoon Mountain, Mount Temi and Mount Helen.

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The newly-defined Mount Royal Volcanic complex encloses the ridges and hills of the proposed HOGWF turbine field and associated infrastructure (Figure 5).

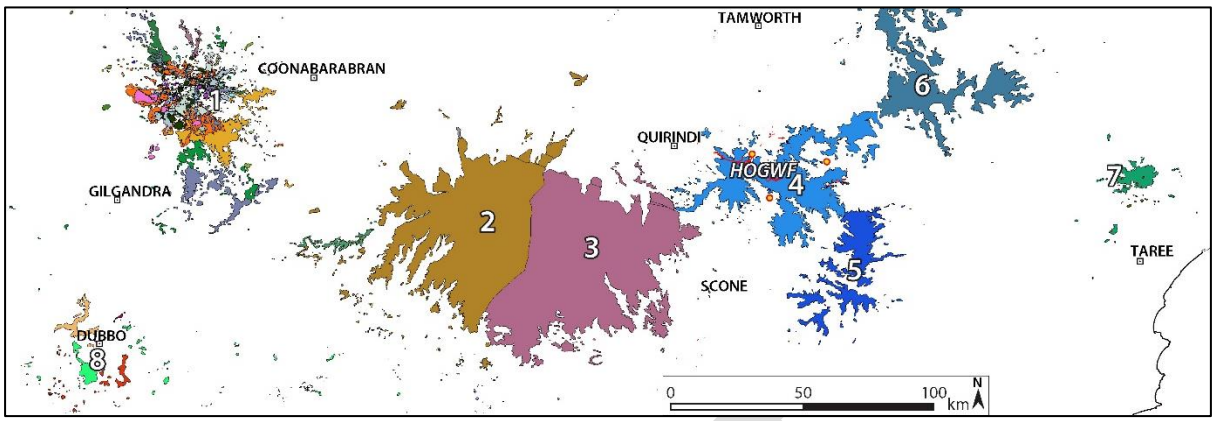

Figure 5. Distribution of volcanic units approximately 100 km radius of proposed HOGWF. **1**, Warrumbungle Volcanic Complex; **2**, Liverpool Range Volcanic Complex – Liverpool West Basalt; **3**, Liverpool Range Volcanic Complex – Liverpool East Basalt; **4**, Mount Royal Volcanic Complex; **5**, Barrington Volcanic Complex; **6**, Walcha Volcanic Complex; **7**, Comboyne Volcano; **8**, Dubbo Volcanic Complex.

The relationship between volcanic outcrop and topography in the region of the HOGWF is shown in Figure 6. The Mount Royal Volcanic province accumulated over Palaeozoic sediment at elevations between 600 m and 900 m ASL. The remnant planar basalt surface along the divide reaches elevations to nearly 1,500 m along the Great Divide indicating lava thickness in places of almost 1,000 metres, in accordance with the figure of 850 m determined by Wellman and McDougall (1974b).

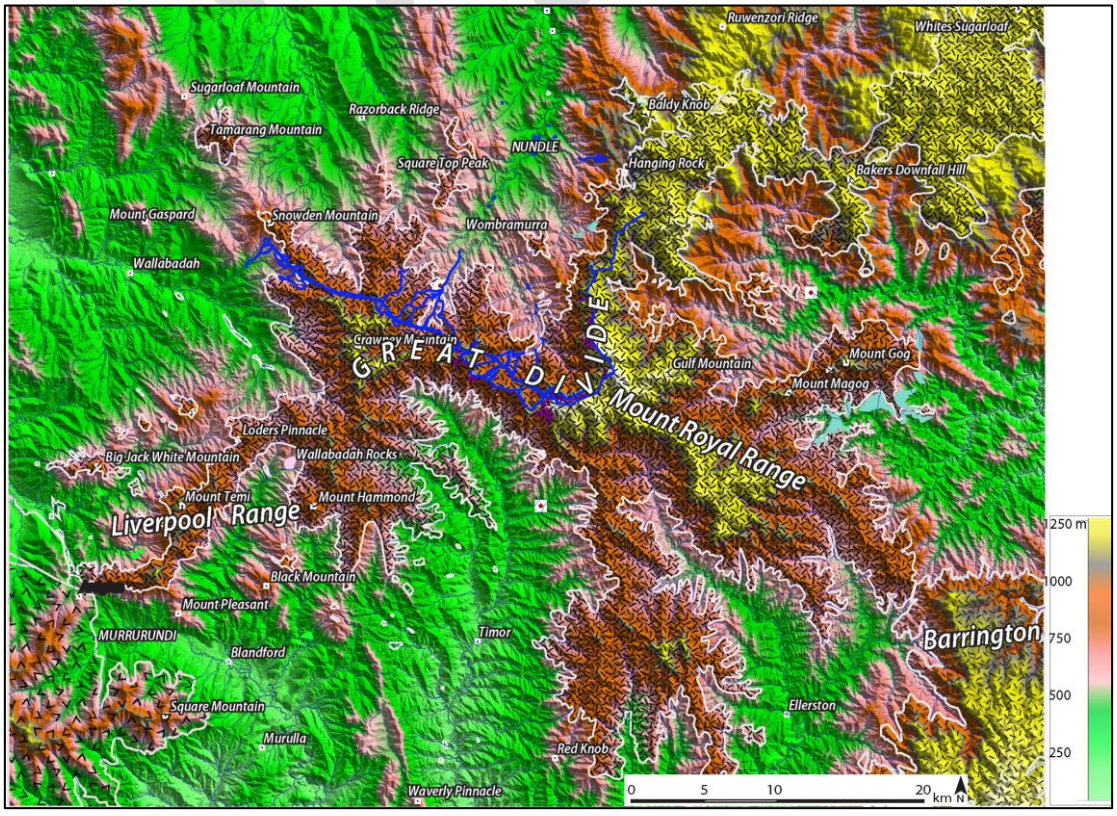

Figure 6. Mount Royal Range and Great Divide volcanic rock distribution. Mount Royal Volcanic Province extends from Whites Sugarloaf to Murrurundi. Base of basalt shown by white lines. (Base: 5 m DEM).

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3 POTENTIAL FOR MICROBAT HABITAT

3.1 Potential Habitat Types

The occurrence of suitable microbat habitat is determined by the presence and persistence of spaces in a coherent rock mass or in accumulations of detached rock clasts. The extent to which either of these niches is present and suitable is a function initially of lithology and rock structure modified over time by geological and environmental processes that can increase or decrease the available space. As noted in Section 1.1 above, suitable space may be due to inherent attributes of the rock mass or produced by subsequent processes.

A broad initial classification of types and origins of habitat in rock groups that are likely to crop out within flight distance of the HOGWF is outlined in Table 1.

TABLE 1. Potential Microbat Habitat by Geology

TYPE	TYPE OF ROCK	SPACE	ORIGIN of SPACE	OPPORTUNITY	CONSTRAINT	MODIFICATION
Inherent structure	Fissile sedimentary. Slate, phyllite, shale, laminated mudstone	Narrow fissure	Partings along planar surfaces -bedding, cleavage, faults, shrinkage joints.	Multiple and close-spaced planes	Narrow, linear, discontinuous, unstable, soft, smooth surface.	Inherently soft rock. Change by failure along slip planes. Weathering.
Inherent structure & weathering	Interbedded, cross-bedded	Variable, overhang, small cavern	Selective failure and weathering of different lithologies.	Overhangs or small cavern	Potentially unstable roof overhangs.	Enlarged by weathering and collapse.
Secondary structure	Sandstone, coarse-grained igneous.	Broad fissure to cavernous.	Tension – stress during deformation, expansion by pressure release on unloading.	Small, cavernous. Rough-textured surface. Dry. Stable.	Wet.	Brittle failure.
Inherent structure and weathering	Conglomerate	Small caverns	Partial disaggregation of rock mass by dislodgement of large clasts	Small, cavernous. Rough-textured surface. Dry. Stable.	Wet.	Enlarged by weathering and collapse.
Inherent structure	Basalt lava flows	Wide range of fissures and caverns	Flow cooling and crusting. Volatile emission. Cooling/contraction fractures.	Wide range of shape and size of caverns and overhangs. Stable.	Wet. Locally unstable due to roof collapse.	Local collapse
Secondary processes	Basalt lava flows	Solution caverns (rare)	Solution of amygdaloidal lava.	Limited occurrence.	Large entrance opening, limited dark space.	Flooding
Secondary processes	Carbonate	Enlarged fissures and caverns.	Weathering – solution and precipitation.	Wide range of habitat.		Flooding, sediment and precipitation infill

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TYPE	TYPE OF ROCK	SPACE	ORIGIN of SPACE	OPPORTUNITY	CONSTRAINT	MODIFICATION
Inherent properties and secondary processes	Intrusive igneous (granitic)	Enlarged fissure, overhang, small caverns.	Weathering enlarging joints developed by stress release and expansion	Typically vertical and fluted fissures to overhang and caverns.	Wide openings and limited dark space.	Accumulation of colluvium and surface wash debris. Vegetation growth.
Secondary processes	Basalt, sandstone, conglomerate.	Irregular caverns	Stacking and arrangement of fallen talus and landslide rock blocks.	Newly developed.	Irregular space. Limited entry size or limited dark space. Unstable.	Slope movement. Infill by fines, Vegetation growth.

3.2 Known Habitat Occurrence

Biosis supplied the location of three known cave roosting sites in proximity to the HOGWF areas—Timor Caves, Travelling Stock Route and Barry Cave (Figure 7). No details of the cave site were provided. The caves were located on the Seamless Geology map and the distribution of that geological formation displayed across the study area.

3.2.1 Timor Caves

Timor Caves are developed in the Timor Limestone Member of the Yarrimie Formation located in the valley of Isis River. Cave and geological details are provided by Connolly and Francis (1979). Limestone of the Yarrimie Formation crops out across nearly 900 ha along the Isis River but caves are known from only two small localities.

3.2.2 Barry Caves

Barry Cave is located on the crest of a spur 250 m north of a bend in the Barnard River in an area mapped as Myra beds of the Woolomin Group. The cave is not in limestone but in low-grade metamorphic geology described as slate, phyllite, chert, jasper and metabasalts. Rocks of the Myra Group crop out in NW-SE strike in -wide belts and are exposed here as the Mount Royal Range Volcanics have been eroded. The cave is described in Allen *et al.* (1986).

3.2.3 Glenrock

Glenrock karst area is 30 km southeast of the HOGWF. Over 100 caves are known in Silver Gully Formation limestone along a ridge and slopes between Orham Creek and Spring Creek (tributaries of Barnard River) (Allen et al. (1986).

3.2.4 Travelling Stock Route

Travelling Stock Route Cave is marked as adjacent to an outcrop and block scatter of rocks shown as Yarrimie Formation mudstone, chert, siliceous siltstone, limestone, and

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conglomerate. It is possible the cave is developed in the Crawney Limestone Member "coralline biohermal limestone" as that formation is mapped 140 metres from the cave location. The Crawney Limestone Member is mainly covered by Liverpool Range and Royal Range basalt and crops out along strike for a short distance south of the of the marked cave location. No detail of cave geomorphology is available for this site.

3.3 Potential Habitat Occurrence

Advice from an academic and expert speleologist—Dr Susan White (La Trobe University) is that the foraging range of bats is significantly larger than previously thought and may be at least 75 km (Appendix A). Potential roost sites in basalt and other lithologies across this wider area e.g., up to 75 km foraging range must be considered.

3.3.1 Biosis Desktop Assessment

A desktop study by Biosis identified several discontinuous areas of potential habitat along the upper slopes on both sides of the Main Divide and some higher ridges between Crawney Pass and Wardens Brook. All were areas of surficial basalt geology. It was assessed that the likelihood for unreported caves was low given the areas were not remote and there was generally good surface visibility. No assessment was made of areas of non-basalt geology beyond these limits.

3.3.2 This Desktop Review

As shown in Table 1, potential habitat can occur in a wide range of geological materials. Some habitat entrances will not be discernible on aerial photography or airborne LiDAR, and small outcrop with potential habitat sites can be masked by medium to tall or other closely-spaced vegetation. After examining Point Cloud LiDAR and orthophotography of the HOGWF precinct and immediately adjacent terrain the conclusion of this desktop review is that while these techniques can be applicable for exposed ground surfaces, they cannot be conclusive in identifying (or dismissing) the likelihood of potential geological habitat.

It is unlikely that large caverns—such as those formed by dissolution of limestone at Timor and amygdaloidal basalt as at Coolah Tops—have remained undetected in the immediate and adjacent study area. The area is not remote and has been mapped in some geological detail by expert groups (Government and academic). It is an area visited by trampers and speleologists and there are known caves (see 3.2 above and Appendix A). The limited area of limestone constrains the potential for large habitat caves. Habitat in other rock type is also constrained by limited outcrop of suitable structural and weathering forms.

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The undulating plateau and ridge terrain of the proposed HOGWF has no extended rock escarpments and limited outcrop of fractured basalt as vertical or inclined columnar structures. Detailed ground survey would be needed to define the extent of such outcrop but the evidence from the available data point to discontinuous and limited habitat in the immediate vicinity. Talus deposits appear to be inactive and substantially vegetated at the altitude range of the HOGWF, reducing the likelihood of habitat cavity flight entry being preserved.

3.3.3 Potential Habitat in Extended Area

The New England Orogen has limited areas of karst and cave development (Figure 7).

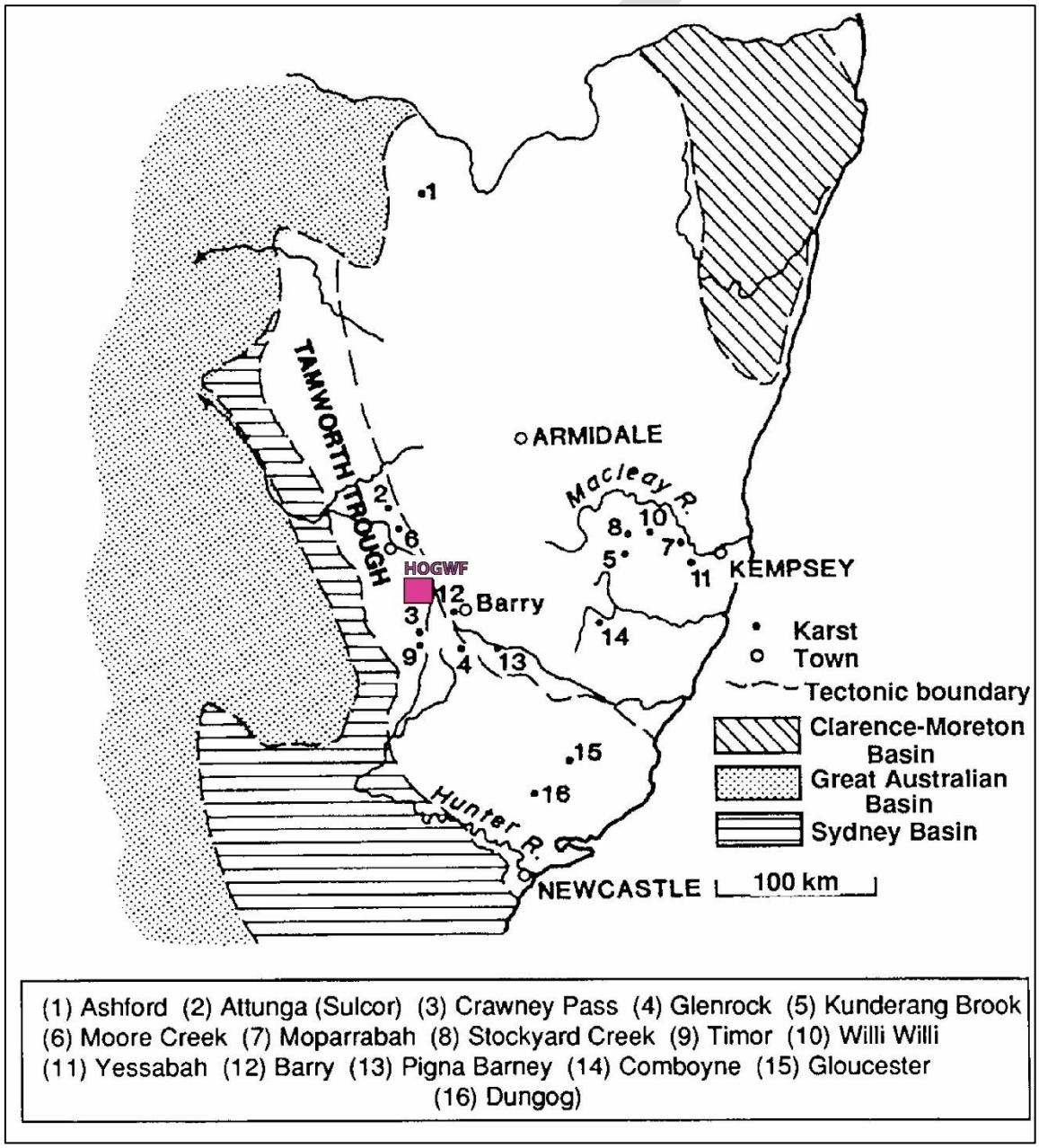

Figure 7. Karsts of the New England Fold Belt (Orogen). (From Osborne and Branagan 1988).

Dense crystalline Devonian limestone has developed multiple caverns and other karst terrain at Timor and Glenrock. The cave at Barry is unusual in being developed in non-carbonate rock.

As outlined in section 1.3 above, an envelope of approximately 30 km around the HOGWF was examined for potential habitat (Figure 7).

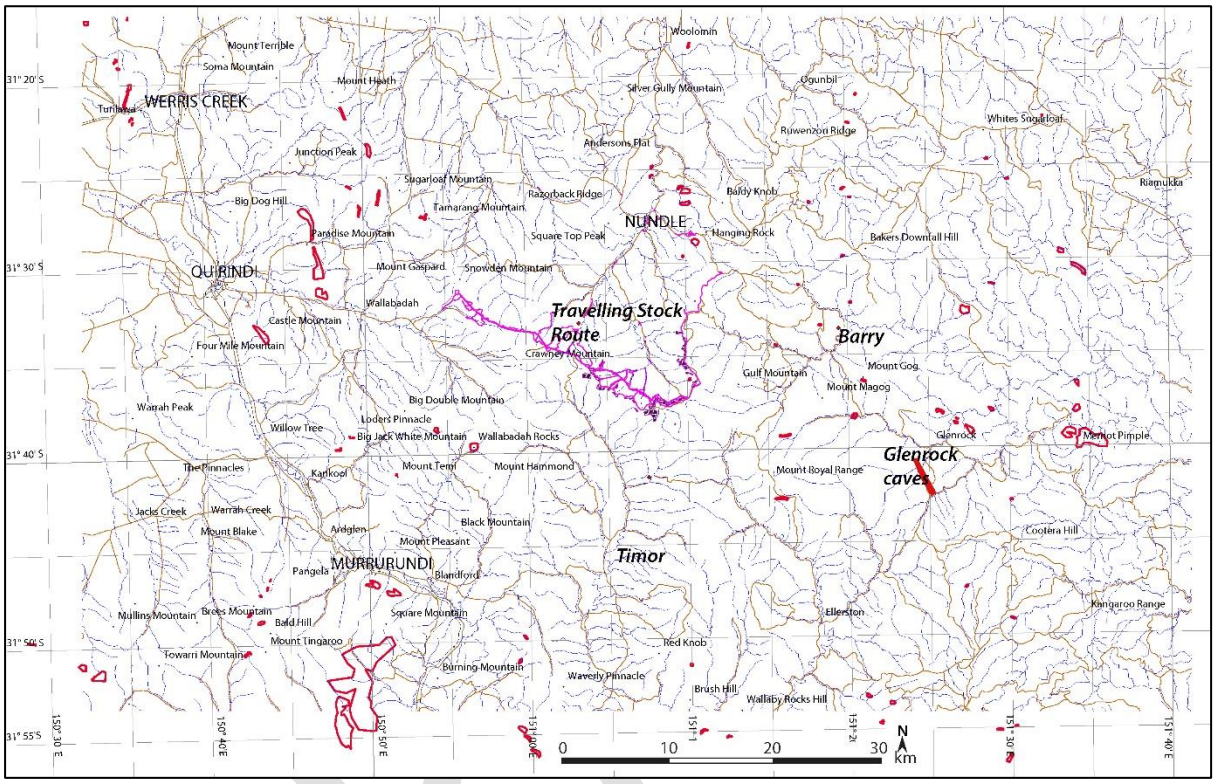

Figure 8. Potential habitat (red outlines) determined from LiDAR 5 m DEM and aerial photography. Four known cave areas shown are Glenrock, Barry, Timor and Travelling Stock Route.

The extent of basalt exposure in valleys and at the margins of the several lava fields within foraging range means smaller cavities formed in this rock may occur. Outcrop of fractured and weathered rock and downslope accumulations of blocky scree as potential habitat sites are also possibly widespread. As the basalts are hundreds of metres total thickness and are comprised of multiple flow units, there are numerous discontinuities in a vertical exposure. The discontinuities may be intra-flow e.g., separation and inflation planes of flow tongues and lobes, or more substantially defined by time-separation of upper flows with lithological differences and weathering developing stepped profiles with broad overhands and access to cavities.

Basalt relict blockstreams and limited areas of exposed scree with minimal vegetation cover at higher altitudes east and south of the HOGWF area are habitat potential, but assessment of extent and distribution of these is beyond the scope of the present study.

3.3.3.1 Habitat in Other Lithologies

The structure of the basement rocks exposed north and south of the main lava fields produce narrow ridges aligned along the NNW strike direction with a core of resistant beds forming the ridge crest and upper slopes. Isolated and groups of such ridges with crestal outcrop occur across parts of the Liverpool Plains and on the lower and mid-slopes of the Main Divide, Liverpool Range and Mount Royal Range. The wide range of lithology including carbonate and close-bedded sandstone-mudstone units have the inherent and secondary properties to develop potential habitat sites.

3.4 Landform Diversity

The geological evolution of northeast NSW has resulted in a diverse and dynamic landscape. Key elements in producing this diversity are the tectonic and volcanic history generating a range of slope forms developed by palaeo and on-going landforming processes on diverse geological materials. Cenozoic climate changes produced weathering regimes where episodes of intense rock decomposition alternated with mechanical breakdown in subsequent cold climate. Uplift of the Eastern Uplands and the rejuvenation of river systems has developed a complex drainage system.

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4 CONCLUSION

Diverse terrain and lithology and dynamic geomorphology of the New England Orogen make high potential for microbat roosting sites across landscapes at all elevations in a range of rock types.

In the immediate area of the HOGWF, outcrops of fractured basalt may provide localised habitat, However, terrain and geology of this precinct provides limited opportunity for extensive habitat. While several large solution caverns in limestone and basalt occur in surrounding terrain, these are localised and there is a low probability that similar unreported large habitat sites occur. It is extremely unlikely there are basalt caverns of the dimension to accommodate a large colony. There is also a low possibility that unknown caves occur in the Devonian crystalline limestone, as these outcrops have been searched on several occasions (Allen *et al.* (1986).

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Caves containing bats in the Tamworth area, NSW

There are no caves with bats recorded very close to Tamworth but caves containing bats, both as large populations and occasional roosting occur within the flight ranges of bats. Over the past few years with better monitoring capabilities, the range of foraging bats is now known to be significantly larger than previously thought and now needs to be *at least* 75 Km radius from major bat roosts and maternity caves (pers comm; Emmi van Harten 2021).

The following places have been recorded with bats (Matthews 1985) that are within the potential range of wind towers in the Tamworth area. There may be more recent information but the major bat caves are listed in the table below.

There are other areas with caves but no bat populations are recorded for them in the information I can access. If there are now other caves known with extensive bat populations in the area, the best contact is Kempsey Speleological Society (KSS) who can be contacted via PO Box 31, Kempsey, NSW 2440. The contact person is Glen Bowman: email bowmac@live.com.au. KSS may also probably know the status of the populations. If further contacts are needed I can possibly provide them but KSS would probably be the best local knowledge.

The other major bat caves in the NE NSW and SE Queensland are further away but significant bat maternity sites occur at Riverton (just over the border into Queensland) at Riverton Main Cave (4RN-1) and at Ashford at Ashford Main Cave (2AS-1). Other smaller roosting sites might also occur in these areas.

Reference: Matthews, P.G. 1985 Australian Karst Index (Australian Speleological Federation Inc).

Susan White
13 April 2021
84 Saunders St
Coburg VIC 3058 Australia

Cave Area	District	Cave Number	Cave Name	Significant number of bats	Occasional roosting
Kunderang Brook	East of Kempsey	2KB-1	Youdales Cave, Hut Cave	Yes	
		2KB2			Yes
Timor (Incl Isaacs Ck; Isis R; Allston)	Timor	2TR-2	Belfry Cave		Yes
		2TR-4	Helictite Cave		Yes
Stockyard Creek	West of Kempsey	2SC-5	Carrai Bat Cave	Yes	
		2SC-7		Yes	
		2SC-9			Yes
Moparabah	West of Kempsey	2MP-1	Moparabah Cave; Main Cave	Yes	
Yessabah	WSW of Kempsey	2YE-1	Yessabah Bat Cave	Yes	
Willi Willi	West of Kempsey	2WW-1	Willi Willi Bat Cave	Yes	
		2WW-4	Possum Cave	Yes	
Moore Creek	North of Tamworth	2MC-1	Moore Creek		Yes
Sulcor	North of Tamworth	2S-4	Bullock Hole		Yes

Appendix G Offset credit summary reports

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BAM Credit Summary Report

Proposal Details

Assessment Id 00020779/BAAS18138/20/00020780	Proposal Name Hills of Gold Wind Farm - Nandewar-Peel IBRA split	BAM data last updated * 24/11/2021
Assessor Name Callan Wharfe	Report Created 23/03/2022	BAM Data version * 50
Assessor Number BAAS18138	BAM Case Status Finalised	Date Finalised 23/03/2022
Assessment Revision 4	Assessment Type Major Projects	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits

Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South Bioregion and Nandewar Bioregion												
20	599_High	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	99.9	99.9	0.36	PCT Cleared - 80%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	22

21	599_Moderate	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	99.9	99.9	0.09	PCT Cleared - 80%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	6

22	599_Low	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	99.9	99.9	0.98	PCT Cleared - 80%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	61
											Subtotal	**89**
River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range												
3	486_High	Not a TEC	99.1	99.1	0.1	PCT Cleared - 40%	High Sensitivity to Potential Gain			1.50		4
4	486_Moderate	Not a TEC	99.1	99.1	1.3	PCT Cleared - 40%	High Sensitivity to Potential Gain			1.50		49
5	486_Low	Not a TEC	99.1	99.1	0.06	PCT Cleared - 40%	High Sensitivity to Potential Gain			1.50		2

6	486_DNG	Not a TEC	69.2	69.2	0.07	PCT Cleared - 40%	High Sensitivity to Potential Gain			1.50		2
											Subtotal	**57**
Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, Brigalow Belt South Bioregion												
7	490_Low	Not a TEC	98.3	98.3	1.8	PCT Cleared - 28%	High Sensitivity to Potential Gain			1.50		68
											Subtotal	**68**
Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion												
12	540_High	Not a TEC	80.3	80.3	5	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		177
13	540_Moderate	Not a TEC	86.1	86.1	8.9	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		336
14	540_Low	Not a TEC	95.9	95.9	2.7	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		115
15	540_DNG	Not a TEC	45.9	45.9	3	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		60

											Subtotal	**688**
Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion												
16	541_High	Not a TEC	87.3	87.3	2.4	PCT Cleared - 64%	High Sensitivity to Potential Gain			1.75		90
17	541_Moderate	Not a TEC	83.6	83.6	1.5	PCT Cleared - 64%	High Sensitivity to Potential Gain			1.75		56
18	541_Low	Not a TEC	69.4	69.4	1.7	PCT Cleared - 64%	High Sensitivity to Potential Gain			1.75		52
19	541_DNG	Not a TEC	54.7	54.7	2.1	PCT Cleared - 64%	High Sensitivity to Potential Gain			1.75		49
											Subtotal	**247**

Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion												
8	492_High	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	93	93.0	2.6	PCT Cleared - 43%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	151

9	492_Moderate	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	93	93.0	0.02	PCT Cleared - 43%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	1

10	492_Low	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	60.3	60.3	0.58	PCT Cleared - 43%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	22

11	492_DNG	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	59.9	59.9	0.89	PCT Cleared - 43%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	33
											Subtotal	**207**

White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion												
1	433_Moderate	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	99.9	99.9	0.01	PCT Cleared - 85%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	1

2	433_Low	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highla	99.9	99.9	0.01	PCT Cleared - 85%	High Sensitivity to Potential Gain	Critically Endangered Ecological Community	Critically Endangered	2.50	TRUE	1
											Subtotal	**2**
											Total	**1358**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Cercartetus nanus / Eastern Pygmy-possum (Fauna)									
599_High	99.9	99.9	0.36			Vulnerable	Not Listed	False	18
								Subtotal	**18**

Chalinolobus dwyeri / Large-eared Pied Bat (Fauna)									
599_Low	99.9	99.9	0.22			Vulnerable	Vulnerable	True	16
599_High	99.9	99.9	0.06			Vulnerable	Vulnerable	True	4
599_Moderate	99.9	99.9	0.04			Vulnerable	Vulnerable	True	3
								Subtotal	**23**
Litoria booroolongensis / Booroolong Frog (Fauna)									
486_Moderate	99.1	99.1	0.6			Endangered	Endangered	False	30
540_High	80.3	80.3	0.04			Endangered	Endangered	False	2
541_High	87.3	87.3	0.01			Endangered	Endangered	False	1
								Subtotal	**33**
Petaurus norfolcensis / Squirrel Glider (Fauna)									
433_Moderate	99.9	99.9	0.01			Vulnerable	Not Listed	False	1
599_High	99.9	99.9	0.36			Vulnerable	Not Listed	False	18
599_Moderate	99.9	99.9	0.07			Vulnerable	Not Listed	False	3
								Subtotal	**22**
Phascolarctos cinereus / Koala (Fauna)									
433_Moderate	99.9	99.9	0.01			Vulnerable	Vulnerable	False	1
599_Low	99.9	99.9	0.94			Vulnerable	Vulnerable	False	47
599_High	99.9	99.9	0.36			Vulnerable	Vulnerable	False	18
599_Moderate	99.9	99.9	0.09			Vulnerable	Vulnerable	False	4
433_Low	99.9	99.9	0.01			Vulnerable	Vulnerable	False	1
								Subtotal	**71**
Uvidicolus sphyrurus / Border Thick-tailed Gecko (Fauna)									
599_High	99.9	99.9	0.13			Vulnerable	Vulnerable	False	6

599_Moderate	99.9	99.9	0.04			Vulnerable	Vulnerable	False	2
								Subtotal	**8**
Vespadelus troughtoni / Eastern Cave Bat (Fauna)									
599_Low	99.9	99.9	0.22			Vulnerable	Not Listed	True	16
599_High	99.9	99.9	0.06			Vulnerable	Not Listed	True	4
599_Moderate	99.9	99.9	0.04			Vulnerable	Not Listed	True	3
								Subtotal	**23**

BAM Credit Summary Report

Proposal Details

Assessment Id 00031734/BAAS18138/22/00031735	Proposal Name HoG - NSW North Coast - Tomalla	BAM data last updated * 24/11/2021
Assessor Name Callan Wharfe	Report Created 23/03/2022	BAM Data version * 50
Assessor Number BAAS18138	BAM Case Status Finalised	Date Finalised 23/03/2022
Assessment Revision 0	Assessment Type Major Projects	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits

Black Sallee - Snow Gum grassy woodland of the New England Tableland Bioregion												
4	507_Moderate	Not a TEC	57.6	57.6	0.09	PCT Cleared - 87%	High Sensitivity to Potential Gain			2.00		3
											Subtotal	**3**
Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion												
12	931_Moderate	Not a TEC	45	45.0	0.47	PCT Cleared - 85%	High Sensitivity to Potential Gain			2.00		11
											Subtotal	**11**
Messmate open forest of the tableland edge of the NSW North Coast Bioregionand New England Tableland Bioregion												
13	934_High	Not a TEC	87	87.0	3.3	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		145
14	934_Moderate	Not a TEC	99.7	99.7	0.17	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		8
15	934_DNG	Not a TEC	19.1	19.1	0.17	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		2
											Subtotal	**155**

Mountain Ribbon Gum - Messmate open forest of escarpment ranges of the NSW North Coast Bioregion and New England Tableland Bioregion												
16	954_High	Not a TEC	99.8	99.8	1.2	PCT Cleared - 50%	High Sensitivity to Potential Gain			1.75		54
											Subtotal	**54**
River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range												
1	486_High	Not a TEC	99.8	99.8	0.42	PCT Cleared - 40%	High Sensitivity to Potential Gain			1.50		16
2	486_Moderate	Not a TEC	99.8	99.8	0.17	PCT Cleared - 40%	High Sensitivity to Potential Gain			1.50		6
											Subtotal	**22**
Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion												
5	540_High	Not a TEC	72.9	72.9	4.5	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		143
6	540_Moderate	Not a TEC	78	78.0	11.4	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		388
7	540_Low	Not a TEC	94.9	94.9	2.6	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		107

8	540_DNG	Not a TEC	28.6	28.6	1.1	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		14
											Subtotal	**652**
Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion												
9	541_High	Not a TEC	79.9	79.9	1.1	PCT Cleared - 64%	High Sensitivity to Potential Gain			1.75		38
10	541_Moderate	Not a TEC	76.9	76.9	1.8	PCT Cleared - 64%	High Sensitivity to Potential Gain			1.75		62
11	541_Low	Not a TEC	61.5	61.5	0.8	PCT Cleared - 64%	High Sensitivity to Potential Gain			1.75		22
											Subtotal	**122**
Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, Brigalow Belt South Bioregion												
3	492_Moderate	Not a TEC	89.1	89.1	0.53	PCT Cleared - 43%	High Sensitivity to Potential Gain			1.50		18
											Subtotal	**18**

Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion												
17	1194_High	Not a TEC	64.9	64.9	7.1	PCT Cleared - 80%	High Sensitivity to Potential Gain			2.00		229
18	1194_Moderate	Not a TEC	65.7	65.7	9	PCT Cleared - 80%	High Sensitivity to Potential Gain			2.00		294
19	1194_Low	Not a TEC	38	38.0	1.6	PCT Cleared - 80%	High Sensitivity to Potential Gain			2.00		31
20	1194_DNG	Not a TEC	7.8	7.8	3.6	PCT Cleared - 80%	High Sensitivity to Potential Gain			2.00		0
											Subtotal	**554**
											Total	**1591**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Cercartetus nanus / Eastern Pygmy-possum (Fauna)									
934_High	87.0	87.0	1.8			Vulnerable	Not Listed	False	77
954_High	99.8	99.8	1.2			Vulnerable	Not Listed	False	61
1194_High	64.9	64.9	5.4			Vulnerable	Not Listed	False	176

								Subtotal	**314**
Myotis macropus / Southern Myotis (Fauna)									
1194_Moderate	65.7	65.7	1.4			Vulnerable	Not Listed	False	47
								Subtotal	**47**
Ninox connivens / Barking Owl (Fauna)									
540_Moderate	78.0	78.0	1.8			Vulnerable	Not Listed	False	69
1194_Moderate	65.7	65.7	0.23			Vulnerable	Not Listed	False	8
								Subtotal	**77**
Ninox strenua / Powerful Owl (Fauna)									
540_Moderate	78.0	78.0	1.8			Vulnerable	Not Listed	False	69
1194_Moderate	65.7	65.7	0.23			Vulnerable	Not Listed	False	8
								Subtotal	**77**
Petaurus norfolcensis / Squirrel Glider (Fauna)									
1194_High	64.9	64.9	3.5			Vulnerable	Not Listed	False	112
1194_Moderate	65.7	65.7	1.3			Vulnerable	Not Listed	False	42
								Subtotal	**154**
Phascolarctos cinereus / Koala (Fauna)									
507_Moderate	57.6	57.6	0.09			Vulnerable	Vulnerable	False	3
931_Moderate	45.0	45.0	0.28			Vulnerable	Vulnerable	False	6
934_High	87.0	87.0	2.7			Vulnerable	Vulnerable	False	116
934_Moderate	99.7	99.7	0.13			Vulnerable	Vulnerable	False	6
954_High	99.8	99.8	1.1			Vulnerable	Vulnerable	False	56
1194_High	64.9	64.9	6.6			Vulnerable	Vulnerable	False	216
1194_Moderate	65.7	65.7	2.2			Vulnerable	Vulnerable	False	71

1194_Low	38.0	38.0	1.6			Vulnerable	Vulnerable	False	31
								Subtotal	**505**
Tyto novaehollandiae / Masked Owl (Fauna)									
540_Moderate	78.0	78.0	0.99			Vulnerable	Not Listed	False	39
								Subtotal	**39**
Tyto tenebricosa / Sooty Owl (Fauna)									
540_Moderate	78.0	78.0	1.8			Vulnerable	Not Listed	True	103
1194_Moderate	65.7	65.7	0.23			Vulnerable	Not Listed	True	11
								Subtotal	**114**

BAM Credit Summary Report

Proposal Details

Assessment Id
00031734/BAAS18138/22/00031737

Proposal Name
Hog - New England Tablelands - Walcha Plateau

BAM data last updated *
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Assessor Name
Callan Wharfe

Report Created
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Assessment Type
Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Messmate - Mountain Gum tall moist forest of the far southern New England Tableland Bioregion												
7	931_High	Not a TEC	44.4	44.4	1.1	PCT Cleared - 85%	High Sensitivity to Potential Gain			2.00		24

8	931_Moderate	Not a TEC	55.1	55.1	1.4	PCT Cleared - 85%	High Sensitivity to Potential Gain			2.00		39
9	931_Low	Not a TEC	26.9	26.9	0.22	PCT Cleared - 85%	High Sensitivity to Potential Gain			2.00		3
											Subtotal	**66**
Messmate open forest of the tableland edge of the NSW North Coast Bioregionand New England Tableland Bioregion												
10	934_High	Not a TEC	91.2	91.2	2.3	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		103
11	934_Moderate	Not a TEC	99.6	99.6	0.13	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		6
12	934_Low	Not a TEC	99.6	99.6	0.4	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		20
13	934_DNG	Not a TEC	20.7	20.7	16.5	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		171
											Subtotal	**300**
Mountain Ribbon Gum - Messmate - Broad-leaved Stringybark open forest on granitic soils of the New England Tableland Bioregion												
1	526_High	Not a TEC	99.3	99.3	0.43	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		19

2	526_Moderate	Not a TEC	99.3	99.3	0.69	PCT Cleared - 56%	High Sensitivity to Potential Gain			1.75		30
											Subtotal	**49**
Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar Bioregion, southern New England Tableland Bioregion and NSW North Coast Bioregion												
3	540_High_TEC	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	73.3	73.3	0.49	PCT Cleared - 56%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		18
4	540_Moderate_TEC	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	82.1	82.1	0.89	PCT Cleared - 56%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		37

5	540_Low_TEC	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	95.4	95.4	0.03	PCT Cleared - 56%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		1
											Subtotal	**56**
Snow Grass - Swamp Foxtail tussock grassland sedgeland of cold air drainage valleys of the New England Tableland Bioregion												
6	586_Low	Not a TEC	41.7	41.7	2.6	PCT Cleared - 75%	High Sensitivity to Potential Gain			2.00		53
											Subtotal	**53**

Snow Gum - Mountain Gum - Mountain Ribbon Gum open forest on ranges of the NSW North Coast Bioregion and eastern New England Tableland Bioregion												
14	1194_High_TEC	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	63.1	63.1	5.6	PCT Cleared - 80%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		175
15	1194_Moderate_TEC	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	64.6	64.6	7.6	PCT Cleared - 80%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		246
16	1194_Low_TEC	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	37.5	37.5	3.1	PCT Cleared - 80%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		58

17	1194_DNG_TEC	Ribbon Gum—Mountain Gum—Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	7.4	7.4	1.9	PCT Cleared - 80%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00	0
										Subtotal	**479**
										Total	**1003**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Cercartetus nanus / Eastern Pygmy-possum (Fauna)									
526_High	99.3	99.3	0.43			Vulnerable	Not Listed	False	21
931_High	44.4	44.4	1.1			Vulnerable	Not Listed	False	24
934_High	91.2	91.2	2.3			Vulnerable	Not Listed	False	103
1194_High_TEC	63.1	63.1	5.6			Vulnerable	Not Listed	False	175
								Subtotal	**323**
Chalinolobus dwyeri / Large-eared Pied Bat (Fauna)									
931_High	44.4	44.4	0.29			Vulnerable	Vulnerable	True	10
931_Moderate	55.1	55.1	1.4			Vulnerable	Vulnerable	True	59

934_Moderate	99.6	99.6	0.13			Vulnerable	Vulnerable	True	10
934_Low	99.6	99.6	0.4			Vulnerable	Vulnerable	True	30
934_DNG	20.7	20.7	7.5			Vulnerable	Vulnerable	True	117
1194_High_TEC	63.1	63.1	2.7			Vulnerable	Vulnerable	True	128
1194_Moderate_TEC	64.6	64.6	4			Vulnerable	Vulnerable	True	193
1194_Low_TEC	37.5	37.5	1.8			Vulnerable	Vulnerable	True	49
1194_DNG_TEC	7.4	7.4	1.2			Vulnerable	Vulnerable	True	6
								Subtotal	**602**
Myotis macropus / Southern Myotis (Fauna)									
934_DNG	20.7	20.7	1.8			Vulnerable	Not Listed	False	19
1194_High_TEC	63.1	63.1	0.06			Vulnerable	Not Listed	False	2
1194_Moderate_TEC	64.6	64.6	0.64			Vulnerable	Not Listed	False	21
								Subtotal	**42**
Petaurus norfolcensis / Squirrel Glider (Fauna)									
526_High	99.3	99.3	0.43			Vulnerable	Not Listed	False	21
526_Moderate	99.3	99.3	0.68			Vulnerable	Not Listed	False	34
1194_High_TEC	63.1	63.1	3.3			Vulnerable	Not Listed	False	103
1194_Moderate_TEC	64.6	64.6	6.5			Vulnerable	Not Listed	False	210
								Subtotal	**368**
Phascolarctos cinereus / Koala (Fauna)									
526_High	99.3	99.3	0.43			Vulnerable	Vulnerable	False	21
526_Moderate	99.3	99.3	0.68			Vulnerable	Vulnerable	False	34

931_High	44.4	44.4	1.1			Vulnerable	Vulnerable	False	24
931_Moderate	55.1	55.1	1.4			Vulnerable	Vulnerable	False	39
931_Low	26.9	26.9	0.12			Vulnerable	Vulnerable	False	2
934_High	91.2	91.2	2.3			Vulnerable	Vulnerable	False	103
934_Moderate	99.6	99.6	0.13			Vulnerable	Vulnerable	False	6
934_Low	99.6	99.6	0.4			Vulnerable	Vulnerable	False	20
1194_High_TEC	63.1	63.1	5.6			Vulnerable	Vulnerable	False	175
1194_Moderate_TEC	64.6	64.6	5.3			Vulnerable	Vulnerable	False	170
1194_Low_TEC	37.5	37.5	2.9			Vulnerable	Vulnerable	False	55
								Subtotal	**649**
Vespadelus troughtoni / Eastern Cave Bat (Fauna)									
931_High	44.4	44.4	0.29			Vulnerable	Not Listed	True	10
931_Moderate	55.1	55.1	1.4			Vulnerable	Not Listed	True	59
934_Moderate	99.6	99.6	0.13			Vulnerable	Not Listed	True	10
934_Low	99.6	99.6	0.4			Vulnerable	Not Listed	True	30
934_DNG	20.7	20.7	7.5			Vulnerable	Not Listed	True	117
1194_High_TEC	63.1	63.1	2.7			Vulnerable	Not Listed	True	128
1194_Moderate_TEC	64.6	64.6	4			Vulnerable	Not Listed	True	193
1194_Low_TEC	37.5	37.5	1.8			Vulnerable	Not Listed	True	49
1194_DNG_TEC	7.4	7.4	1.2			Vulnerable	Not Listed	True	6
								Subtotal	**602**

BAM Credit Summary Report

Proposal Details

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Proposal Name
Hills of Gold Wind Farm

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Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter												
1	1604_Low	Not a TEC	99.7	99.7	0.02	PCT Cleared - 71%	High Sensitivity to Potential Gain			2.00		1
											Subtotal	**1**

Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter												
2	1691_Low	Not a TEC	99.7	99.7	0.04	PCT Cleared - 77%	High Sensitivity to Potential Gain			2.00		2
											Subtotal	**2**
											Total	**3**

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Myotis macropus / Southern Myotis (Fauna)									
1604_Low	99.7	99.7	0.02			Vulnerable	Not Listed	False	1
								Subtotal	**1**
Phascolarctos cinereus / Koala (Fauna)									
1604_Low	99.7	99.7	0.02			Vulnerable	Vulnerable	False	1
1691_Low	99.7	99.7	0.02			Vulnerable	Vulnerable	False	1
								Subtotal	**2**

Appendix H BAM plot survey data

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BDAR plot	Field ID	PCT	Cond.	easting	northing	bearing	Comp Tree	Comp Shrub	Comp Grass	Comp Forbs	Comp Ferns	Comp Other	Struc Tree	Struc Shrub	Struc Grass
1	HoG-Mar-13	931	Low	327308.9662	6509746.216	352	1	0	2	4	1	0	55.0	0.0	6.0
2	HoG_Mar_14	1194	DNG	318788.1415	6501027.491	112	0	0	3	15	1	1	0.0	0.0	14.1
3	HoG_Mar_15	541	High	319104.1107	6501473.217	282	2	4	4	25	1	3	70.0	50.6	2.7
4	HoG_Mar_16	540	High	319185.5396	6501621.687	180	1	4	9	27	2	2	75.0	27.4	9.4
5	HoG_TLC_Mar_01	1194	Low	324070.4841	6499595.519	300	1	2	9	27	1	5	5.0	0.2	7.9
6	HoG_TLC_Mar_02	540	High	321676.0275	6500657.758	0	1	7	17	27	1	4	60.0	12.7	33.5
7	HoG_TLC_Mar_03	540	Moderate	320039.0753	6501800.129	320	3	6	15	18	4	6	15.2	65.2	74.1
8	HoG_TLC_Mar_04	540	DNG	320626.6472	6501288.621	30	1	6	9	25	0	1	0.1	1.7	112.1
9	HoG_TLC_Mar_05	492	Moderate	320460.6042	6501462.687	190	4	7	13	26	2	5	54.3	5.5	28.1
10	HoG-Mar-01	934	High	326223.9671	6500317.283	340	2	6	5	18	1	3	40.0	9.7	85.3
11	HoG-Mar-02	1194	Low	326447.0812	6500884.121	345	1	2	1	9	1	1	5.0	70.0	20.0
12	HoG-Mar-03	1194	High	325970.2763	6503456.045	136	2	5	3	13	1	1	20.0	5.3	82.5
13	HoG-Mar-04	1194	Moderate	325897.2991	6504202.339	10	3	3	2	14	1	5	25.0	10.3	3.0
14	HoG-Mar-05	1194	DNG	325809.2251	6498707.069	176	0	0	2	6	1	0	0.0	0.0	52.0
15	HoG-Mar-06	931	High	325416.449	6498917.793	294	1	2	2	9	1	2	45.0	6.0	6.0
16	HoG-Mar-07	934	DNG	323571.1749	6499222.691	168	0	0	4	11	1	1	0.0	0.0	21.1
17	HoG-Mar-08	1194	Moderate	323694.2016	6499507.521	116	2	1	2	11	1	1	25.0	8.0	31.0
18	HoG-Mar-09	931	Moderate	317618.9057	6502049.383	56	1	3	2	9	1	3	40.0	3.6	3.1
19	HoG-Mar-10	507	Moderate	317222.7521	6502995.643	304	2	2	3	17	1	3	33.0	2.5	11.1
20	HoG-Mar-11	1194	High	316955.454	6502914.754	58	2	4	6	20	1	1	15.5	15.1	77.8
21	HoG-Mar-12	931	Moderate	327223.7577	6509755.951	0	2	2	3	12	0	2	23.0	1.0	74.0
22	HoG_TLC_Mar_07	492	Low	309500.9931	6506810.496	282	1	2	6	12	0	1	5.0	8.0	37.0
23	HoG_TLC_Mar_06	541	High	307959.7084	6507113.884	126	2	4	5	13	0	2	35.0	35.2	14.0
24	HoG_TLC_Mar_08	492	Moderate	308602.1704	6507013.704	81	2	1	7	12	1	3	30.0	50.0	65.0
25	NWF_02	934	DNG	324407.3537	6498745.128	112	0	0	0	0	0	0	0.0	0.0	0.0
26	NWF_01	1194	High	324838.1716	6497967.382	100	0	0	0	0	0	0	0.0	0.0	0.0
27	34784_01	540	Moderate	323407.929	6500249.198	150	3	5	9	20	0	5	55.1	6.3	69.7
28	34784_02	540	Moderate	324879.2154	6500128.176	55	3	8	8	25	1	5	20.1	2.5	49.9
29	34784_04	541	Moderate	319336.5404	6502344.313	345	2	9	11	16	1	6	15.0	19.0	79.8
30	34784_05	1194	Moderate	329445.6977	6512527.375	225	3	2	6	16	0	1	22.0	0.6	76.5
31	34784_07	1194	High	325201.2616	6499090.96	270	2	0	3	11	1	1	35.1	0.0	30.2
32	34784_13	540	Low	319781.5162	6501896.426	155	2	5	6	18	0	3	85.0	3.2	21.2
33	34784_16	540	Moderate	323184.6919	6500162.409	330	4	2	7	21	2	2	30.2	0.3	23.7
34	34784_17	540	High	324824.4673	6500104.34	40	2	6	14	29	1	4	20.1	0.7	26.9
35	34784_20	492	High	326388.8792	6516251.367	100	6	6	13	22	3	5	22.5	4.4	72.9
36	34784_28	586	Low	324631.2	6500025.962	90	0	0	7	5	0	0	0.0	0.0	11.5
37	34784_34	934	High	325935.6234	6500220.052	60	4	7	5	17	2	5	32.0	80.6	85.7
38	34784_42	931	Moderate	324169.2682	6499236.13	200	3	0	2	11	1	0	0.3	0.0	60.1
39	34784_46	541	Low	314828.1934	6504683.359	130	0	1	12	13	0	1	0.0	0.1	78.7

BDAR plot	Field ID	PCT	Cond.	Struc Forbs	Struc Ferns	Struc Other	Fun Large Trees	Fun Hollow Trees	Fun Litter Cover	Fun Len Fallen Logs	Fun Tree Stem 5to9	Fun Tree Stem 10to19	Fun Tree Stem 20to29
1	HoG-Mar-13	931	Low	2.6	0.1	0.0	4	0	4.0	0.0	0	0	0
2	HoG_Mar_14	1194	DNG	91.4	4.0	0.1	0	0	2.0	0.0	0	0	0
3	HoG_Mar_15	541	High	13.0	0.1	0.8	1	0	22.0	0.0	1	0	1
4	HoG_Mar_16	540	High	9.1	0.2	0.6	1	1	62.0	35.0	0	1	1
5	HoG_TLC_Mar_01	1194	Low	4.6	70.0	0.6	0	1	7.0	60.0	0	0	1
6	HoG_TLC_Mar_02	540	High	15.5	0.2	3.9	2	0	45.0	5.0	0	0	1
7	HoG_TLC_Mar_03	540	Moderate	10.0	2.3	5.9	1	0	21.0	53.0	0	0	1
8	HoG_TLC_Mar_04	540	DNG	15.0	0.0	0.1	0	0	2.0	0.0	0	0	0
9	HoG_TLC_Mar_05	492	Moderate	7.6	1.1	2.3	5	0	56.0	356.0	0	1	1
10	HoG-Mar-01	934	High	12.6	5.0	2.5	0	2	62.0	64.0	0	1	1
11	HoG-Mar-02	1194	Low	27.4	1.0	5.0	0	0	29.0	19.0	0	1	1
12	HoG-Mar-03	1194	High	6.4	0.2	0.1	2	2	73.0	24.0	0	1	1
13	HoG-Mar-04	1194	Moderate	10.3	1.0	2.3	2	0	70.0	22.0	0	1	1
14	HoG-Mar-05	1194	DNG	11.9	95.0	0.0	0	0	8.0	0.0	0	0	0
15	HoG-Mar-06	931	High	74.9	0.5	4.0	0	0	72.0	56.0	0	1	1
16	HoG-Mar-07	934	DNG	14.0	75.0	0.1	0	0	11.0	0.0	0	0	0
17	HoG-Mar-08	1194	Moderate	14.0	3.0	0.5	8	6	94.0	203.0	0	0	1
18	HoG-Mar-09	931	Moderate	28.7	0.1	0.8	8	7	51.0	28.0	0	0	0
19	HoG-Mar-10	507	Moderate	20.6	5.0	0.3	2	4	52.0	72.0	0	1	1
20	HoG-Mar-11	1194	High	7.7	0.1	0.1	2	4	57.0	44.0	0	0	1
21	HoG-Mar-12	931	Moderate	16.1	0.0	0.6	2	2	18.0	86.0	0	1	1
22	HoG_TLC_Mar_07	492	Low	46.4	0.0	0.1	1	0	45.0	73.0	0	0	1
23	HoG_TLC_Mar_06	541	High	14.7	0.0	2.0	2	1	37.0	64.0	0	0	0
24	HoG_TLC_Mar_08	492	Moderate	47.7	1.0	1.6	2	2	33.0	36.0	0	0	1
25	NWF_02	934	DNG	0.0	0.0	0.0	0	0	9.0	0.0	0	0	0
26	NWF_01	1194	High	0.0	0.0	0.0	4	0	62.0	70.0	0	1	1
27	34784_01	540	Moderate	19.8	0.0	3.3	3	1	30.0	66.0	0	0	1
28	34784_02	540	Moderate	13.5	4.0	1.1	2	0	41.0	82.0	1	0	1
29	34784_04	541	Moderate	12.2	0.2	6.7	1	1	25.0	66.0	1	1	1
30	34784_05	1194	Moderate	13.5	0.0	0.1	4	2	21.0	55.0	1	1	1
31	34784_07	1194	High	16.3	0.1	0.1	4	0	50.0	19.0	0	0	0
32	34784_13	540	Low	16.5	0.0	1.6	2	1	54.0	34.0	1	1	1
33	34784_16	540	Moderate	34.9	0.2	6.0	3	2	12.0	77.0	1	1	1
34	34784_17	540	High	3.8	0.1	0.4	12	0	32.0	73.0	0	1	1
35	34784_20	492	High	8.4	0.3	0.6	10	1	29.0	45.0	0	1	1
36	34784_28	586	Low	0.7	0.0	0.0	0	0	11.0	0.0	0	0	0
37	34784_34	934	High	2.5	0.8	0.7	1	3	83.0	202.0	1	1	1
38	34784_42	931	Moderate	1.6	30.0	0.0	3	3	4.0	17.0	0	0	0
39	34784_46	541	Low	5.6	0.0	0.1	0	0	56.0	0.0	0	1	1

BDAR plot	Field ID	PCT	Cond.	Fun Tree Stem 30to49	Fun Tree Stem 50to79	Fun Tree Regen	Fun High Threat Exotic
1	HoG-Mar-13	931	Low	0	0	0	0.0
2	HoG_Mar_14	1194	DNG	0	0	0	0.0
3	HoG_Mar_15	541	High	1	1	0	0.1
4	HoG_Mar_16	540	High	1	0	0	0.0
5	HoG_TLC_Mar_01	1194	Low	1	1	1	0.0
6	HoG_TLC_Mar_02	540	High	1	0	0	0.0
7	HoG_TLC_Mar_03	540	Moderate	0	0	0	0.7
8	HoG_TLC_Mar_04	540	DNG	0	0	0	0.6
9	HoG_TLC_Mar_05	492	Moderate	1	0	0	0.2
10	HoG-Mar-01	934	High	1	1	0	4.0
11	HoG-Mar-02	1194	Low	0	0	0	1.0
12	HoG-Mar-03	1194	High	1	1	0	0.2
13	HoG-Mar-04	1194	Moderate	1	1	0	10.0
14	HoG-Mar-05	1194	DNG	0	0	0	0.0
15	HoG-Mar-06	931	High	1	0	0	0.0
16	HoG-Mar-07	934	DNG	0	0	0	0.0
17	HoG-Mar-08	1194	Moderate	1	1	0	1.0
18	HoG-Mar-09	931	Moderate	0	1	0	1.0
19	HoG-Mar-10	507	Moderate	1	0	0	1.0
20	HoG-Mar-11	1194	High	1	1	0	0.0
21	HoG-Mar-12	931	Moderate	1	1	0	0.0
22	HoG_TLC_Mar_07	492	Low	1	0	0	0.0
23	HoG_TLC_Mar_06	541	High	1	0	0	0.0
24	HoG_TLC_Mar_08	492	Moderate	1	0	0	0.0
25	NWF_02	934	DNG	0	0	0	0.0
26	NWF_01	1194	High	1	0	0	0.0
27	34784_01	540	Moderate	1	0	0	0.0
28	34784_02	540	Moderate	1	0	1	0.0
29	34784_04	541	Moderate	1	0	0	0.0
30	34784_05	1194	Moderate	1	1	1	0.0
31	34784_07	1194	High	0	1	0	0.0
32	34784_13	540	Low	1	0	0	0.0
33	34784_16	540	Moderate	1	0	0	0.0
34	34784_17	540	High	1	1	0	0.0
35	34784_20	492	High	1	1	1	0.0
36	34784_28	586	Low	0	0	0	0.7
37	34784_34	934	High	1	1	1	0.0
38	34784_42	931	Moderate	1	0	0	0.2
39	34784_46	541	Low	1	0	1	0.0

BDAR plot	Field ID	PCT	Cond.	easting	northing	bearing	Comp Tree	Comp Shrub	Comp Grass	Comp Forbs	Comp Ferns	Comp Other	Struc Tree	Struc Shrub	Struc Grass
40	34784_47	492	High	326274.4454	6516190.311	90	6	7	12	17	0	7	12.6	16.2	24.9
41	34784_08	1194	Low	323360.9042	6499626.655	295	1	2	1	16	1	1	40.0	0.3	1.0
42	34784_09	1194	High	326494.6185	6508705.079	45	1	3	8	16	1	5	1.0	3.0	8.0
43	34784_11	1194	High	317363.9959	6502097.867	310	3	4	5	26	2	4	51.2	5.6	65.1
44	34784_21	492	High	326599.2775	6516285.376	20	3	7	12	19	0	6	18.5	9.9	70.5
45	34784_23	541	High	314558.1255	6504520.94	105	4	6	11	18	2	6	16.2	6.8	97.7
46	34784_27	586	Low	325034.6554	6500182.867	50	0	0	6	10	0	0	0.0	0.0	33.1
47	34784_29	586	Low	325349.1568	6500365.69	232	0	0	9	9	0	0	0.0	0.0	85.2
48	34784_32	541	Moderate	314437.0618	6504741.527	110	2	8	10	20	2	8	40.2	8.6	34.6
49	34784_35	541	High	318203.0365	6501353.959	130	4	8	6	25	1	6	40.0	13.6	52.1
50	34784_45	541	Low	314275.2971	6504581.488	340	3	3	5	20	0	2	50.1	0.3	50.2

BDAR plot	Field ID	PCT	Cond.	Struc Forbs	Struc Ferns	Struc Other	Fun Large Trees	Fun Hollow Trees	Fun Litter Cover	Fun Len Fallen Logs	Fun Tree Stem 5to9	Fun Tree Stem 10to19	Fun Tree Stem 20to29
40	34784_47	492	High	2.8	0.0	1.2	4	1	69.0	15.0	0	1	1
41	34784_08	1194	Low	16.4	0.5	0.1	1	2	27.0	17.0	0	0	1
42	34784_09	1194	High	16.0	1.0	5.0	9	0	52.0	65.0	0	1	1
43	34784_11	1194	High	11.9	2.1	2.6	3	3	58.0	69.0	1	1	1
44	34784_21	492	High	7.3	0.0	2.5	10	0	9.0	47.0	1	1	1
45	34784_23	541	High	9.9	0.2	6.5	0	1	71.0	181.0	1	1	1
46	34784_27	586	Low	7.8	0.0	0.0	0	0	4.0	0.0	0	0	0
47	34784_29	586	Low	6.8	0.0	0.0	0	0	4.0	0.0	0	0	0
48	34784_32	541	Moderate	11.4	1.0	7.2	2	0	70.0	16.0	1	1	1
49	34784_35	541	High	20.7	3.0	8.7	4	0	43.0	139.0	1	1	1
50	34784_45	541	Low	18.0	0.0	1.5	4	0	32.0	58.0	1	1	1

BDAR plot	Field ID	PCT	Cond.	Fun Tree Stem 30to49	Fun Tree Stem 50to79	Fun Tree Regen	Fun High Threat Exotic
40	34784_47	492	High	1	1	1	0.1
41	34784_08	1194	Low	1	1	0	0.0
42	34784_09	1194	High	1	1	0	0.0
43	34784_11	1194	High	1	1	0	0.0
44	34784_21	492	High	1	1	1	0.0
45	34784_23	541	High	1	0	1	0.0
46	34784_27	586	Low	0	0	0	0.0
47	34784_29	586	Low	0	0	0	0.0
48	34784_32	541	Moderate	1	0	1	0.0
49	34784_35	541	High	1	1	0	0.0
50	34784_45	541	Low	1	0	1	0.0

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Native species																																	
Acanthaceae	Pseuderanthemum variabile	Pastel Flower																			0.1	20											
Adiantaceae	Adiantum formosum	Giant Maidenhair																	0.1	1													
Adiantaceae	Cheilanthes distans	Bristly Cloak Fern													1	100																	
Adiantaceae	Pellaea falcata	Sickle Fern													1	60																	
Adiantaceae	Pellaea nana	Dwarf Sickle Fern																															
Anthericaceae	Arthropodium milleflorum										0.1	7	0.2	5	5	200			0.4	20													
Anthericaceae	Arthropodium sp.																																
Anthericaceae	Laxmannia gracilis																																
Anthericaceae	Thysanotus sp.																																
Anthericaceae	Thysanotus tuberosus										0.1	4																					
Anthericaceae	Tricoryne elatior																																
Apiaceae	Daucus glochidiatus								0.1	6	0.1	1	0.1	20	0.1	10																	
Apiaceae	Daucus sp.																																
Apiaceae	Hydrocotyle laxiflora	Stinking Pennywort																			1	50	0.5	100	2	500	1	200			1	100	0.3	50
Apiaceae	Hydrocotyle sibthorpioides												2	100			0.5	70	0.5	40													
Apocynaceae	Tylophora barbata	Bearded Tylophora																															
Araliaceae	Astrotricha sp.																																
Araliaceae	Polyscias sambucifolia																																
Aspleniaceae	Asplenium flabellifolium	Necklace Fern							0.1	4					0.2	30																	
Asteraceae	Ammobium alatum				0.1	1																											
Asteraceae	Brachyscome aculeata	Hill Daisy																															
Asteraceae	Brachyscome microcarpa																																
Asteraceae	Brachyscome multifida var. multifida																0.4	70															
Asteraceae	Brachyscome nova	anglica											0.1	1																			
Asteraceae	Brachyscome sieberi										0.1	2																					
Asteraceae	Brachyscome sp.																																
Asteraceae	Brachyscome spathulata						0.1	4			0.1	1	0.1	2																			
Asteraceae	Calotis sp.	A Burr-daisy																															
Asteraceae	Cassinia laevis	Cough Bush					30	50	25	20			1	10	60	60																	
Asteraceae	Cassinia quinquefaria																																
Asteraceae	Chrysocephalum apiculatum										0.1	8			0.1	10																	
Asteraceae	Cotula australis	Common Cotula																									0.1	50			0.1	10		
Asteraceae	Cymbonotus lawsonianus	Bear's Ear			1	30	0.1	1	0.1	1			0.2	10			0.2	8	0.1	3													
Asteraceae	Euchiton involucratus	Star Cudweed																															
Asteraceae	Euchiton japonicus										0.1	60																					
Asteraceae	Euchiton sphaericus	Star Cudweed			0.1	1											0.1	20															
Asteraceae	Euchiton spp.	A Cudweed																									1	50					
Asteraceae	Helichrysum spp.																																
Asteraceae	Lagenophora gracilis	Slender Lagenophora																															
Asteraceae	Lagenophora spp.																														0.1	30	

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Native species																																	
Acanthaceae	Pseuderanthemum variabile	Pastel Flower																															
Adiantaceae	Adiantum formosum	Giant Maidenhair																															
Adiantaceae	Cheilanthes distans	Bristly Cloak Fern																															
Adiantaceae	Pellaea falcata	Sickle Fern																															
Adiantaceae	Pellaea nana	Dwarf Sickle Fern																															
Anthericaceae	Arthropodium milleflorum																														0.1	2	
Anthericaceae	Arthropodium sp.																		0.1		0.1								0.1		0.1		
Anthericaceae	Laxmannia gracilis																				0.1		0.1										
Anthericaceae	Thysanotus sp.																																
Anthericaceae	Thysanotus tuberosus																																
Anthericaceae	Tricoryne elatior																																
Apiaceae	Daucus glochidiatus																																
Apiaceae	Daucus sp.																												0.1				
Apiaceae	Hydrocotyle laxiflora	Stinking Pennywort	0.1	20			5	200			0.5	20									2		2		5						5		
Apiaceae	Hydrocotyle sibthorpioides																										10	5000				0.2	500
Apocynaceae	Tylophora barbata	Bearded Tylophora																															
Araliaceae	Astrotricha sp.																																
Araliaceae	Polyscias sambucifolia																																
Aspleniaceae	Asplenium flabellifolium	Necklace Fern																													0.1		
Asteraceae	Ammobium alatum																																
Asteraceae	Brachyscome aculeata	Hill Daisy							1	30																							
Asteraceae	Brachyscome microcarpa																																
Asteraceae	Brachyscome multifida var. multifida																																
Asteraceae	Brachyscome nova	anglica																															
Asteraceae	Brachyscome sieberi																																
Asteraceae	Brachyscome sp.																								0.2								
Asteraceae	Brachyscome spathulata																																
Asteraceae	Calotis sp.	A Burr-daisy																	0.1		0.1										0.1		
Asteraceae	Cassinia laevis	Cough Bush											5	20	15	30																	
Asteraceae	Cassinia quinquefaria																						15						1			0.1	1
Asteraceae	Chrysocephalum apiculatum																																
Asteraceae	Cotula australis	Common Cotula					0.1	10	0.1	5					0.1	10	0.1	20															
Asteraceae	Cymbonotus lawsonianus	Bear's Ear																															
Asteraceae	Euchiton involucratus	Star Cudweed																									0.1	1				0.1	10
Asteraceae	Euchiton japonicus						0.1	5																								0.1	1
Asteraceae	Euchiton sphaericus	Star Cudweed																	0.5		0.1		0.2						0.2		3		
Asteraceae	Euchiton spp.	A Cudweed																															
Asteraceae	Helichrysum spp.																															0.1	1
Asteraceae	Lagenophora gracilis	Slender Lagenophora																															
Asteraceae	Lagenophora spp.																																

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Native species																																	
Acanthaceae	Pseuderanthemum variabile	Pastel Flower																															
Adiantaceae	Adiantum formosum	Giant Maidenhair																															
Adiantaceae	Cheilanthes distans	Bristly Cloak Fern																															
Adiantaceae	Pellaea falcata	Sickle Fern					0.5	30																									
Adiantaceae	Pellaea nana	Dwarf Sickle Fern	0.1	10																													
Anthericaceae	Arthropodium milleflorum		0.3	100									0.2	200																			
Anthericaceae	Arthropodium sp.														0.1														0.1				
Anthericaceae	Laxmannia gracilis																				0.1												
Anthericaceae	Thysanotus sp.																						0.1										
Anthericaceae	Thysanotus tuberosus																																
Anthericaceae	Tricoryne elatior																						0.1										
Apiaceae	Daucus glochidiatus																																
Apiaceae	Daucus sp.										0.1																0.1						0.1	
Apiaceae	Hydrocotyle laxiflora	Stinking Pennywort					0.2	100			2				3		10						5						1		5		5	
Apiaceae	Hydrocotyle sibthorpioides		0.1	1					0.2	100																							
Apocynaceae	Tylophora barbata	Bearded Tylophora											0.1	1																			
Araliaceae	Astrotricha sp.														0.2																		
Araliaceae	Polyscias sambucifolia																				0.1												
Aspleniaceae	Asplenium flabellifolium	Necklace Fern	0.1	10															0.1										0.5				
Asteraceae	Ammobium alatum																																
Asteraceae	Brachyscome aculeata	Hill Daisy																															
Asteraceae	Brachyscome microcarpa		1	1000									0.1	30																			
Asteraceae	Brachyscome multifida var. multifida																																
Asteraceae	Brachyscome nova	anglica																															
Asteraceae	Brachyscome sieberi																																
Asteraceae	Brachyscome sp.																																
Asteraceae	Brachyscome spathulata																																
Asteraceae	Calotis sp.	A Burr-daisy																			0.5								0.1				
Asteraceae	Cassinia laevis	Cough Bush																															
Asteraceae	Cassinia quinquefaria		3	500									15	200							9								3		0.2		0.1	
Asteraceae	Chrysocephalum apiculatum																																
Asteraceae	Cotula australis	Common Cotula																															
Asteraceae	Cymbonotus lawsonianus	Bear's Ear							0.1	1																							
Asteraceae	Euchiton involucratus	Star Cudweed	0.1	20	0.1	10			0.1	1																							
Asteraceae	Euchiton japonicus								0.1	10																							
Asteraceae	Euchiton sphaericus	Star Cudweed									0.1				0.1		0.1		0.1				0.1		0.1				0.5		0.1		0.5	
Asteraceae	Euchiton spp.	A Cudweed																															
Asteraceae	Helichrysum spp.																																
Asteraceae	Lagenophora gracilis	Slender Lagenophora											0.1	10																			
Asteraceae	Lagenophora spp.																																

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Asteraceae	Lagenophora stipitata	Common Lagenophora																														
Asteraceae	Leontodon spp.												0.1	1					0.1	5												
Asteraceae	Olearia alpicola	Alpine Daisy-bush											0.1	1																		
Asteraceae	Olearia elliptica	Sticky Daisy-bush																														
Asteraceae	Olearia elliptica subsp. Elliptica																															
Asteraceae	Olearia sp.																															
Asteraceae	Olearia spp.																															
Asteraceae	Podolepis sp.																															
Asteraceae	Senecio diaschides																															
Asteraceae	Senecio gunnii																0.1	10														
Asteraceae	Senecio hispidulus	Hill Fireweed					0.2	4	0.1	1									1	40												
Asteraceae	Senecio linearifolius	Fireweed Groundsel																														
Asteraceae	Senecio minimus																															
Asteraceae	Senecio prenanthoides						0.1	1	0.1	7	0.1	10							0.2	20	1	20	0.1	10	0.1	1	0.5	30				
Asteraceae	Senecio quadridentatus	Cotton Fireweed					0.6	10	0.2	5			0.4	10					0.1	1												
Asteraceae	Senecio sp.																															
Asteraceae	Senecio spp.	Groundsel, Fireweed																														
Asteraceae	Senecio tenuiflorus										0.3	20																				
Asteraceae	Sigesbeckia orientalis subsp. Orientalis	Indian Weed			5	100	5	200	5	100	0.1	1			1	50	0.3	10	0.6	60												
Asteraceae	Solenogyne gunnii	Solengyne							0.1	1			0.2	20	0.1	2																
Asteraceae	Vittadinia cervicularis												0.1	1																		
Asteraceae	Vittadinia cuneata	A Fuzzweed																														
Asteraceae	Vittadinia cuneata var. cuneata	A Fuzzweed											0.1	2			0.3	50														
Asteraceae	Vittadinia hispidula																0.1	10														
Asteraceae	Vittadinia sp.																															
Bignoniaceae	Pandorea pandorana	Wonga Wonga Vine													0.1	1																
Blechnaceae	Blechnum sp.																															
Boraginaceae	Cynoglossum australe																															
Boraginaceae	Hackelia latifoli						0.1	2																								
Boraginaceae	Hackelia latifolia				0.4	5													0.1	1												
Campanulaceae	Lobelia concolor	Poison Pratia					0.1	3	0.1	5	0.1	2	0.2	50			0.1	10	0.1	5			0.1	50	0.1	10	2	100			0.1	30		
Campanulaceae	Lobelia pedunculata										0.1	10																				
Campanulaceae	Lobelia purpurascens	whiteroot																			0.1	50										
Campanulaceae	Lobelia spp.																				0.5	30										
Campanulaceae	Wahlenbergia gracilis	Sprawling Bluebell			0.1	6	0.1	4									0.1	10			0.1	5										
Campanulaceae	Wahlenbergia stricta	Tall Bluebell																														
Campanulaceae	Wahlenbergia stricta subsp. Stricta	Tall Bluebell							0.2	6					0.4	30	0.1	10	0.1	3												
Caryophyllaceae	Scleranthus biflorus	Two-flowered Knawel															0.1	2														
Caryophyllaceae	Stellaria pungens				0.1	1	0.1	5	0.1	3	0.2	10			0.1	10					0.2	30			0.1	10	0.2	50				
Casuarinaceae	Allocasuarina torulosa	Forest Oak													0.1	1																
Chenopodiaceae	Dysphania pumilio	Small Crumbweed	0.8	20	55	200	2	40	0.1	7	0.3	5			0.5	10	0.4	20	0.1	1			3	100					0.2	100			1	100
Chenopodiaceae	Einadia hastata	Berry Saltbush	0.3	7																												

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Asteraceae	Lagenophora stipitata	Common Lagenophora																														
Asteraceae	Leontodon spp.																															
Asteraceae	Olearia alpicola	Alpine Daisy-bush																														
Asteraceae	Olearia elliptica	Sticky Daisy-bush																														
Asteraceae	Olearia elliptica subsp. Elliptica																															
Asteraceae	Olearia sp.																															
Asteraceae	Olearia spp.						2	20	5	5																						
Asteraceae	Podolepis sp.																				0.1								0.1			
Asteraceae	Senecio diaschides																		2		0.5								10			
Asteraceae	Senecio gunnii																															
Asteraceae	Senecio hispidulus	Hill Fireweed																									0.1	2			0.1	1
Asteraceae	Senecio linearifolius	Fireweed Groundsel					1	20			0.5	10															0.1	20				
Asteraceae	Senecio minimus				0.5	20																										
Asteraceae	Senecio prenanthoides		0.1	5					0.1	10																						
Asteraceae	Senecio quadridentatus	Cotton Fireweed																														
Asteraceae	Senecio sp.																		0.2						0.2				0.1			
Asteraceae	Senecio spp.	Groundsel, Fireweed																													0.1	10
Asteraceae	Senecio tenuiflorus																															
Asteraceae	Sigesbeckia orientalis subsp. Orientalis	Indian Weed			2	30	0.1	10	0.1	10											0.5								3		0.1	1
Asteraceae	Solenogyne gunnii	Solengyne																			1				0.2					0.1		
Asteraceae	Vittadinia cervicularis																															
Asteraceae	Vittadinia cuneata	A Fuzzweed													1	10	1	10														
Asteraceae	Vittadinia cuneata var. cuneata	A Fuzzweed																														
Asteraceae	Vittadinia hispidula																															
Asteraceae	Vittadinia sp.																						0.1		0.1							
Bignoniaceae	Pandorea pandorana	Wonga Wonga Vine																														
Blechnaceae	Blechnum sp.																															
Boraginaceae	Cynoglossum australe																															
Boraginaceae	Hackelia latifoli																															
Boraginaceae	Hackelia latifolia				0.1	5																							1			
Campanulaceae	Lobelia concolor	Poison Pratia	0.1	20									0.5	20	1	20	3	50														
Campanulaceae	Lobelia pedunculata																														0.2	100
Campanulaceae	Lobelia purpurascens	whiteroot					1	50	0.5	30											0.1				2							
Campanulaceae	Lobelia spp.								0.1	5																						
Campanulaceae	Wahlenbergia gracilis	Sprawling Bluebell																	0.1		0.1											
Campanulaceae	Wahlenbergia stricta	Tall Bluebell							0.1	5			1	20	0.5	20	0.5	20													0.1	500
Campanulaceae	Wahlenbergia stricta subsp. Stricta	Tall Bluebell																	1		1		0.1		0.3				0.5		5	
Caryophyllaceae	Scleranthus biflorus	Two-flowered Knawel																														
Caryophyllaceae	Stellaria pungens		0.5	70	0.1	10			1	30	5	300															0.5	20				
Casuarinaceae	Allocasuarina torulosa	Forest Oak																											35			
Chenopodiaceae	Dysphania pumilio	Small Crumbweed			15	1000							40	200	1	50	1	30														
Chenopodiaceae	Einadia hastata	Berry Saltbush									0.5	20																				

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Asteraceae	Lagenophora stipitata	Common Lagenophora					0.1	30																								
Asteraceae	Leontodon spp.																															
Asteraceae	Olearia alpicola	Alpine Daisy-bush																														
Asteraceae	Olearia elliptica	Sticky Daisy-bush	0.1	5									0.5	30																		
Asteraceae	Olearia elliptica subsp. Elliptica																										1					
Asteraceae	Olearia sp.																		1													
Asteraceae	Olearia spp.																															
Asteraceae	Podolepis sp.										0.1				0.1		0.2		0.1								0.5					
Asteraceae	Senecio diaschides																		1		0.2						0.1		2		2	
Asteraceae	Senecio gunnii																															
Asteraceae	Senecio hispidulus	Hill Fireweed	0.5	500			0.1	1	0.1	10			0.5	200																		
Asteraceae	Senecio linearifolius	Fireweed Groundsel					0.1	1																								
Asteraceae	Senecio minimus																															
Asteraceae	Senecio prenanthoides																															
Asteraceae	Senecio quadridentatus	Cotton Fireweed																														
Asteraceae	Senecio sp.														2		0.1				0.1						0.1		0.5		0.1	
Asteraceae	Senecio spp.	Groundsel, Fireweed	0.1	100									0.5	200																		
Asteraceae	Senecio tenuiflorus																															
Asteraceae	Sigesbeckia orientalis subsp. Orientalis	Indian Weed	0.1	10															1		0.1		0.1						0.5		0.1	
Asteraceae	Solenogyne gunnii	Solengyne																	0.1		1						0.1		0.1			
Asteraceae	Vittadinia cervicularis																															
Asteraceae	Vittadinia cuneata	A Fuzzweed	0.1	1									0.1	2																		
Asteraceae	Vittadinia cuneata var. cuneata	A Fuzzweed																														
Asteraceae	Vittadinia hispidula																															
Asteraceae	Vittadinia sp.														0.1						2		0.2				0.1					
Bignoniaceae	Pandorea pandorana	Wonga Wonga Vine					0.2	50																								
Blechnaceae	Blechnum sp.																										0.5					
Boraginaceae	Cynoglossum australe		0.6	10			0.2	50																								
Boraginaceae	Hackelia latifoli																															
Boraginaceae	Hackelia latifolia														3				1										0.5		0.1	
Campanulaceae	Lobelia concolor	Poison Pratia																														
Campanulaceae	Lobelia pedunculata				0.2	2000																										
Campanulaceae	Lobelia purpurascens	whiteroot					0.1	100			2								0.5				1		0.2		0.2				0.5	
Campanulaceae	Lobelia spp.																															
Campanulaceae	Wahlenbergia gracilis	Sprawling Bluebell															1						0.2				0.1		0.1		0.1	
Campanulaceae	Wahlenbergia stricta	Tall Bluebell	0.1	100					0.2	1000			0.1	1000																		
Campanulaceae	Wahlenbergia stricta subsp. Stricta	Tall Bluebell									0.1				0.1		2		0.1		2		0.2				0.2		0.1		0.5	
Caryophyllaceae	Scleranthus biflorus	Two-flowered Knawel																														
Caryophyllaceae	Stellaria pungens		2	100																												
Casuarinaceae	Allocasuarina torulosa	Forest Oak																														
Chenopodiaceae	Dysphania pumilio	Small Crumbweed													2																	
Chenopodiaceae	Einadia hastata	Berry Saltbush																														

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Chenopodiaceae	Einadia nutans						1	40	0.1	10	0.1	2																						
Chenopodiaceae	Einadia sp.																																	
Chenopodiaceae	Einadia trigonos	Fishweed			3	60	0.5	20	0.2	20	0.5	20									1	30							0.1	50			5	2000
Clusiaceae	Hypericum gramineum	Small St John's Wort											4	600			0.1	10	0.1	1	0.5	100			0.1	1								
Convolvulaceae	Dichondra repens						1	80	0.1	3	0.1	10	3	100					2	100	5	500	2	50	2	200	2	300			1	500		
Crassulaceae	Crassula sieberiana	Australian Stonecrop					0.1	1	0.1	10																								
Crassulaceae	Crassula sieberiana subsp. Sieberiana																																	
Cyperaceae	Carex appressa	Tall Sedge															3	60	1	20														
Cyperaceae	Carex incomitata				0.1	10			0.1	10	0.1	6																						
Cyperaceae	Carex inversa	Knob Sedge									0.2	60	0.3	30	0.2	20													2	1000			0.1	50
Cyperaceae	Carex sp.																																	
Cyperaceae	Carex spp.																																	
Cyperaceae	Cyperus sp.																																	
Cyperaceae	Cyperus spp.																																	
Cyperaceae	Gahnia aspera																																	
Cyperaceae	Lepidosperma laterale	Variable Sword-sedge							1	10																								
Cyperaceae	Lepidosperma limicola														0.5	4																		
Cyperaceae	Schoenoplectus sp.																																	
Dennstaedtiaceae	Pteridium esculentum		0.1	1	4	30	0.1	1			70	200							1	20	5	30	1	30	0.2	10	1	5	95	3000	0.5	10	75	1000
Dicksoniaceae	Calochlaena dubia	Rainbow Fern																													1	5		
Dicksoniaceae	Dicksonia antarctica	Soft Treefern																																
Dilleniaceae	Hibbertia acicularis												0.2	8	0.1	3	0.1	1	0.1	1														
Dilleniaceae	Hibbertia obtusifolia	Hoary Guinea Flower																																
Dilleniaceae	Hibbertia sp.																																	
Dilleniaceae	Hibbertia spp.																								0.1	2								
Ericaceae	Acrothamnus hookeri																				0.1	10												
Ericaceae	Epacris sp.																																	
Ericaceae	Leucopogon lanceolatus																																	
Ericaceae	Melichrus urceolatus	Urn Heath											0.5	10	0.7	9	0.1	2																
Ericaceae	Monotoca scoparia																0.6	9																
Escalloniaceae	Quintinia sieberi	Possumwood																	7	50														
Euphorbiaceae	Euphorbia spp.												0.1	20	0.1	4			0.1	4														
Fabaceae	Acacia implexa	Hickory Wattle					0.1	1	0.1	5																								
Fabaceae	Acacia melanoxylon	Blackwood													0.1	1			0.3	7			5	6			5	1			45	30		
Fabaceae	Acacia spp.	Wattle																			0.1	2			0.1	3								
Fabaceae	Daviesia genistifolia	Broom Bitter Pea																																
Fabaceae	Daviesia ulicifolia	Gorse Bitter Pea																			3	10												
Fabaceae	Desmodium brachypodum	Large Tick-trefoil																																
Fabaceae	Desmodium gunnii	Slender Tick-trefoil																																
Fabaceae	Desmodium rhytidophyllum																																	
Fabaceae	Desmodium spp.	Tick-trefoil																																

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Chenopodiaceae	Einadia nutans														2	50	0.5	30															
Chenopodiaceae	Einadia sp.																												0.1				
Chenopodiaceae	Einadia trigonos	Fishweed			5	200	2	50	0.1	10																							
Clusiaceae	Hypericum gramineum	Small St John's Wort																															
Convolvulaceae	Dichondra repens		2	300			5	500	1	100	1	50	1	50	5	1000	5	50	1		1		3		1		0.1	10	5				0.2	500
Crassulaceae	Crassula sieberiana	Australian Stonecrop																															
Crassulaceae	Crassula sieberiana subsp. Sieberiana																		1		0.1		0.1		0.2						3		
Cyperaceae	Carex appressa	Tall Sedge																															0.1	2
Cyperaceae	Carex incomitata										1	30																					
Cyperaceae	Carex inversa	Knob Sedge							0.1	10			5	200	3	100	10	1000									0.1	5					0.2	50
Cyperaceae	Carex sp.																								0.1								
Cyperaceae	Carex spp.																																
Cyperaceae	Cyperus sp.																																
Cyperaceae	Cyperus spp.																																0.1	2
Cyperaceae	Gahnia aspera																						1						3				
Cyperaceae	Lepidosperma laterale	Variable Sword-sedge																					1										
Cyperaceae	Lepidosperma limicola																																
Cyperaceae	Schoenoplectus sp.																																
Dennstaedtiaceae	Pteridium esculentum		3	20	0.1	10	5	70	0.1	5							1	10			4						0.1	5			0.1		0.1	5
Dicksoniaceae	Calochlaena dubia	Rainbow Fern																															
Dicksoniaceae	Dicksonia antarctica	Soft Treefern																															
Dilleniaceae	Hibbertia acicularis																																
Dilleniaceae	Hibbertia obtusifolia	Hoary Guinea Flower																															
Dilleniaceae	Hibbertia sp.																						0.1										
Dilleniaceae	Hibbertia spp.																																
Ericaceae	Acrothamnus hookeri																																
Ericaceae	Epacris sp.																		2		0.1		0.1		0.1								
Ericaceae	Leucopogon lanceolatus																				0.5		1										
Ericaceae	Melichrus urceolatus	Urn Heath																															
Ericaceae	Monotoca scoparia																																
Escalloniaceae	Quintinia sieberi	Possumwood																															
Euphorbiaceae	Euphorbia spp.																																
Fabaceae	Acacia implexa	Hickory Wattle																			0.5		0.1										
Fabaceae	Acacia melanoxylon	Blackwood					3	10	0.5	1	3	1							0.1		0.1				5		0.1	10			0.2		0.1	5
Fabaceae	Acacia spp.	Wattle			0.1	2																											
Fabaceae	Daviesia genistifolia	Broom Bitter Pea							8	20																							
Fabaceae	Daviesia ulicifolia	Gorse Bitter Pea																															
Fabaceae	Desmodium brachypodum	Large Tick-trefoil																															
Fabaceae	Desmodium gunnii	Slender Tick-trefoil					0.2	30	0.1	10	0.5	50	0.5	20									0.5						0.5		1		0.1	50
Fabaceae	Desmodium rhytidophyllum																																0.1	1
Fabaceae	Desmodium spp.	Tick-trefoil			0.2	30																											

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Chenopodiaceae	Einadia nutans																															
Chenopodiaceae	Einadia sp.																															
Chenopodiaceae	Einadia trigonos	Fishweed											0.1	1																		
Clusiaceae	Hypericum gramineum	Small St John's Wort																					0.1									
Convolvulaceae	Dichondra repens						0.1	50			0.5						3												2		3		
Crassulaceae	Crassula sieberiana	Australian Stonecrop	0.1	20																												
Crassulaceae	Crassula sieberiana subsp. Sieberiana										0.2				0.1		0.1		0.1				0.1		0.1		0.5		0.5		0.1		
Cyperaceae	Carex appressa	Tall Sedge																														
Cyperaceae	Carex incomitata						0.1	1					0.5	10																		
Cyperaceae	Carex inversa	Knob Sedge	0.2	1000	0.2	1000			0.1	10			0.1	50																		
Cyperaceae	Carex sp.										0.5																					
Cyperaceae	Carex spp.				0.1	1																										
Cyperaceae	Cyperus sp.										0.5														2							
Cyperaceae	Cyperus spp.						0.1	1																								
Cyperaceae	Gahnia aspera										1										0.2						0.5					
Cyperaceae	Lepidosperma laterale	Variable Sword-sedge	0.5	100									1	20							5								1			
Cyperaceae	Lepidosperma limicola																															
Cyperaceae	Schoenoplectus sp.																								0.1							
Dennstaedtiaceae	Pteridium esculentum						0.3	20	30	5000					0.5		0.5		2				0.1							3		
Dicksoniaceae	Calochlaena dubia	Rainbow Fern																														
Dicksoniaceae	Dicksonia antarctica	Soft Treefern					0.1	1											0.1													
Dilleniaceae	Hibbertia acicularis																															
Dilleniaceae	Hibbertia obtusifolia	Hoary Guinea Flower											0.1	5																		
Dilleniaceae	Hibbertia sp.																				0.1		0.5									
Dilleniaceae	Hibbertia spp.																															
Ericaceae	Acrothamnus hookeri																															
Ericaceae	Epacris sp.																						0.5									
Ericaceae	Leucopogon lanceolatus												0.1	2							0.1		0.5									
Ericaceae	Melichrus urceolatus	Urn Heath	0.1	2									0.3	5																		
Ericaceae	Monotoca scoparia																															
Escalloniaceae	Quintinia sieberi	Possumwood																														
Euphorbiaceae	Euphorbia spp.																															
Fabaceae	Acacia implexa	Hickory Wattle													0.1														0.1		0.2		
Fabaceae	Acacia melanoxylon	Blackwood	0.1	5					0.1	1			0.1	10					0.2		0.5		0.2									
Fabaceae	Acacia spp.	Wattle																														
Fabaceae	Daviesia genistifolia	Broom Bitter Pea																														
Fabaceae	Daviesia ulicifolia	Gorse Bitter Pea																														
Fabaceae	Desmodium brachypodum	Large Tick-trefoil											0.1	1																		
Fabaceae	Desmodium gunnii	Slender Tick-trefoil	0.1	50			0.2	1000					0.1	500									0.1							4		1
Fabaceae	Desmodium rhytidophyllum																															
Fabaceae	Desmodium spp.	Tick-trefoil																														

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Fabaceae	Desmodium varians	Slender Tick-trefoil			0.1	1	0.4	30	0.3	30	0.1	20	3	100	0.5	30			0.3	20	0.5	100					0.5	100						
Fabaceae	Glycine clandestina	Twining glycine											0.1	1											0.1	30	1	100						
Fabaceae	Glycine microphylla	Small-leaf Glycine					0.1	1	0.3	40	0.1	5	0.5	100	0.1	10	0.1	10	0.1	10														
Fabaceae	Glycine tabacina										0.2	50			3	100					1	200												
Fabaceae	Hardenbergia violacea										0.1	1							0.8	10														
Fabaceae	Indigofera australis	Australian Indigo																	0.7	20														
Fabaceae	Swainsona galegifolia										0.5	30	0.3	10							0.1	5												
Geraniaceae	Geranium homeanum																																	
Geraniaceae	Geranium potentilloides																						0.2	30	0.1	20	0.2	50	0.5	100	0.5	100	0.1	50
Geraniaceae	Geranium solanderi	Native Geranium																																
Geraniaceae	Geranium solanderi var. solanderi				0.4	30	0.1	6	0.4	30	0.5	50	0.5	20	0.2	20	5	200	0.5	60														
Geraniaceae	Geranium sp.																																	
Geraniaceae	Geranium spp.																				0.2	30												
Haloragaceae	Gonocarpus micranthus										0.1	20																						
Haloragaceae	Gonocarpus sp.																																	
Haloragaceae	Gonocarpus tetragynus	Poverty Raspwort																																
Haloragaceae	Gonocarpus teucrioides	Germander Raspwort																			0.5	50											0.1	40
Haloragaceae	Haloragis heterophylla	Variable Raspwort																																
Juncaceae	Juncus flavidus										1	40																						
Juncaceae	Juncus subsecundus																																	
Juncaceae	Luzula flaccida	Woodrush																																
Lamiaceae	Ajuga australis	Austral Bugle							0.7	30			0.5	20	1	30	0.1	4																
Lamiaceae	Mentha diemenica	Slender Mint			0.2	10	0.1	1									0.2	10																
Lamiaceae	Mentha satureioides																																	
Lamiaceae	Plectranthus parviflorus																																	
Lamiaceae	Scutellaria humilis	Dwarf Skullcap					0.1	10	0.1	2			1	200	0.1	30			0.5	60														
Lamiaceae	Scutellaria mollis	Soft Skullcap																																
Lamiaceae	Scutellaria sp.																																	
Lomandraceae	Lomandra bracteata	Mat-rush																	0.1	1														
Lomandraceae	Lomandra confertifolia	Matrush											0.1	3																				
Lomandraceae	Lomandra filiformis	Wattle Matt-rush																			0.2	20												
Lomandraceae	Lomandra filiformis subsp. filiformis												0.1	1																				
Lomandraceae	Lomandra filiformis subsp. Flavior								0.5	30	0.1	4	0.1	10			0.1	1																
Lomandraceae	Lomandra glauca	Pale Mat-rush													1	70																		
Lomandraceae	Lomandra longifolia										4	80			40	100			0.2	2	50	300												
Lomandraceae	Lomandra multiflora subsp. Multiflora	Many-flowered Mat-rush																	0.2	2														
Lomandraceae	Lomandra sp.																																	
Loranthaceae	Amyema sp.																																	
Luzuriagaceae	Eustrephus latifolius	Wombat Berry					0.3	7			0.1	2	0.3	5	2	20			1	20														
Luzuriagaceae	Geitonoplesium cymosum	Scrambling Lily																									0.1	3						
Myrsinaceae	Myrsine variabilis																																	
Myrtaceae	Angophora floribunda	Rough-barked Apple																	40	5														
Myrtaceae	Callistemon spp.																																	
Myrtaceae	Eucalyptus blakelyi						5	2																										

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Fabaceae	Desmodium varians	Slender Tick-trefoil													1	50							3		0.1							
Fabaceae	Glycine clandestina	Twining glycine					0.1	30	0.1	20			0.1	20			0.1	20	0.5		0.2										0.1	10
Fabaceae	Glycine microphylla	Small-leaf Glycine																	2		0.2		1						5		0.1	10
Fabaceae	Glycine tabacina				0.1	10					0.5	20			1	100	0.5	10														
Fabaceae	Hardenbergia violacea						0.1	1											0.5				2						1			
Fabaceae	Indigofera australis	Australian Indigo																	0.2													
Fabaceae	Swainsona galegifolia								0.1	1																					0.1	1
Geraniaceae	Geranium homeanum																										5	1000				
Geraniaceae	Geranium potentilloides		0.5	50	5	300	1	200	1	30			0.2	10	0.5	10	0.1	10							0.5							
Geraniaceae	Geranium solanderi	Native Geranium																	10		5		5						2		5		0.5	1000
Geraniaceae	Geranium solanderi var. solanderi																															
Geraniaceae	Geranium sp.																		2				0.5									
Geraniaceae	Geranium spp.																															
Haloragaceae	Gonocarpus micranthus																															
Haloragaceae	Gonocarpus sp.																		0.1						2				0.1			
Haloragaceae	Gonocarpus tetragynus	Poverty Raspwort																														
Haloragaceae	Gonocarpus teucrioides	Germander Raspwort							0.5	20																					0.1	10
Haloragaceae	Haloragis heterophylla	Variable Raspwort																														
Juncaceae	Juncus flavidus																															
Juncaceae	Juncus subsecundus																															
Juncaceae	Luzula flaccida	Woodrush																													0.1	1
Lamiaceae	Ajuga australis	Austral Bugle																	0.1		0.2		0.1						0.5			
Lamiaceae	Mentha diemenica	Slender Mint																														
Lamiaceae	Mentha satureioides																		0.1				0.1									
Lamiaceae	Plectranthus parviflorus																						0.1									
Lamiaceae	Scutellaria humilis	Dwarf Skullcap																														
Lamiaceae	Scutellaria mollis	Soft Skullcap																													0.1	1
Lamiaceae	Scutellaria sp.																		0.1										0.1			
Lomandraceae	Lomandra bracteata	Mat-rush																														
Lomandraceae	Lomandra confertifolia	Matrush																														
Lomandraceae	Lomandra filiformis	Wattle Matt-rush																	0.1										0.1			
Lomandraceae	Lomandra filiformis subsp. filiformis																														0.1	2
Lomandraceae	Lomandra filiformis subsp. Flavior																															
Lomandraceae	Lomandra glauca	Pale Mat-rush																														
Lomandraceae	Lomandra longifolia						0.1	5	0.5	1									3		3				0.1				0.1		0.5		0.1	1
Lomandraceae	Lomandra multiflora subsp. Multiflora	Many-flowered Mat-rush																	0.1		0.1		0.2						0.1		0.1			
Lomandraceae	Lomandra sp.																															
Loranthaceae	Amyema sp.																				0.5											
Luzuriagaceae	Eustrephus latifolius	Wombat Berry																	0.2				0.1								0.1	20
Luzuriagaceae	Geitonoplesium cymosum	Scrambling Lily									0.1	2					1	5			0.1								0.5			
Myrsinaceae	Myrsine variabilis																				0.1											
Myrtaceae	Angophora floribunda	Rough-barked Apple													20	2							5						50			
Myrtaceae	Callistemon spp.																														0.1	3
Myrtaceae	Eucalyptus blakelyi																															

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Fabaceae	Desmodium varians	Slender Tick-trefoil									0.1						3				1		5						0.5				1	
Fabaceae	Glycine clandestina	Twining glycine	0.2	200									0.1	100							0.1		0.2						0.5					
Fabaceae	Glycine microphylla	Small-leaf Glycine					0.1	10									1		1		1		0.5						1		2			
Fabaceae	Glycine tabacina																																	
Fabaceae	Hardenbergia violacea												0.5	100							0.2								3		1			
Fabaceae	Indigofera australis	Australian Indigo																			0.2								3		0.1			
Fabaceae	Swainsona galegifolia		0.3	20			0.1	1					0.2	200																				
Geraniaceae	Geranium homeanum						0.2	1000	0.3	1000			0.2	1000																				
Geraniaceae	Geranium potentilloides																																	
Geraniaceae	Geranium solanderi	Native Geranium	0.2	1000			0.1	500			0.1				2		3		2		0.1						5		5		3		5	
Geraniaceae	Geranium solanderi var. solanderi																																	
Geraniaceae	Geranium sp.																		0.1		0.1										0.1		1	
Geraniaceae	Geranium spp.																																	
Haloragaceae	Gonocarpus micranthus																																	
Haloragaceae	Gonocarpus sp.																		0.1								0.1				0.1			
Haloragaceae	Gonocarpus tetragynus	Poverty Raspwort							0.1	1																								
Haloragaceae	Gonocarpus teucrioides	Germander Raspwort																																
Haloragaceae	Haloragis heterophylla	Variable Raspwort			0.2	5000																												
Juncaceae	Juncus flavidus																																	
Juncaceae	Juncus subsecundus																						0.1		20		2							
Juncaceae	Luzula flaccida	Woodrush	0.1	1																														
Lamiaceae	Ajuga australis	Austral Bugle													0.1								0.1						0.1		0.1			
Lamiaceae	Mentha diemenica	Slender Mint									0.1								0.1															
Lamiaceae	Mentha satureioides																		0.5				0.2											
Lamiaceae	Plectranthus parviflorus																				0.1													
Lamiaceae	Scutellaria humilis	Dwarf Skullcap							0.1	3																								
Lamiaceae	Scutellaria mollis	Soft Skullcap																																
Lamiaceae	Scutellaria sp.																						0.1		0.1									
Lomandraceae	Lomandra bracteata	Mat-rush																																
Lomandraceae	Lomandra confertifolia	Matrush																																
Lomandraceae	Lomandra filiformis	Wattle Matt-rush																															0.1	
Lomandraceae	Lomandra filiformis subsp. filiformis																																	
Lomandraceae	Lomandra filiformis subsp. Flavior																																	
Lomandraceae	Lomandra glauca	Pale Mat-rush																																
Lomandraceae	Lomandra longifolia		0.5	20			85	2000													5								1					
Lomandraceae	Lomandra multiflora subsp. Multiflora	Many-flowered Mat-rush	2	100									1	200			0.1				3		0.1						0.5		0.1		0.1	
Lomandraceae	Lomandra sp.																		0.1															
Loranthaceae	Amyema sp.																												0.1					
Luzuriagaceae	Eustrephus latifolius	Wombat Berry	0.1	10			0.1	10					0.2	50			0.1		1		0.1		0.2						1		5		0.5	
Luzuriagaceae	Geitonoplesium cymosum	Scrambling Lily	0.1	10									0.1	20																				
Myrsinaceae	Myrsine variabilis																																	
Myrtaceae	Angophora floribunda	Rough-barked Apple	0.3	2									0.1	1									10						40					
Myrtaceae	Callistemon spp.						40	200																										
Myrtaceae	Eucalyptus blakelyi																																	

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16)		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Myrtaceae	Eucalyptus dalrympleana subsp. Heptantha		55	4																														
Myrtaceae	Eucalyptus dives	Broad-leaved Peppermint																																
Myrtaceae	Eucalyptus fastigata																																	
Myrtaceae	Eucalyptus laevopinea	Silver-top Stringybark					65	10	75	20			60	8	15	1	0.1	1																
Myrtaceae	Eucalyptus melliodora	Yellow Box																																
Myrtaceae	Eucalyptus nobilis	Forest Ribbon Gum																			30	6												
Myrtaceae	Eucalyptus nobilis subsp. Nobilis																																	
Myrtaceae	Eucalyptus nortonii	Large-flowered Bundy																																
Myrtaceae	Eucalyptus obliqua	Messmate																																
Myrtaceae	Eucalyptus pauciflora										5	10									10	1			15	7	15	5						
Myrtaceae	Eucalyptus stellulata	Black Sally																																
Myrtaceae	Eucalyptus viminalis	Ribbon Gum																	7	1					5	2	5	1						
Myrtaceae	Leptospermum polygalifolium	Tantoon																																
Oleaceae	Notelaea longifolia																																	
Oleaceae	Notelaea microcarpa	Native Olive																																
Onagraceae	Epilobium billardierianum																																	
Onagraceae	Epilobium billardierianum subsp. Cinereum				0.7	10																												
Orchidaceae	Acianthus sp.																																	
Orchidaceae	Pterostylis sp.																																	
Orchidaceae	Pterostylis sp. 2																																	
Orchidaceae	Pterostylis spp.	Greenhood																																
Oxalidaceae	Oxalis chnoodes																																	
Oxalidaceae	Oxalis perrenans						0.1	1	0.1	6					0.1	3	0.1	20	0.1	6	1	100					1	100					5	200
Phormiaceae	Dianella caerulea	Blue Flax-lily																							0.1	10								
Phormiaceae	Dianella longifolia	Blueberry Lily											0.2	5																				
Phormiaceae	Dianella revoluta	Blueberry Lily											0.1	2	0.5	30																		
Phormiaceae	Dianella sp.																																	
Phyllanthaceae	Phyllanthus virgatus	Wiry Spurge															0.1	10																
Phyllanthaceae	Poranthera microphylla	Small Poranthera																																
Pittosporaceae	Billardiera mutabilis	Climbing Apple Berry																									0.5	50					0.1	20
Pittosporaceae	Bursaria spinosa	Native Blackthorn																																
Pittosporaceae	Bursaria spinosa subsp. Spinosa	Native Blackthorn							2	10			10	30	3	10	0.4	3	1	10														
Pittosporaceae	Pittosporum revolutum																																	
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum													0.6	3																		
Plantaginaceae	Plantago debilis	Shade Plantain					0.1	1	0.1	3																								
Plantaginaceae	Plantago spp.	Plantain																					0.5	40										
Plantaginaceae	Veronica calycina								0.2	10	0.1	4																						
Plantaginaceae	Veronica plebeia	Trailing Speedwell			0.2	5	0.3	10																							0.1	5		
Plantaginaceae	Veronica sp.																																	

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Myrtaceae	Eucalyptus dalrympleana subsp. Heptantha																															
Myrtaceae	Eucalyptus dives	Broad-leaved Peppermint																														
Myrtaceae	Eucalyptus fastigata																												10			
Myrtaceae	Eucalyptus laevopinea	Silver-top Stringybark															20	1	50		10		10						10			
Myrtaceae	Eucalyptus melliodora	Yellow Box															10	4														
Myrtaceae	Eucalyptus nobilis	Forest Ribbon Gum	10	2																												
Myrtaceae	Eucalyptus nobilis subsp. Nobilis																															
Myrtaceae	Eucalyptus nortonii	Large-flowered Bundy											5	1	15	3																
Myrtaceae	Eucalyptus obliqua	Messmate			40	6																										
Myrtaceae	Eucalyptus pauciflora		15	5					15	0															2							
Myrtaceae	Eucalyptus stellulata	Black Sally					30	8																								
Myrtaceae	Eucalyptus viminalis	Ribbon Gum									20	4							5		10				15		35	4			10		20	9
Myrtaceae	Leptospermum polygalifolium	Tantoon																														
Oleaceae	Notelaea longifolia																															
Oleaceae	Notelaea microcarpa	Native Olive																														
Onagraceae	Epilobium billardierianum																				0.1										0.1	5
Onagraceae	Epilobium billardierianum subsp. Cinereum																															
Orchidaceae	Acianthus sp.																															
Orchidaceae	Pterostylis sp.																															
Orchidaceae	Pterostylis sp. 2																															
Orchidaceae	Pterostylis spp.	Greenhood																														
Oxalidaceae	Oxalis chnoodes																															
Oxalidaceae	Oxalis perrenans						1	100			0.5	30	0.1	20	1	50	5	200			0.1										0.1	1
Phormiaceae	Dianella caerulea	Blue Flax-lily	0.1	1																												
Phormiaceae	Dianella longifolia	Blueberry Lily																													0.1	1
Phormiaceae	Dianella revoluta	Blueberry Lily																														
Phormiaceae	Dianella sp.																															
Phyllanthaceae	Phyllanthus virgatus	Wiry Spurge											1	30																		
Phyllanthaceae	Poranthera microphylla	Small Poranthera																													0.5		0.1	10
Pittosporaceae	Billardiera mutabilis	Climbing Apple Berry																														
Pittosporaceae	Bursaria spinosa	Native Blackthorn					0.5	2	0.1	1									2		0.3		2					0.1				
Pittosporaceae	Bursaria spinosa subsp. Spinosa	Native Blackthorn																													0.2	10
Pittosporaceae	Pittosporum revolutum																															
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum																														
Plantaginaceae	Plantago debilis	Shade Plantain																			0.2		0.1		0.5						0.1	1
Plantaginaceae	Plantago spp.	Plantain							0.1	5																						
Plantaginaceae	Veronica calycina																				0.2							0.1			0.1	1
Plantaginaceae	Veronica plebeia	Trailing Speedwell									0.1	20															0.1	2				
Plantaginaceae	Veronica sp.																		0.1										0.1			

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Myrtaceae	Eucalyptus dalrympleana subsp. Heptantha																															
Myrtaceae	Eucalyptus dives	Broad-leaved Peppermint							0.1	1																						
Myrtaceae	Eucalyptus fastigata																						1									
Myrtaceae	Eucalyptus laevopinea	Silver-top Stringybark	10	7									10	10							3		5							5		25
Myrtaceae	Eucalyptus melliodora	Yellow Box	10	8									2	1																		
Myrtaceae	Eucalyptus nobilis	Forest Ribbon Gum											0.2	1							15									5		25
Myrtaceae	Eucalyptus nobilis subsp. Nobilis		2	2			10	5																								
Myrtaceae	Eucalyptus nortonii	Large-flowered Bundy											0.2	1																		
Myrtaceae	Eucalyptus obliqua	Messmate					5	1																						20		
Myrtaceae	Eucalyptus pauciflora																		50													
Myrtaceae	Eucalyptus stellulata	Black Sally					2	1																								
Myrtaceae	Eucalyptus viminalis	Ribbon Gum					15	7	0.1	1					40		50		1											10		
Myrtaceae	Leptospermum polygalifolium	Tantoon					10	20																								
Oleaceae	Notelaea longifolia																												0.2			
Oleaceae	Notelaea microcarpa	Native Olive	0.1	1																												
Onagraceae	Epilobium billardierianum																															
Onagraceae	Epilobium billardierianum subsp. Cinereum																															
Orchidaceae	Acianthus sp.																		0.1													
Orchidaceae	Pterostylis sp.																		0.1		0.1								0.1			
Orchidaceae	Pterostylis sp. 2																				0.1								0.1			
Orchidaceae	Pterostylis spp.	Greenhood	0.1	10			0.1	30					0.1	2																		
Oxalidaceae	Oxalis chnoodes																										0.1			0.1		
Oxalidaceae	Oxalis perrenans										0.1								1													0.1
Phormiaceae	Dianella caerulea	Blue Flax-lily																														
Phormiaceae	Dianella longifolia	Blueberry Lily	2	50									0.1	10																		
Phormiaceae	Dianella revoluta	Blueberry Lily																														
Phormiaceae	Dianella sp.																				0.1		0.1						0.1	0.1		
Phyllanthaceae	Phyllanthus virgatus	Wiry Spurge																														
Phyllanthaceae	Poranthera microphylla	Small Poranthera	0.1	10																	0.2									0.1		0.1
Pittosporaceae	Billardiera mutabilis	Climbing Apple Berry																														
Pittosporaceae	Bursaria spinosa	Native Blackthorn									0.1						0.1				0.3		5						0.3	2		
Pittosporaceae	Bursaria spinosa subsp. Spinosa	Native Blackthorn	0.1	10			0.2	10					0.1	30																		
Pittosporaceae	Pittosporum revolutum																													5		
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum																														
Plantaginaceae	Plantago debilis	Shade Plantain															3				0.1		2							0.1		
Plantaginaceae	Plantago spp.	Plantain																														
Plantaginaceae	Veronica calycina		0.1	1													0.5															
Plantaginaceae	Veronica plebeia	Trailing Speedwell																														
Plantaginaceae	Veronica sp.																		0.1										0.5			

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16)		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Poaceae	Anthosachne scabra	Wheatgrass, Common Wheatgrass											0.1	1																			
Poaceae	Aristida lignosa														5	100																	
Poaceae	Aristida ramosa	Purple Wiregrass							0.1	2			0.1	10	4	200																	
Poaceae	Aristida sp.																																
Poaceae	Aristida vagans	Threeawn Speargrass											0.1	1																			
Poaceae	Austrostipa scabra	Speargrass																															
Poaceae	Austrostipa verticillata	Slender Bamboo Grass																															
Poaceae	Bothriochloa decipiens var. decipiens	Pitted Bluegrass							0.1	3			20	500	15	300	75	700	1	50													
Poaceae	Bothriochloa macra	Red Grass																															
Poaceae	Chloris truncata	Windmill Grass																															
Poaceae	Cymbopogon refractus	Barbed Wire Grass											0.5	30	4	100																	
Poaceae	Dichelachne crinita	Longhair Plumegrass																	0.3	50													
Poaceae	Dichelachne micrantha	Shorthair Plumegrass											0.1	1																			
Poaceae	Echinopogon cheelii	Long-flowered Hedgehog Grass																															
Poaceae	Echinopogon mckiei						0.1	2	5	200	0.2	20	0.3	30	0.1	1			3	300													
Poaceae	Echinopogon ovatus	Forest Hedgehog Grass																									2	50	2	100			
Poaceae	Enneapogon nigricans	Niggerheads																	0.2	10													
Poaceae	Entolasia marginata										1	70																					
Poaceae	Eragrostis leptostachya	Paddock Lovegrass															0.5	50															
Poaceae	Eragrostis sp.																																
Poaceae	Eriochloa pseudoacrotricha	Early Spring Grass																															10	200
Poaceae	Imperata cylindrica	Blady Grass																	6	200													
Poaceae	Lachnagrostis aemula																																
Poaceae	Lachnagrostis filiformis																																
Poaceae	Microlaena stipoides	Weeping Grass	5	100	10	200	2	80	0.3	20	1	50	5	300	2	100	25	1000	5	400	5	300	20	1000	0.5	30	1	100	50	2000	5	500	10	500
Poaceae	Microlaena stipoides var. stipoides																																
Poaceae	Panicum effusum																																
Poaceae	Panicum simile																																
Poaceae	Paspalum distichum	Water Couch																															
Poaceae	Pennisetum alopecuroides																																
Poaceae	Poa labillardierei var. labillardierei	Tussock	1	30	4	40	0.5	20	2	50	0.3	30	0.5	30	1	30	4	50	10	400													
Poaceae	Poa sieberiana	Snowgrass											5	100	0.5	20																	
Poaceae	Poa sieberiana var. sieberiana	Snowgrass																			30	100			80	500					1	20	1	20
Poaceae	Rytidosperma carphoides	Short Wallaby Grass																			0.1	50											
Poaceae	Rytidosperma laeve	Wallaby Grass					0.1	10					0.1	10			3	200															
Poaceae	Rytidosperma penicillatum	Slender Wallaby Grass							0.3	20			1	100	0.2	20	0.5	50	0.3	40													

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Poaceae	Anthosachne scabra	Wheatgrass, Common Wheatgrass																													0.2	20
Poaceae	Aristida lignosa																															
Poaceae	Aristida ramosa	Purple Wiregrass																														
Poaceae	Aristida sp.																				0.2		2					2				
Poaceae	Aristida vagans	Threeawn Speargrass																														
Poaceae	Austrostipa scabra	Speargrass							0.2	10																						
Poaceae	Austrostipa verticillata	Slender Bamboo Grass											2	50			5	100														
Poaceae	Bothriochloa decipiens var. decipiens	Pitted Bluegrass																														
Poaceae	Bothriochloa macra	Red Grass											10	300	5	500	5	200					25									
Poaceae	Chloris truncata	Windmill Grass											3	50			2	50														
Poaceae	Cymbopogon refractus	Barbed Wire Grass																					5									
Poaceae	Dichelachne crinita	Longhair Plumegrass																													0.2	30
Poaceae	Dichelachne micrantha	Shorthair Plumegrass																			15											
Poaceae	Echinopogon cheelii	Long-flowered Hedgehog Grass																														
Poaceae	Echinopogon mckiei																															
Poaceae	Echinopogon ovatus	Forest Hedgehog Grass							1	10									10				5		5.2				2		5	2000
Poaceae	Enneapogon nigricans	Niggerheads																														
Poaceae	Entolasia marginata																															
Poaceae	Eragrostis leptostachya	Paddock Lovegrass																														
Poaceae	Eragrostis sp.																															
Poaceae	Eriochloa pseudoacrotricha	Early Spring Grass																														
Poaceae	Imperata cylindrica	Blady Grass																					0.1									
Poaceae	Lachnagrostis aemula																															
Poaceae	Lachnagrostis filiformis																														0.1	10
Poaceae	Microlaena stipoides	Weeping Grass	1	50	0.1	10	1	100	1	30	70	2000	2	100	3	500	40	1000									0.1	10			0.5	200
Poaceae	Microlaena stipoides var. stipoides																		5		0.5				1			15				
Poaceae	Panicum effusum																		1										1			
Poaceae	Panicum simile																															
Poaceae	Paspalum distichum	Water Couch																													0.1	100
Poaceae	Pennisetum alopecuroides																															
Poaceae	Poa labillardierei var. labillardierei	Tussock																	30		30		20		70			1		10		
Poaceae	Poa sieberiana	Snowgrass																	20		1						30	2000		10	20	500
Poaceae	Poa sieberiana var. sieberiana	Snowgrass	30	100	3	50	10	100	75	700	3	20	15	100	1	10	2	30														
Poaceae	Rytidosperma carphoides	Short Wallaby Grass																														
Poaceae	Rytidosperma laeve	Wallaby Grass													2	100																
Poaceae	Rytidosperma penicillatum	Slender Wallaby Grass																														

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Poaceae	Anthosachne scabra	Wheatgrass, Common Wheatgrass	3	300									0.2	20																		
Poaceae	Aristida lignosa																															
Poaceae	Aristida ramosa	Purple Wiregrass																														
Poaceae	Aristida sp.																						5									
Poaceae	Aristida vagans	Threeawn Speargrass																														
Poaceae	Austrostipa scabra	Speargrass																														
Poaceae	Austrostipa verticillata	Slender Bamboo Grass																														
Poaceae	Bothriochloa decipiens var. decipiens	Pitted Bluegrass																														
Poaceae	Bothriochloa macra	Red Grass									25										2		20				50		3			5
Poaceae	Chloris truncata	Windmill Grass																														
Poaceae	Cymbopogon refractus	Barbed Wire Grass											0.5	30									0.5						0.1			
Poaceae	Dichelachne crinita	Longhair Plumegrass	0.1	10									0.1	2																		
Poaceae	Dichelachne micrantha	Shorthair Plumegrass									5										5		1									
Poaceae	Echinopogon cheelii	Long-flowered Hedgehog Grass	0.1	10	0.1	10																										
Poaceae	Echinopogon mckiei																															
Poaceae	Echinopogon ovatus	Forest Hedgehog Grass	1	1000	0.5	1000							0.5	100			1		10		5		10						5		20		5
Poaceae	Enneapogon nigricans	Niggerheads																														
Poaceae	Entolasia marginata																															
Poaceae	Eragrostis leptostachya	Paddock Lovegrass																									5					
Poaceae	Eragrostis sp.										0.5																					
Poaceae	Eriochloa pseudoacrotricha	Early Spring Grass																														
Poaceae	Imperata cylindrica	Blady Grass																														
Poaceae	Lachnagrostis aemula																										1					
Poaceae	Lachnagrostis filiformis				0.5	1000											0.2								1							
Poaceae	Microlaena stipoides	Weeping Grass	0.2	100	10	1000	0.3	30	60	1000			0.5	50																		
Poaceae	Microlaena stipoides var. stipoides																5		10		0.2		10						10		5	
Poaceae	Panicum effusum										5												1									
Poaceae	Panicum simile										10						0.5										0.2					
Poaceae	Paspalum distichum	Water Couch																														
Poaceae	Pennisetum alopecuroides																								5		0.5					
Poaceae	Poa labillardierei var. labillardierei	Tussock									20						20		20		25		15		5		25		3		20		40
Poaceae	Poa sieberiana	Snowgrass	60	2000			0.2	30					15	1000	1		10		25								1				5		
Poaceae	Poa sieberiana var. sieberiana	Snowgrass																														
Poaceae	Rytidosperma carphoides	Short Wallaby Grass																														
Poaceae	Rytidosperma laeve	Wallaby Grass																														
Poaceae	Rytidosperma penicillatum	Slender Wallaby Grass																														

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Poaceae	Rytidosperma pilosum	Smooth-flowered Wallaby Grass																														
Poaceae	Rytidosperma racemosum	Wallaby Grass																														
Poaceae	Rytidosperma racemosum var. racemosum	Wallaby Grass													0.1	5	1	70	0.8	100												
Poaceae	Rytidosperma sp.																															
Poaceae	Rytidosperma spp.																															
Poaceae	Sorghum leiocladum	Wild Sorghum											0.1	2	0.5	50																
Poaceae	Sporobolus creber																															
Poaceae	Themeda triandra																															
Polygalaceae	Polygala japonica	Dwarf Milkwort											0.1	10																		
Polygonaceae	Persicaria decipiens	Slender Knotweed																														
Polygonaceae	Persicaria hydropiper	Water Pepper																														
Polygonaceae	Rumex brownii	Swamp Dock	1	10	0.1	1	0.2	3	0.2	5	0.1	1					0.3	5	0.1	1									1	50		
Portulacaceae	Portulaca oleracea	Pigweed															0.1	1	0.1	1												
Proteaceae	Lomatia arborescens	Tree Lomatia																					10	10							5	2
Pteridaceae	Cheilanthes sieberi																															
Pteridaceae	Cheilanthes sieberi subsp. Sieberi	Rock Fern							0.1	1			0.2	6	0.1	10																
Ranunculaceae	Clematis aristata	Old Man's Beard																	0.1	2												
Ranunculaceae	Clematis glycinoides	Headache Vine													0.2	7																
Ranunculaceae	Ranunculus lappaceus																															
Ranunculaceae	Ranunculus sessiliflorus	Small-flowered Buttercup											0.1	1																		
Rosaceae	Acaena novae-zelandiae	Bidgee-widgee			25	200			0.1	1							0.1	10									0.2	40			0.1	30
Rosaceae	Acaena ovina	Acaena															0.2	10	0.1	6												
Rosaceae	Rubus parvifolius	Native Raspberry							0.3	20	0.1	2	0.2	10	0.8	10	0.3	4	0.8	20	0.5	10			0.1	5	0.1	30				
Rubiaceae	Asperula conferta	Common Woodruff					0.1	20	0.2	30			1	200	0.2	30	5	1000	0.1	1	0.1	100			0.1	50	0.5	200				
Rubiaceae	Asperula scoparia								0.1	1																						
Rubiaceae	Coprosma quadrifida	Prickly Currant Bush																			5	10			2	10	0.2	1				
Rubiaceae	Galium binifolium																															
Rubiaceae	Galium binifolium subsp. Binifolium																															
Rubiaceae	Galium ciliare										0.2	60							0.1	10												
Rubiaceae	Galium gaudichaudii	Rough Bedstraw																			0.1	50			0.1	50	0.1	20			0.3	50
Rubiaceae	Galium gaudichaudii subsp. gaudichaudii																															
Rubiaceae	Galium leiocarpum												0.1	10	0.2	10													0.1	50		
Rubiaceae	Galium leptogonium						0.3	80	0.1	10	0.1	3			0.2	20			0.2	10												
Rubiaceae	Galium sp. 2																															
Rubiaceae	Morinda jasminoides																															
Santalaceae	Exocarpos cupressiformis	Cherry Ballart																	2	1												
Sapindaceae	Dodonaea viscosa subsp. Spatulata	Broad-leaf Hopbush																														
Smilacaceae	Smilax australis	Lawyer Vine																			1	20	5	30			0.2	30			3	10
Solanaceae	Solanum aviculare	Kangaroo Apple					0.5	6											0.2	2												

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Poaceae	Rytidosperma pilosum	Smooth-flowered Wallaby Grass															1	50														
Poaceae	Rytidosperma racemosum	Wallaby Grass																													0.1	10
Poaceae	Rytidosperma racemosum var. racemosum	Wallaby Grass																			0.1				0.1							
Poaceae	Rytidosperma sp.																		0.5				0.5									
Poaceae	Rytidosperma spp.																															
Poaceae	Sorghum leiocladum	Wild Sorghum																														
Poaceae	Sporobolus creber																															
Poaceae	Themeda triandra																						20									
Polygalaceae	Polygala japonica	Dwarf Milkwort																														
Polygonaceae	Persicaria decipiens	Slender Knotweed																														
Polygonaceae	Persicaria hydropiper	Water Pepper																													0.2	30
Polygonaceae	Rumex brownii	Swamp Dock											0.5	5	1	20	1	20														
Portulacaceae	Portulaca oleracea	Pigweed																														
Proteaceae	Lomatia arborescens	Tree Lomatia							2	10																						
Pteridaceae	Cheilanthes sieberi																						0.2									
Pteridaceae	Cheilanthes sieberi subsp. Sieberi	Rock Fern																														
Ranunculaceae	Clematis aristata	Old Man's Beard																			0.1		0.5						1			
Ranunculaceae	Clematis glycinoides	Headache Vine																														
Ranunculaceae	Ranunculus lappaceus																															
Ranunculaceae	Ranunculus sessiliflorus	Small-flowered Buttercup																														
Rosaceae	Acaena novae-zelandiae	Bidgee-widgee	0.1	10			0.5	20	0.5	10	0.5	20	0.5	10	0.1	5					0.5				1						0.2	0.2	50
Rosaceae	Acaena ovina	Acaena																														
Rosaceae	Rubus parvifolius	Native Raspberry									0.5	5			0.2	5			2		0.2		0.5		0.5				1		0.1	5
Rubiaceae	Asperula conferta	Common Woodruff					0.5	100	0.5	40			0.1	10					0.1		0.1		0.1		0.1		0.1	10	1		0.1	
Rubiaceae	Asperula scoparia																															
Rubiaceae	Coprosma quadrifida	Prickly Currant Bush																			0.5										0.1	1
Rubiaceae	Galium binifolium																										0.1	2				
Rubiaceae	Galium binifolium subsp. Binifolium																														0.1	2
Rubiaceae	Galium ciliare																															
Rubiaceae	Galium gaudichaudii	Rough Bedstraw									1	30																				
Rubiaceae	Galium gaudichaudii subsp. gaudichaudii																														0.1	20
Rubiaceae	Galium leiocarpum						2	100																								
Rubiaceae	Galium leptogonium																														0.1	10
Rubiaceae	Galium sp. 2																												0.1		0.1	
Rubiaceae	Morinda jasminoides																						0.1						0.1			
Santalaceae	Exocarpos cupressiformis	Cherry Ballart																	0.1				0.1									
Sapindaceae	Dodonaea viscosa subsp. Spatulata	Broad-leaf Hopbush													10	20																
Smilacaceae	Smilax australis	Lawyer Vine	0.5	10	0.5	4	0.1	5											0.1								0.1	1			0.1	5
Solanaceae	Solanum aviculare	Kangaroo Apple			0.5	5																							0.1		0.2	

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Poaceae	Rytidosperma pilosum	Smooth-flowered Wallaby Grass																														
Poaceae	Rytidosperma racemosum	Wallaby Grass	5	500									5	500																		
Poaceae	Rytidosperma racemosum var. racemosum	Wallaby Grass									0.2										0.1											
Poaceae	Rytidosperma sp.										10						0.5				5								1		2	
Poaceae	Rytidosperma spp.				0.1	20																										
Poaceae	Sorghum leiocladum	Wild Sorghum																														
Poaceae	Sporobolus creber										1																					
Poaceae	Themeda triandra		0.2	100									0.5	30							15		35						10			
Polygalaceae	Polygala japonica	Dwarf Milkwort																														
Polygonaceae	Persicaria decipiens	Slender Knotweed			0.1	30																			3							
Polygonaceae	Persicaria hydropiper	Water Pepper																							2		0.2					
Polygonaceae	Rumex brownii	Swamp Dock			0.1	10	0.1	1							3				0.1						2		0.5					
Portulacaceae	Portulaca oleracea	Pigweed																														
Proteaceae	Lomatia arborescens	Tree Lomatia																														
Pteridaceae	Cheilanthes sieberi		0.1	10																			0.1									
Pteridaceae	Cheilanthes sieberi subsp. Sieberi	Rock Fern																														
Ranunculaceae	Clematis aristata	Old Man's Beard											0.1	2			0.1				0.1		0.5						1		0.5	
Ranunculaceae	Clematis glycinoides	Headache Vine	0.1	20									0.1	30																		
Ranunculaceae	Ranunculus lappaceus																								0.1							
Ranunculaceae	Ranunculus sessiliflorus	Small-flowered Buttercup																														
Rosaceae	Acaena novae-zelandiae	Bidgee-widgee													0.5		0.5		1		0.1										0.5	
Rosaceae	Acaena ovina	Acaena																														
Rosaceae	Rubus parvifolius	Native Raspberry					0.1	10									0.2		0.5				0.2						0.5		0.1	
Rubiaceae	Asperula conferta	Common Woodruff							0.2	500	0.1						0.1				0.2		0.1								0.1	1
Rubiaceae	Asperula scoparia																															
Rubiaceae	Coprosma quadrifida	Prickly Currant Bush					20	500																								
Rubiaceae	Galium binifolium		0.2	200																												
Rubiaceae	Galium binifolium subsp. Binifolium						0.1	30					0.1	50																		
Rubiaceae	Galium ciliare		0.1	2																												
Rubiaceae	Galium gaudichaudii	Rough Bedstraw							0.1	10																						
Rubiaceae	Galium gaudichaudii subsp. gaudichaudii																															
Rubiaceae	Galium leiocarpum																															
Rubiaceae	Galium leptogonium						0.1	20																								
Rubiaceae	Galium sp. 2																														0.1	
Rubiaceae	Morinda jasminoides																												0.1		0.1	
Santalaceae	Exocarpos cupressiformis	Cherry Ballart	1	1									0.1	1							0.1		0.1						0.5			0.1
Sapindaceae	Dodonaea viscosa subsp. Spatulata	Broad-leaf Hopbush																														
Smilacaceae	Smilax australis	Lawyer Vine					0.2	20							0.1		0.5		0.5				0.1								0.1	
Solanaceae	Solanum aviculare	Kangaroo Apple																	0.1												1	

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Solanaceae	Solanum linearifolium	Mountain Kangaroo Apple																																
Solanaceae	Solanum papaverifolium																																	
Solanaceae	Solanum prinophyllum	Forest Nightshade																					1	10	0.1	5			0.1	20	2	30		
Solanaceae	Solanum pungetium	Eastern Nightshade																																
Solanaceae	Solanum sp.	A Nightshade																																
Sterculiaceae	Brachychiton populneus subsp. Populneus																																	
Thymelaeaceae	Pimelea curviflora var. divergens												0.2	20			0.9	70	0.1	1														
Thymelaeaceae	Pimelea curviflora var. gracilis												0.7	60			0.2	40																
Thymelaeaceae	Pimelea linifolia																																	
Urticaceae	Urtica incisa	Stinging Nettle	0.5	10			0.5	40			0.2	10									0.1	3	20	300	0.5	10	1	20	10	200	70	500	2	50
Violaceae	Hybanthus monopetalus	Slender Violet-bush																																
Violaceae	Melicytus dentatus	Tree Violet					20	40			0.1	1							0.7	1	1	5	60	50	3	7	10	10			1	3		
Violaceae	Viola betonicifolia								0.1	3	0.1	4	0.5	50	0.1	10			0.1	3	1	50			1	100	0.5	30						
Violaceae	Viola hederacea	Ivy-leaved Violet																																
Violaceae	Viola sp.																																	
Zamiaceae	Macrozamia concinna																																	
	Rainforest species																																	
	Rainforest sp.																																	
Introduced Species																																		
Amaranthaceae	Amaranthus viridis	Green Amaranth	0.1	1																														
Amygdalaceae	Prunus avium																		0.1	1														
Apiaceae	Cyclospermum leptophyllum	Slender Celery					0.1	5									0.1	10	0.2	20														
Apocynaceae	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																																
Asteraceae	Ambrosia artemisifolia	Annual Ragweed																																
Asteraceae	Bidens pilosa	Cobbler's Pegs							1	50			0.1	10	20	200			0.1	10														
Asteraceae	Bidens sp.																																	
Asteraceae	Bidens subalternans	Greater Beggar's Ticks					1	50	0.1	1																								
Asteraceae	Bidens tripartita						3	100																										
Asteraceae	Carthamus lanatus	Saffron Thistle					0.1	2									0.1	3																
Asteraceae	Centaurea spp.	Thistle																					0.1	5										
Asteraceae	Cirsium spp.																								0.1	20								
Asteraceae	Cirsium vulgare	Spear Thistle	2	40	2	40	0.3	10	0.2	30	5	50			0.1	10	2	50	0.2	30							0.1	5	1	100	0.1	10	1	20
Asteraceae	Conyza bonariensis	Flaxleaf Fleabane			2	30											1	100	0.1	10														
Asteraceae	Conyza parva	Fleabane															0.1	10																
Asteraceae	Conyza sp.																																	
Asteraceae	Gamochaeta purpurea	Purple Cudweed															0.1	6																
Asteraceae	Hypochaeris radicata	Catsear	0.2	10	2	40			0.1	1	0.1	1	0.1	4	0.1	2	1	80	0.2	20	0.5	20	0.1	10	0.2	10	0.1	10					1	20
Asteraceae	Senecio madagascariensis	Fireweed			0.1	1																												
Asteraceae	Sonchus asper										0.1	10																						
Asteraceae	Sonchus oleraceus	Common Sowthistle					0.1	2					0.1	1					0.3	40														
Asteraceae	Sonchus sp.																																	

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Solanaceae	Solanum linearifolium	Mountain Kangaroo Apple																														
Solanaceae	Solanum papaverifolium														0.5	10	0.5	5														
Solanaceae	Solanum prinophyllum	Forest Nightshade			0.5	10	0.5	10																								
Solanaceae	Solanum pungetium	Eastern Nightshade																														
Solanaceae	Solanum sp.	A Nightshade																	0.5		0.1				0.1				2		0.2	
Sterculiaceae	Brachychiton populneus subsp. Populneus																															
Thymelaeaceae	Pimelea curviflora var. divergens																															
Thymelaeaceae	Pimelea curviflora var. gracilis																															
Thymelaeaceae	Pimelea linifolia																						0.1								0.1	
Urticaceae	Urtica incisa	Stinging Nettle	10	50	0.5	10					5	20	1	6	1	10	30	100			0.1				0.1				0.1		0.2	
Violaceae	Hybanthus monopetalus	Slender Violet-bush																									0.1	1				
Violaceae	Melicytus dentatus	Tree Violet	8	7	3	20					0.5	10	3	2	10	50	50	40			0.3								1		0.1	5
Violaceae	Viola betonicifolia						0.5	20	0.5	30	1	30							0.5		0.1		0.1								0.1	2
Violaceae	Viola hederacea	Ivy-leaved Violet	0.5	20			0.1	20	0.1	20																						
Violaceae	Viola sp.																															
Zamiaceae	Macrozamia concinna																															
	Rainforest species																															
	Rainforest sp.																															
Introduced Species																																
Amaranthaceae	Amaranthus viridis	Green Amaranth																														
Amygdalaceae	Prunus avium																															
Apiaceae	Cyclospermum leptophyllum	Slender Celery																													0.1	2
Apocynaceae	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																														
Asteraceae	Ambrosia artemisifolia	Annual Ragweed																														
Asteraceae	Bidens pilosa	Cobbler's Pegs			0.2	20	0.1	20	0.1	5							0.1	5														
Asteraceae	Bidens sp.																						0.2						5		0.5	
Asteraceae	Bidens subalternans	Greater Beggar's Ticks																														
Asteraceae	Bidens tripartita																															
Asteraceae	Carthamus lanatus	Saffron Thistle																														
Asteraceae	Centaurea spp.	Thistle																														
Asteraceae	Cirsium spp.																															
Asteraceae	Cirsium vulgare	Spear Thistle	1	10	1	30	1	50	0.1	10	1	30			1	10	1	10	0.5		0.1		0.1				0.1	5	0.5		0.5		0.1	10
Asteraceae	Conyza bonariensis	Flaxleaf Fleabane					0.5	10																			0.1	1					0.1	1
Asteraceae	Conyza parva	Fleabane																														
Asteraceae	Conyza sp.																		1		0.2				0.2				1		1	
Asteraceae	Gamochaeta purpurea	Purple Cudweed																														
Asteraceae	Hypochaeris radicata	Catsear							1	10					1	30			0.5		0.2		0.1		0.2		0.1	1	0.5		0.1		0.1	10
Asteraceae	Senecio madagascariensis	Fireweed																														
Asteraceae	Sonchus asper																															
Asteraceae	Sonchus oleraceus	Common Sowthistle																														
Asteraceae	Sonchus sp.																															

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Solanaceae	Solanum linearifolium	Mountain Kangaroo Apple	0.1	1																													
Solanaceae	Solanum papaverifolium																																
Solanaceae	Solanum prinophyllum	Forest Nightshade					0.1	1									0.1																
Solanaceae	Solanum pungetium	Eastern Nightshade	0.1	10									0.1	2																			
Solanaceae	Solanum sp.	A Nightshade									0.1						0.1		0.2		0.1				0.1				0.1		0.1		0.1	
Sterculiaceae	Brachychiton populneus subsp. Populneus																																0.1	
Thymelaeaceae	Pimelea curviflora var. divergens																																	
Thymelaeaceae	Pimelea curviflora var. gracilis																																	
Thymelaeaceae	Pimelea linifolia																																	
Urticaceae	Urtica incisa	Stinging Nettle					0.5	200					0.1	2	0.1				0.1						0.1								0.1	
Violaceae	Hybanthus monopetalus	Slender Violet-bush																	0.1														
Violaceae	Melicytus dentatus	Tree Violet					10	30									0.2		4								0.2		5		0.1		
Violaceae	Viola betonicifolia														0.1		1		0.2										0.2		0.1		
Violaceae	Viola hederacea	Ivy-leaved Violet																	2														
Violaceae	Viola sp.																		0.1														
Zamiaceae	Macrozamia concinna		0.1	2																													
	Rainforest species						0.3	1																									
	Rainforest sp.						0.1	1																									
Introduced Species																																	
Amaranthaceae	Amaranthus viridis	Green Amaranth																															
Amygdalaceae	Prunus avium																																
Apiaceae	Cyclospermum leptophyllum	Slender Celery																															
Apocynaceae	Gomphocarpus fruticosus	Narrow-leaved Cotton Bush											0.1	1																			
Asteraceae	Ambrosia artemisifolia	Annual Ragweed																					0.1										
Asteraceae	Bidens pilosa	Cobbler's Pegs	0.1	2									0.1	5																			
Asteraceae	Bidens sp.										0.1										0.1		0.2				0.2						
Asteraceae	Bidens subalternans	Greater Beggar's Ticks	0.1	2									0.1	1																			
Asteraceae	Bidens tripartita																																
Asteraceae	Carthamus lanatus	Saffron Thistle															0.1				0.1												
Asteraceae	Centaurea spp.	Thistle																															
Asteraceae	Cirsium spp.																																
Asteraceae	Cirsium vulgare	Spear Thistle			0.1	1	0.1	20	0.1	10			0.1	10	0.5		0.3		0.1		0.1				0.2				0.1				
Asteraceae	Conyza bonariensis	Flaxleaf Fleabane	0.1	20	0.1	2	0.1	1					0.1	10																			
Asteraceae	Conyza parva	Fleabane																															
Asteraceae	Conyza sp.										0.1										0.1		0.1		0.2		0.1		0.2		0.1		0.5
Asteraceae	Gamochaeta purpurea	Purple Cudweed																															
Asteraceae	Hypochaeris radicata	Catsear			0.1	10			0.1	10							0.5		0.5				0.3		0.5		0.5		0.2				0.1
Asteraceae	Senecio madagascariensis	Fireweed																															
Asteraceae	Sonchus asper																																
Asteraceae	Sonchus oleraceus	Common Sowthistle																															
Asteraceae	Sonchus sp.														0.2																		

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Asteraceae	Tagetes minuta	Stinking Roger			40	200	4	100	0.3	7																							
Asteraceae	Taraxacum officinale	Dandelion	0.1	7													0.5	40															
Asteraceae	Xanthium spinosum	Bathurst Burr																															
Boraginaceae	Echium plantagineum	Patterson's Curse																															
Brassicaceae	Brassica juncea	Indian Mustard																															
Brassicaceae	Brassica napus	Canola	0.1	2																													
Brassicaceae	Brassica spp.	Brassica																													0.1	20	
Brassicaceae	Brassicaceae indeterminate	Mustards																									0.1	2					
Brassicaceae	Capsella bursa	pastoris*																															
Brassicaceae	Raphanus raphanistrum						0.1	2																									
Brassicaceae	Rapistrum rugosum	Turnip Weed	1	50																													
Caprifoliaceae	Lonicera japonica																																
Caryophyllaceae	Cerastium glomeratum	Mouse-ear Chickweed	0.3	10							0.1	1																					
Caryophyllaceae	Cerastium spp.																						0.5	100							0.2	300	
Caryophyllaceae	Cerastium vulgare	Mouse-ear Chickweed					1	50	0.2	50																							
Caryophyllaceae	Petrorhagia prolifera	Proliferous Pink																															
Caryophyllaceae	Silene latifolia subsp. Alba						0.1	4	0.1	1																							
Caryophyllaceae	Stellaria media																																
Clusiaceae	Hypericum perforatum																																
Cyperaceae	Cyperus brevifolius																																
Fabaceae (Faboideae)	Medicago lupulina	Black Medic											0.1	3																			
Fabaceae (Faboideae)	Trifolium campestre	Hop Clover															0.3	50															
Fabaceae (Faboideae)	Trifolium pratense																																
Fabaceae (Faboideae)	Trifolium repens	White Clover	0.1	2	0.5	10	0.2	20			0.1	2	0.1	20	0.1	5	0.2	20	0.1	7			0.1	20			0.1	20					0.1	50
Fabaceae (Faboideae)	Trifolium spp.	A Clover																							0.1	10							
Fabaceae (Faboideae)	Trifolium subterraneum	Subterranean Clover																															
Fabaceae (Faboideae)	Vicia hirsuta	Hairy Vetch																															
Gentianaceae	Centaurium tenuiflorum	Branched Centaury, Slender centaury																															
Iridaceae	Romulea sp.																																
Lamiaceae	Lamium amplexicaule	Dead Nettle	0.1	1																													
Lamiaceae	Marrubium vulgare	White Horehound			0.2	2	0.1	10	0.1	2					0.1	1																	
Linaceae	Linum trigynum																																
Malvaceae	Modiola caroliniana	Red-flowered Mallow	0.2	8	3	100	0.1	2	0.1	1																							
Oleaceae	Ligustrum lucidum	Large-leaved Privet																															
Oleaceae	Ligustrum sinense	Small-leaved Privet													0.1	1																	
Phyllanthaceae	Phyllanthus sp.																																
Phytolaccaceae	Phytolacca octandra	Inkweed	0.9	20	5	100	0.1	1	0.3	40	0.1	3	0.1	1	0.1	10			0.1	10					1	50							
Pinaceae	Pinus sp.																																

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Asteraceae	Tagetes minuta	Stinking Roger			1	30																							0.1					
Asteraceae	Taraxacum officinale	Dandelion																																
Asteraceae	Xanthium spinosum	Bathurst Burr																																
Boraginaceae	Echium plantagineum	Patterson's Curse					0.5	5																										
Brassicaceae	Brassica juncea	Indian Mustard			0.5	10											0.1	2																
Brassicaceae	Brassica napus	Canola																																
Brassicaceae	Brassica spp.	Brassica																																
Brassicaceae	Brassicaceae indeterminate	Mustards																																
Brassicaceae	Capsella bursa	pastoris*																																
Brassicaceae	Raphanus raphanistrum																																	
Brassicaceae	Rapistrum rugosum	Turnip Weed																																
Caprifoliaceae	Lonicera japonica																										2							
Caryophyllaceae	Cerastium glomeratum	Mouse-ear Chickweed																																
Caryophyllaceae	Cerastium spp.		0.1	100	5	100					0.1	50			0.5	50	1	50																
Caryophyllaceae	Cerastium vulgare	Mouse-ear Chickweed																																
Caryophyllaceae	Petrorhagia prolifera	Proliferous Pink																																
Caryophyllaceae	Silene latifolia subsp. Alba																																	
Caryophyllaceae	Stellaria media																												0.1					
Clusiaceae	Hypericum perforatum																																	
Cyperaceae	Cyperus brevifolius																										0.1							
Fabaceae (Faboideae)	Medicago lupulina	Black Medic																																
Fabaceae (Faboideae)	Trifolium campestre	Hop Clover																																
Fabaceae (Faboideae)	Trifolium pratense																						1						0.2					
Fabaceae (Faboideae)	Trifolium repens	White Clover			0.1	30	1	50					1	100	0.5	20			0.5		1		0.5		0.1		0.1	5	2				0.2	100
Fabaceae (Faboideae)	Trifolium spp.	A Clover																																
Fabaceae (Faboideae)	Trifolium subterraneum	Subterranean Clover																															0.3	1000
Fabaceae (Faboideae)	Vicia hirsuta	Hairy Vetch																																
Gentianaceae	Centaurium tenuiflorum	Branched Centaury, Slender centaury																																
Iridaceae	Romulea sp.																																	
Lamiaceae	Lamium amplexicaule	Dead Nettle									0.5	20																						
Lamiaceae	Marrubium vulgare	White Horehound																																
Linaceae	Linum trigynum																																	
Malvaceae	Modiola caroliniana	Red-flowered Mallow																															0.1	10
Oleaceae	Ligustrum lucidum	Large-leaved Privet																																
Oleaceae	Ligustrum sinense	Small-leaved Privet																																
Phyllanthaceae	Phyllanthus sp.																		0.1															
Phytolaccaceae	Phytolacca octandra	Inkweed	0.1	10	1	10	0.1	5			0.1	10			0.5	10	2	30											1		0.2			
Pinaceae	Pinus sp.																																	

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Asteraceae	Tagetes minuta	Stinking Roger			0.1	2																										
Asteraceae	Taraxacum officinale	Dandelion									0.1						0.1		0.1						0.1							
Asteraceae	Xanthium spinosum	Bathurst Burr			0.1	2																			0.1		0.1					
Boraginaceae	Echium plantagineum	Patterson's Curse																														
Brassicaceae	Brassica juncea	Indian Mustard																														
Brassicaceae	Brassica napus	Canola																														
Brassicaceae	Brassica spp.	Brassica																														
Brassicaceae	Brassicaceae indeterminate	Mustards																														
Brassicaceae	Capsella bursa	pastoris*																														
Brassicaceae	Raphanus raphanistrum																															
Brassicaceae	Rapistrum rugosum	Turnip Weed																														
Caprifoliaceae	Lonicera japonica																															
Caryophyllaceae	Cerastium glomeratum	Mouse-ear Chickweed					0.1	1																								
Caryophyllaceae	Cerastium spp.																															
Caryophyllaceae	Cerastium vulgare	Mouse-ear Chickweed	0.1	1																												
Caryophyllaceae	Petrorhagia prolifera	Proliferous Pink	0.1	1																												
Caryophyllaceae	Silene latifolia subsp. Alba																															
Caryophyllaceae	Stellaria media																														0.1	
Clusiaceae	Hypericum perforatum										10												5						0.5			
Cyperaceae	Cyperus brevifolius																0.2				0.5				1				0.1		2	
Fabaceae (Faboideae)	Medicago lupulina	Black Medic																														
Fabaceae (Faboideae)	Trifolium campestre	Hop Clover																														
Fabaceae (Faboideae)	Trifolium pratense																								0.3							
Fabaceae (Faboideae)	Trifolium repens	White Clover			5	1000	0.2	100	0.1	100					1		1						0.1		10		10		0.1		1		
Fabaceae (Faboideae)	Trifolium spp.	A Clover																														
Fabaceae (Faboideae)	Trifolium subterraneum	Subterranean Clover																														
Fabaceae (Faboideae)	Vicia hirsuta	Hairy Vetch	0.1	1									0.1	1																		
Gentianaceae	Centaurium tenuiflorum	Branched Centaury, Slender centaury	0.1	10																												
Iridaceae	Romulea sp.														0.1																	
Lamiaceae	Lamium amplexicaule	Dead Nettle																														
Lamiaceae	Marrubium vulgare	White Horehound																														
Linaceae	Linum trigynum																														0.5	
Malvaceae	Modiola caroliniana	Red-flowered Mallow	0.1	1					0.1	3																						
Oleaceae	Ligustrum lucidum	Large-leaved Privet											0.1	1																		
Oleaceae	Ligustrum sinense	Small-leaved Privet																														
Phyllanthaceae	Phyllanthus sp.																															
Phytolaccaceae	Phytolacca octandra	Inkweed	0.1	20			0.1	1					0.1	10	0.5						0.1										0.1	
Pinaceae	Pinus sp.																				2											

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15)		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Plantaginaceae	Plantago lanceolata	Lamb's Tongues															0.2	2	0.1	1														
Poaceae	Anthoxanthum odoratum	Sweet Vernal Grass																																
Poaceae	Avena sp.																																	
Poaceae	Axonopus compressus	Broad-leaved Carpet Grass			5	100											5	200																
Poaceae	Bromus catharticus	Praire Grass	70	500			0.5	20	2	60									0.2	10														
Poaceae	Bromus sp.																																	
Poaceae	Cenchrus clandestinus	Kikuyu Grass																			1	40	1	30	0.2	30	10	300						
Poaceae	Dactylis glomerata	Cocksfoot															0.2	10	1	80														
Poaceae	Echinochloa crusgalli	Barnyard Grass																																
Poaceae	Ehrharta calycina	Perennial Veldtgrass																			3	50												
Poaceae	Ehrharta erecta																																	
Poaceae	Eleusine tristachya																																	
Poaceae	Holcus lanatus	Yorkshire Fog	2	50																									0.1	10				
Poaceae	Lolium multiflorum	Italian Ryegrass	15	200			3	100	1	30																								
Poaceae	Lolium perenne	Perennial Ryegrass																																
Poaceae	Lolium sp.																																	
Poaceae	Lolium spp.	A Ryegrass																																
Poaceae	Panicum gilvum																																	
Poaceae	Paspalum dilatatum	Paspalum													0.5	10	0.5	30	0.2	7														
Poaceae	Paspalum urvillei	Vasey Grass																	0.2	10														
Poaceae	Poa annua																																	
Poaceae	Poaceae indeterminate	Grasses, reeds and bamboos																																
Poaceae	Setaria parviflora																0.2	8																
Poaceae	Sporobolus africanus																																	
Poaceae	Vulpia bromoides	Squirrel Tail Fesque																							0.1	20								
Polygonaceae	Acetosella vulgaris	Sheep Sorrel																																
Polygonaceae	Polygonum aviculare	Wireweed	0.1	1	0.1	1																												
Polygonaceae	Rumex obtusifolius	Broadleaf Dock	0.2	3			0.4	8	0.1	3			0.1	1					0.1	4														
Primulaceae	Lysimachia arvensis	Scarlet Pimpernel			0.2	20	0.1	1					0.1	1	0.1	20	0.2	60	0.1	1														
Rosaceae	Rosa rubiginosa	Sweet Briar													0.1	1																		
Rosaceae	Rubus fruticosus sp. agg.	Blackberry complex			0.1	1	0.1	1			0.1	2	0.1	5	2	20			1	20													0.1	1
Rubiaceae	Galium aparine	Goosegrass					2	100																										
Rubiaceae	Galium divaricatum	Slender Bedstraw	0.2	10			0.1	7					0.1	3																				
Rubiaceae	Galium spurium																		0.7	40														
Rutaceae	Rutaceae indeterminate																												0.5	100				
Salicaceae	Populus sp.																																	
Scrophulariaceae	Parentucellia latifolia	Red Bartsia																																
Scrophulariaceae	Verbascum blattaria										0.1	2																						
Scrophulariaceae	Verbascum thapsus subsp. Thapsus	Great Mullein																																
Scrophulariaceae	Verbascum virgatum	Twiggy Mullein															0.1	1	0.1	1														
Solanaceae	Solanum chenopodioides						4	100	5	70	30	100	0.1	3	0.3	10	0.3	30	1	50														

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Plantaginaceae	Plantago lanceolata	Lamb's Tongues											1	20	0.5	10													0.1				0.1	10
Poaceae	Anthoxanthum odoratum	Sweet Vernal Grass																							0.2		0.2	100	30					
Poaceae	Avena sp.																				0.5													
Poaceae	Axonopus compressus	Broad-leaved Carpet Grass																																
Poaceae	Bromus catharticus	Praire Grass															1	50																
Poaceae	Bromus sp.																																	
Poaceae	Cenchrus clandestinus	Kikuyu Grass	1	20	1	50	1	20			3	50																						
Poaceae	Dactylis glomerata	Cocksfoot									1	30	1	50																			0.2	200
Poaceae	Echinochloa crusgalli	Barnyard Grass																															0.1	10
Poaceae	Ehrharta calycina	Perennial Veldtgrass																																
Poaceae	Ehrharta erecta																																	
Poaceae	Eleusine tristachya																												2					
Poaceae	Holcus lanatus	Yorkshire Fog																																
Poaceae	Lolium multiflorum	Italian Ryegrass																																
Poaceae	Lolium perenne	Perennial Ryegrass																									0.1	2					0.1	2
Poaceae	Lolium sp.																				0.2				0.5									
Poaceae	Lolium spp.	A Ryegrass			15	1000	7	1000																										
Poaceae	Panicum gilvum																																	
Poaceae	Paspalum dilatatum	Paspalum																					0.5		2				1					
Poaceae	Paspalum urvillei	Vasey Grass																																
Poaceae	Poa annua																																	
Poaceae	Poaceae indeterminate	Grasses, reeds and bamboos					1	100																										
Poaceae	Setaria parviflora																																	
Poaceae	Sporobolus africanus																						0.1											
Poaceae	Vulpia bromoides	Squirrel Tail Fesque													0.5	20																		
Polygonaceae	Acetosella vulgaris	Sheep Sorrel																																
Polygonaceae	Polygonum aviculare	Wireweed																																
Polygonaceae	Rumex obtusifolius	Broadleaf Dock																																
Primulaceae	Lysimachia arvensis	Scarlet Pimpernel															0.5	30							0.1									
Rosaceae	Rosa rubiginosa	Sweet Briar																																
Rosaceae	Rubus fruticosus sp. agg.	Blackberry complex	0.1	5															0.5		0.2		5		0.1				5				0.1	10
Rubiaceae	Galium aparine	Goosegrass									0.2	20																						
Rubiaceae	Galium divaricatum	Slender Bedstraw																																
Rubiaceae	Galium spurium																																	
Rutaceae	Rutaceae indeterminate																																	
Salicaceae	Populus sp.																																	
Scrophulariaceae	Parentucellia latifolia	Red Bartsia																															0.1	2
Scrophulariaceae	Verbascum blattaria																																	
Scrophulariaceae	Verbascum thapsus subsp. Thapsus	Great Mullein							0.5	10															0.1									
Scrophulariaceae	Verbascum virgatum	Twiggy Mullein																																
Solanaceae	Solanum chenopodioides																																	

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Plantaginaceae	Plantago lanceolata	Lamb's Tongues									0.5																				1	
Poaceae	Anthoxanthum odoratum	Sweet Vernal Grass							20	6000									5						1		0.2		1		5		1	
Poaceae	Avena sp.																				0.5						0.1						
Poaceae	Axonopus compressus	Broad-leaved Carpet Grass																															
Poaceae	Bromus catharticus	Praire Grass																															
Poaceae	Bromus sp.																												2		2		
Poaceae	Cenchrus clandestinus	Kikuyu Grass			0.5	100									1																		
Poaceae	Dactylis glomerata	Cocksfoot			30	1000	0.2	100																									
Poaceae	Echinochloa crusgalli	Barnyard Grass			0.1	10																											
Poaceae	Ehrharta calycina	Perennial Veldtgrass																															
Poaceae	Ehrharta erecta																																1
Poaceae	Eleusine tristachya																								1								
Poaceae	Holcus lanatus	Yorkshire Fog																															
Poaceae	Lolium multiflorum	Italian Ryegrass																															
Poaceae	Lolium perenne	Perennial Ryegrass			0.1	10																											
Poaceae	Lolium sp.																								20		0.1				1		
Poaceae	Lolium spp.	A Ryegrass																															
Poaceae	Panicum gilvum				0.1	30																											
Poaceae	Paspalum dilatatum	Paspalum			0.1	10					6														25		5		0.5				1
Poaceae	Paspalum urvillei	Vasey Grass																															
Poaceae	Poa annua																								2								
Poaceae	Poaceae indeterminate	Grasses, reeds and bamboos																															
Poaceae	Setaria parviflora																																
Poaceae	Sporobolus africanus																																
Poaceae	Vulpia bromoides	Squirrel Tail Fesque																															
Polygonaceae	Acetosella vulgaris	Sheep Sorrel							0.2	1000																							
Polygonaceae	Polygonum aviculare	Wireweed			0.2	1000																											
Polygonaceae	Rumex obtusifolius	Broadleaf Dock																															
Primulaceae	Lysimachia arvensis	Scarlet Pimpernel									0.1				2								0.1		0.2						0.1		
Rosaceae	Rosa rubiginosa	Sweet Briar																															0.1
Rosaceae	Rubus fruticosus sp. agg.	Blackberry complex			0.1	1	0.1	2			10		0.1	1									1						60		0.1		0.5
Rubiaceae	Galium aparine	Goosegrass																															
Rubiaceae	Galium divaricatum	Slender Bedstraw																															
Rubiaceae	Galium spurium																																
Rutaceae	Rutaceae indeterminate																																
Salicaceae	Populus sp.																																0.2
Scrophulariaceae	Parentucellia latifolia	Red Bartsia																															
Scrophulariaceae	Verbascum blattaria																																
Scrophulariaceae	Verbascum thapsus subsp. Thapsus	Great Mullein	0.1	2							0.1		0.1	2	0.1								0.1						0.1		0.1		
Scrophulariaceae	Verbascum virgatum	Twiggy Mullein									0.1																						
Solanaceae	Solanum chenopodioides																																

Family	Scientific name	Common name	Plot 01 (HoG_Mar_13)		Plot 02 (HoG_Mar_14)		Plot 03 (HoG_Mar_15		Plot 04 (HoG_Mar_16		Plot 05 (HoG_TLC_Mar_01)		Plot 6 (HoG_TLC_Mar_02)		Plot 07 (HoG_TLC_Mar_03)		Plot 08 (HoG_TLC_Mar_04)		Plot 09 (HoG_TLC_Mar_05)		Plot 10 (HoG-Mar-01)		Plot 11 (HoG-Mar-02)		Plot 12 (HoG-Mar-03		Plot 13 (HoG-Mar-04)		Plot 14 (HoG-Mar-05)		Plot 15 (HoG-Mar-06)		Plot 16 (HoG-Mar-07)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Solanaceae	Solanum nigrum	Black-berry Nightshade	0.2	4	10	50															1	100	15	500	0.1	10	0.1	10	1	50	1	100	10	1000
Verbenaceae	Verbena bonariensis	Purpletop													0.1	3	0.1	3	0.1	10														
Verbenaceae	Verbena rigida var. rigida																																	
	Pasture Grass																																	

Family	Scientific name	Common name	Plot 17 (HoG-Mar-08)		Plot 18 (HoG-Mar-09)		Plot 19 (HoG-Mar-10)		Plot 20 (HoG-Mar-11)		Plot 21 (HoG-Mar-12)		Plot 22 (HoG_TLC_Mar_07)		Plot 23 (HoG_TLC_Mar_06)		Plot 24 (HoG_TLC_Mar_08)		Plot 27 (34784_01)		Plot 28 (34784_02)		Plot 29 (34784_04)		Plot 30 (34784_05)		Plot 31 (34784_07)		Plot 32 (34784_13)		Plot 33 (34784_16)		Plot 34 (34784_17)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Solanaceae	Solanum nigrum	Black-berry Nightshade	1	50	30	500	0.1	10	1	20	1	10			1	20	1	30															0.1	20
Verbenaceae	Verbena bonariensis	Purpletop																	0.1				0.1		0.1				0.5				0.1	2
Verbenaceae	Verbena rigida var. rigida																																	
	Pasture Grass																																	

Family	Scientific name	Common name	Plot 35 (34784_20)		Plot 36 (34784_28)		Plot 37 (34784_34)		Plot 38 (34784_42)		Plot 39 (34784_46)		Plot 40 (34784_47)		Plot 41 (34784_08)		Plot 42 (34784_09)		Plot 43 (34784_11)		Plot 44 (34784_21)		Plot 45 (34784_23)		Plot 46 (34784_27)		Plot 47 (34784_29)		Plot 48 (34784_32)		Plot 49 (34784_35)		Plot 50 (34784_45)	
			Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.	Cvr %	Abnd.
Solanaceae	Solanum nigrum	Black-berry Nightshade	0.1	2			0.1	2	0.1	1			0.1	20	0.2																			
Verbenaceae	Verbena bonariensis	Purpletop	0.1	2							0.5		0.1	5							0.1		0.2						0.1				
Verbenaceae	Verbena rigida var. rigida																								0.2		0.1						
	Pasture Grass				20	2000																											

Appendix I AECOM 330 kV Overhead Line vegetation Clearance Report

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Prepared for
Hills of Gold Wind Farm Pty Limited
ABN: 28 145 173 324

AECOM

Hills of Gold Wind Farm

330 kV Overhead Line Vegetation Clearance Report

13-Aug-2021
Hills of Gold Wind Farm Grid Connection

Hills of Gold Wind Farm

330 kV Overhead Line Vegetation Clearance Report

Client: Hills of Gold Wind Farm Pty Limited

ABN: 28 145 173 324

Prepared by

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ABN 20 093 846 925

13-Aug-2021

Job No.: 60633842

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Quality Information

Document: Hills of Gold Wind Farm

60633842

Ref: p:\606x\60633842\400_technical\431_s1 shared network assets\vegetation clearance\hogwf 330kv vegetation clearing report 20210813_cm.docx

Date: 13-Aug-2021

Prepared by: Hew McLachlan

Reviewed by: Rita Bu, Caitie McClelland, Rajesh Arora

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	13-Aug-2021	For Issue	Rajesh Arora Technical Director - Power and Industrial	

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2.0 Scope of Works – 330 kV Concept Vegetation Clearing 1
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Appendix A
Plan and Profile Drawing A

1.0 Overview

Hills of Gold Wind Farm Pty Limited is considering the development of Hills of Gold Wind Farm located 60 km south-east of Tamworth New South Wales, Australia. The wind farm has a proposed capacity of 400 MW and is proposed to connect to the TransGrid network.

The project is currently in the early stages of development for the 330 kV connection interface between a new TransGrid 330 kV switching station and a new 330 kV transmission line (20 km in length) to the Hills of Gold new collector 330/33 kV substation located within the boundaries of the proposed wind farm development.

This report discusses the vegetation clearing that may be required based on an indicative transmission line concept design and route.

2.0 Scope of Works – 330 kV Concept Vegetation Clearing

The agreed scope is as follows:

- Update the transmission line alignment
- Review the Lidar Survey to incorporate the vegetation data for upload into PLS-CADD.
- Prepare the PLS-CADD Maximum design temperature bottom conductor profile with a vegetation clearance line – 3.0 metres plus 1.0 metre regrowth (minimum 4.0 metre required)
- Prepare the structure clearance envelope of 60.0 metres around structure locations.
- Prepare the 50 degree C and 500 pa vegetation clearance envelopes for all spans on the Hills of Gold 330 kV transmission line.

3.0 Key Deliverables

The agreed deliverables are as follows:

- Basis of Design summary on vegetation Standards as per AS7000, inclusive of a table of vegetation clearance locations with chainages. (TransGrid reference standard to be included)
- Shapefiles (and kmz) of the 60 meter transmission line corridor with vegetation clearance locations identified
- Updated plan and profile cross sections with vegetation canopy height and calculated clearance envelopes overlayed. Locations where these overlays intersect requiring vegetation clearance will be clearly shown with chainages

3.1 Concept Design

The PLS-CADD transmission line model has been updated based on the concept design prepared last year (2020). The updated model includes the recently received ground and vegetation lidar, as well as the received alignment centreline which includes both minor and major changes for almost the entirety of the route compared to the previous design. As this is a concept design and the terrain is highly challenging, a single indicative strain pole arrangement has been used for the design to determine the vegetation clearing that may be required. The pole height has been adjusted for the terrain and is a maximum of 32 m.

3.2 Vegetation Clearing Criteria

Vegetation clearing has been assessed with the transmission line at 85°C no wind, and 500 Pa at 50°C. Vegetation within 4 m of the conductors under these conditions have been identified as requiring clearing. This 4 m value is comprised of a 3 m clearance zone plus a 1 m regrowth zone. Although there is no vegetation clearance requirement in AS/NZS 7000, SA/SNZ HB 331 notes 3 m clearance is

required up to 33 kV. We are aware that TransGrid has previously used 7.5 m clearance required for 330 kV lines.

3.3 Vegetation Clearing Results

The vegetation clearing identified from this analysis is shown in the plan and profile drawings, the shapefile, the Google Earth KMZ file, and is summarised in the table below. The approximate total area of vegetation clearance is 193,000 m^2.

Table 1 Vegetation Clearing Results

Site #	Site X (m)	Site Y (m)	Chainage (m)	Approx. Area (m^2)
1	303643	6510443	181	574
2	303709	6510386	269	137
3	303826	6510267	435	2086
4	303906	6510165	565	99
5	304075	6509984	812	1750
6	304297	6509750	1135	178
7	304399	6509643	1283	126
8	304550	6509456	1522	202
9	305242	6508765	2501	31
10	305905	6508233	3351	135
11	305730	6508359	3136	1075
12	305960	6508192	3419	100
13	306007	6508151	3482	148
14	306149	6508048	3658	486
15	306697	6507756	4282	2574
16	307859	6507182	5590	172
17	307958	6507138	5698	262
18	306939	6507680	4536	590
19	307009	6507644	4613	2
20	306830	6507718	4420	7
21	311408	6506370	9286	2686
22	309377	6506829	7151	56
23	309466	6506820	7241	317
24	309275	6506847	7048	249
25	308986	6506886	6756	2766
26	308847	6506911	6614	1109
27	310450	6506707	8232	580
28	310089	6506750	7868	13
29	310179	6506726	7960	537
30	310360	6506705	8142	69
31	311065	6506619	8852	4644
32	310880	6506661	8664	8
33	310801	6506674	8583	24
34	310744	6506680	8526	5

Site #	Site X (m)	Site Y (m)	Chainage (m)	Approx. Area (m^2)
35	310692	6506668	8476	17
36	311833	6505783	10010	618
37	311974	6505566	10269	1459
38	312067	6505446	10421	4358
39	311930	6505654	10171	56
40	312319	6505262	10739	22
41	312473	6505170	10919	2924
42	312997	6505008	11468	2406
43	313372	6504903	11858	49
44	313483	6504861	11976	2665
45	313186	6504938	11669	5971
46	318569	6502287	18095	4563
47	318983	6502368	18517	3087
48	319176	6502420	18716	186
49	319381	6502349	18955	1218
50	319449	6502273	19057	0
51	315456	6504169	14136	3689
52	313898	6504723	12413	4285
53	314119	6504657	12644	3340
54	314746	6504524	13285	26021
55	314272	6504621	12801	1108
56	315589	6503850	14481	3303
57	316011	6503389	15119	23765
58	316553	6503014	15778	2762
59	316745	6502882	16012	2729
60	316969	6502690	16307	796
61	317184	6502493	16599	454
62	317264	6502422	16707	1944
63	318369	6502242	17890	4794
64	317933	6502145	17443	2075
65	317689	6502207	17184	2
66	320967	6500986	21164	3081
67	321173	6500939	21375	598
68	319767	6502003	19473	277
69	319829	6501945	19558	587
70	319984	6501817	19759	2632
71	319506	6502242	19120	0
72	319662	6502106	19327	0
73	320241	6501384	20265	3092
74	320611	6501059	20801	6348
75	320830	6500419	25321	874

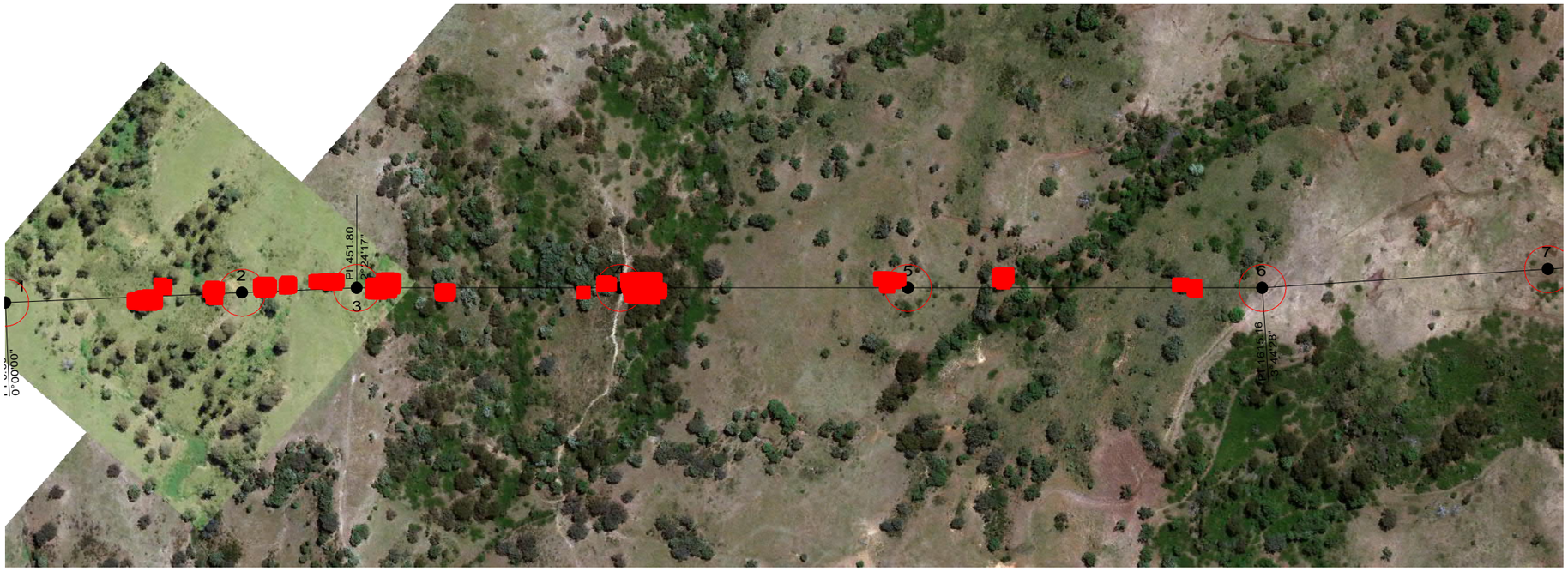
Site #	Site X (m)	Site Y (m)	Chainage (m)	Approx. Area (m^2)
76	322145	6500385	22502	23
77	321359	6500873	21574	219
78	321504	6500803	21737	3338
79	321139	6500815	24819	958
80	321075	6500711	24942	2
81	322063	6500443	22402	1092
82	322420	6500145	22870	7574
83	322966	6499819	23537	23167
84	323336	6499611	24027	4401

Appendix A

Plan and Profile Drawing

Appendix A Plan and Profile Drawing

PLS-CADD Drawing



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20.00
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PROJECT

HILLS OF GOLD WIND FARM

CLIENT

CONSULTANT

AECOM

PROJECT NUMBER

60633842

SHEET TITLE

VEGETATION CLEARING
330 kV CONCEPT DESIGN
LINE PROFILE

SHEET NUMBER

SHEET 1 OF 13

ISSUE/REVISION

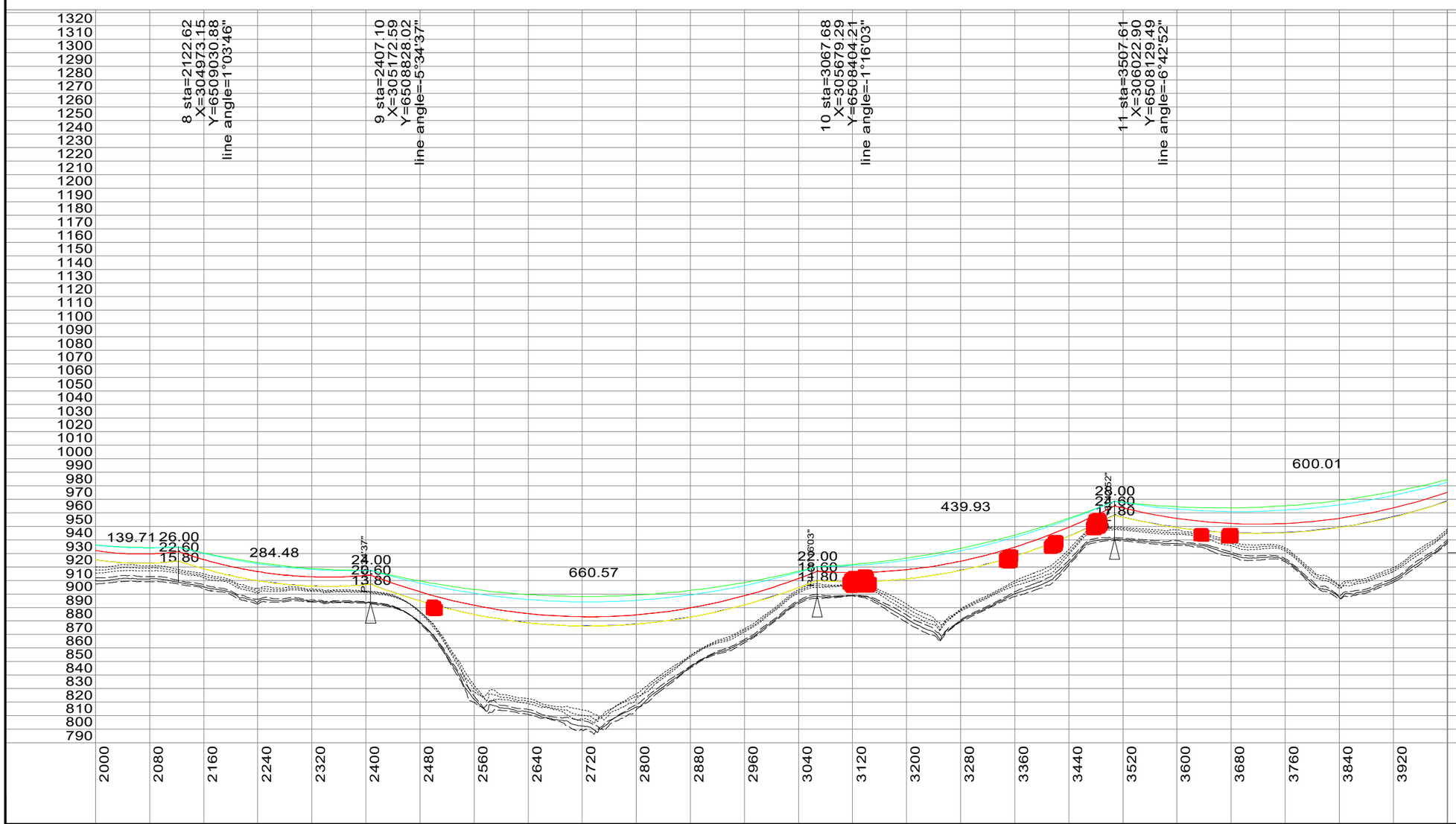
I/R	DATE	DESCRIPTION
0	13/08/2021	CONCEPT VEGETATION CLEARING

NOTES:
1. TWIN CONDUCTOR LEMON ACSR/GZ STRUNG AT 20% CBL @ 15 °C, DISPLAYED AT 85 °C.
2. OPGW & OHEW STRUNG AT 18% CBL @ 15 °C, DISPLAYED AT 50 °C.
3. GROUND CLEARANCE LINE DISPLAYED @ 8.0 m.
4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONCEPT VEGETATION CLEARING REPORT.
5. VEGETATION CLEARANCE IS ASSESSED WITH CONDUCTORS AT 500 Pa @ 50 °C, AS WELL AS 85 °C NO WIND.
6. REQUIRED VEGETATION CLEARING IS SHOWN AS RED MARKERS, AS WELL AS RED CIRCLES AT STRUCTURE LOCATIONS WITH DIAMETER 60 m.

100.0 m Horiz. Scale

50.0 m Vert. Scale

PLS-CADD Drawing



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50.0 m Vert. Scale

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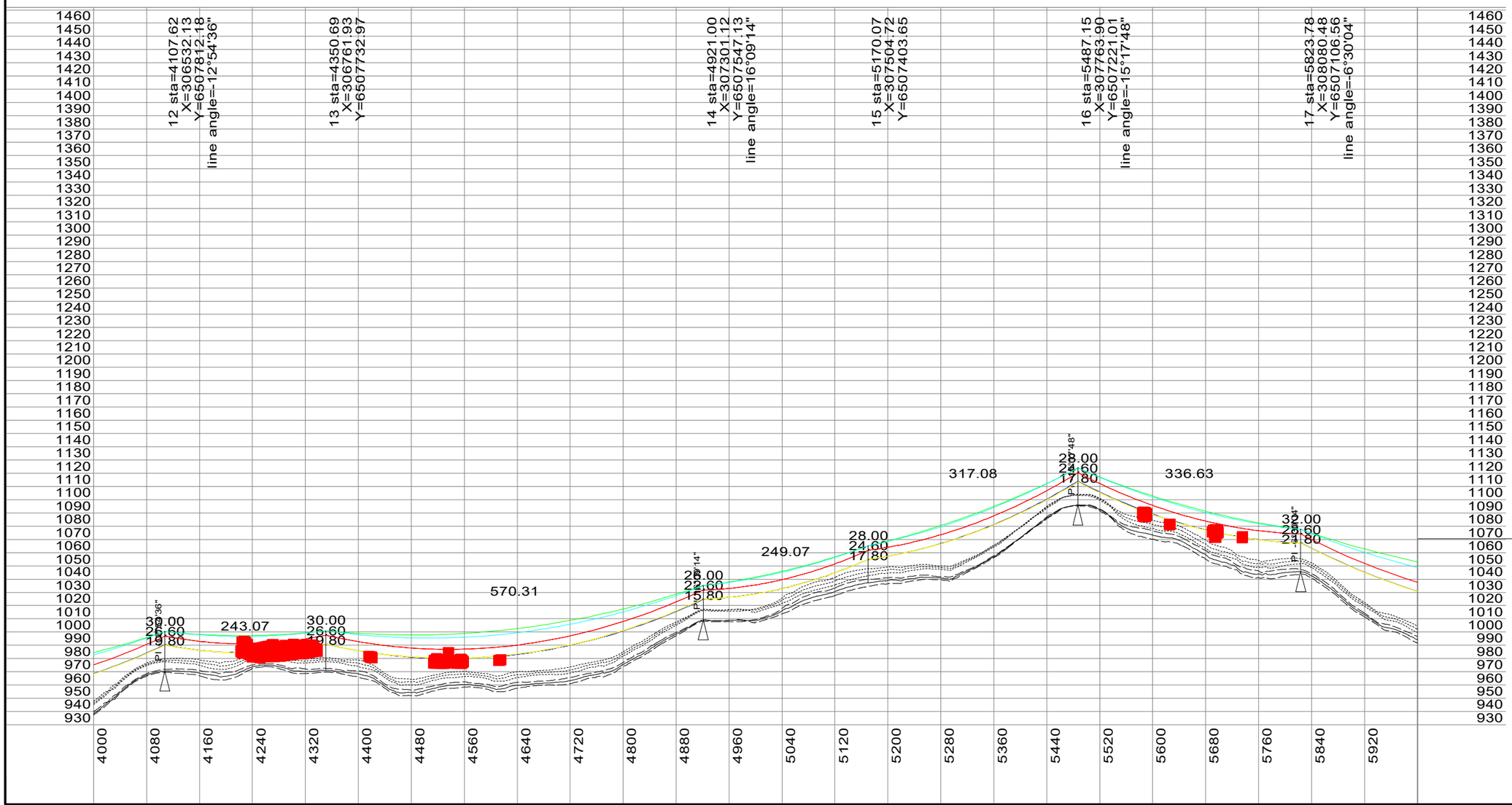

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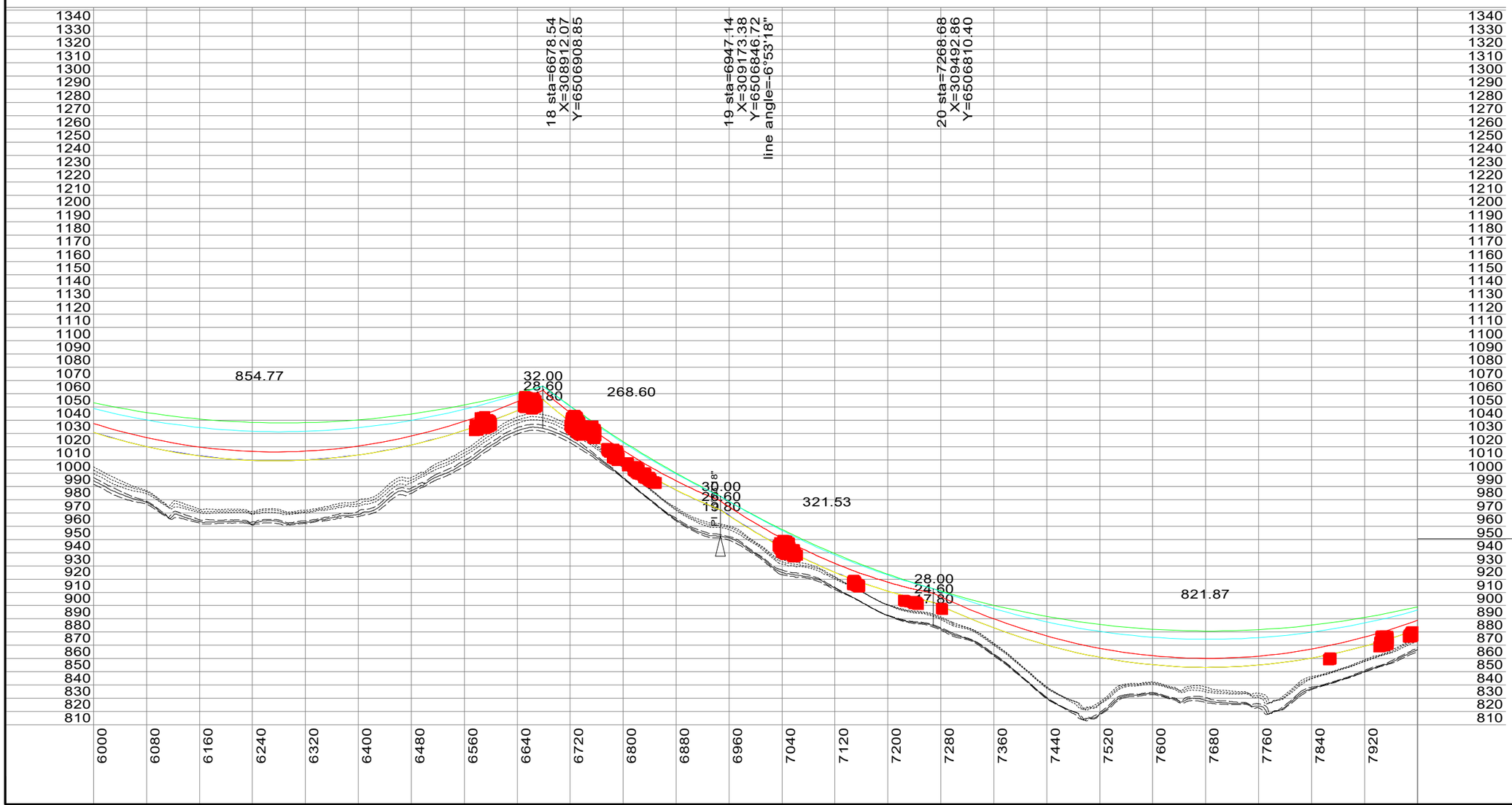
100.0 m Horiz. Scale

50.0 m Vert. Scale

PLS-CADD Drawing

North



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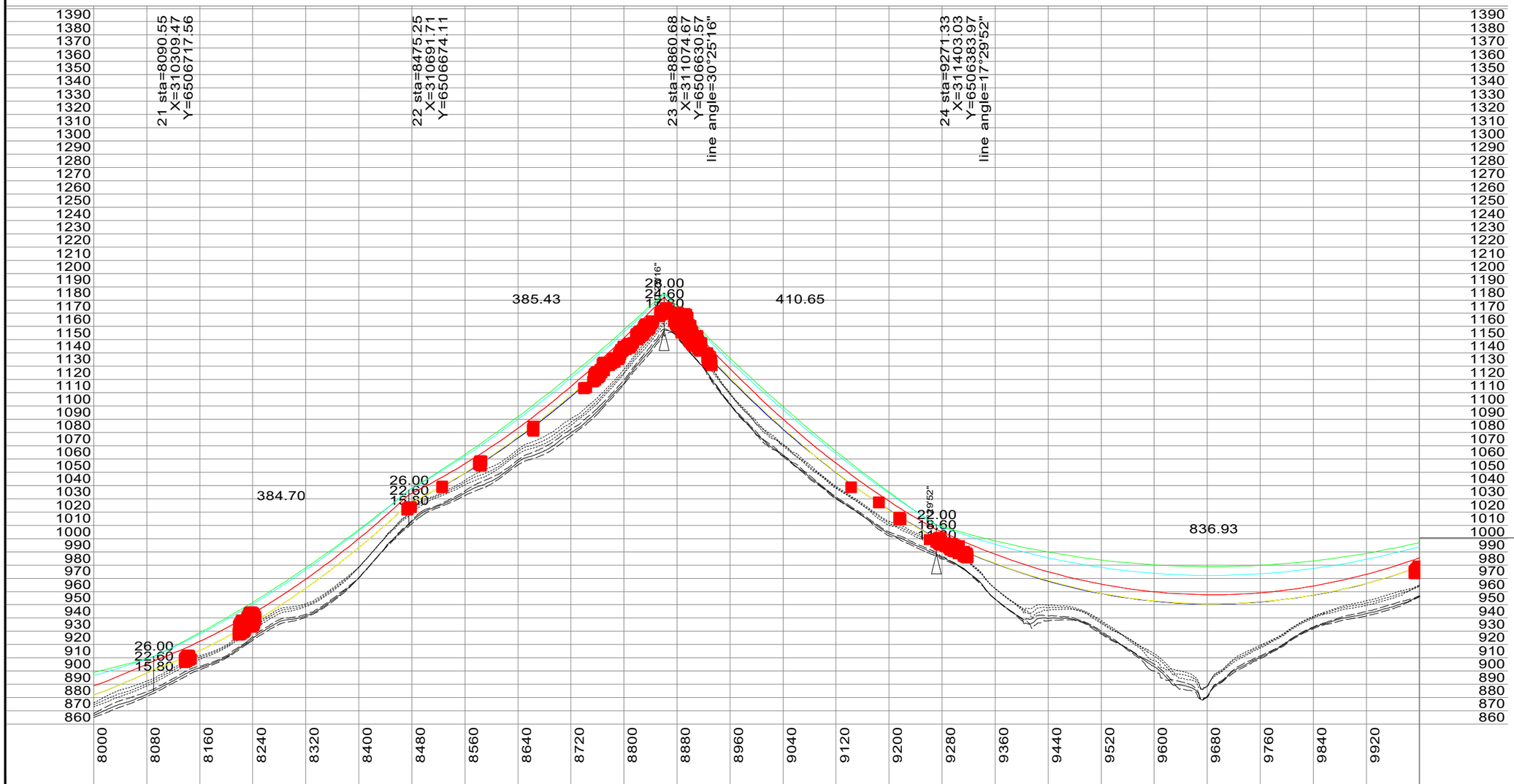

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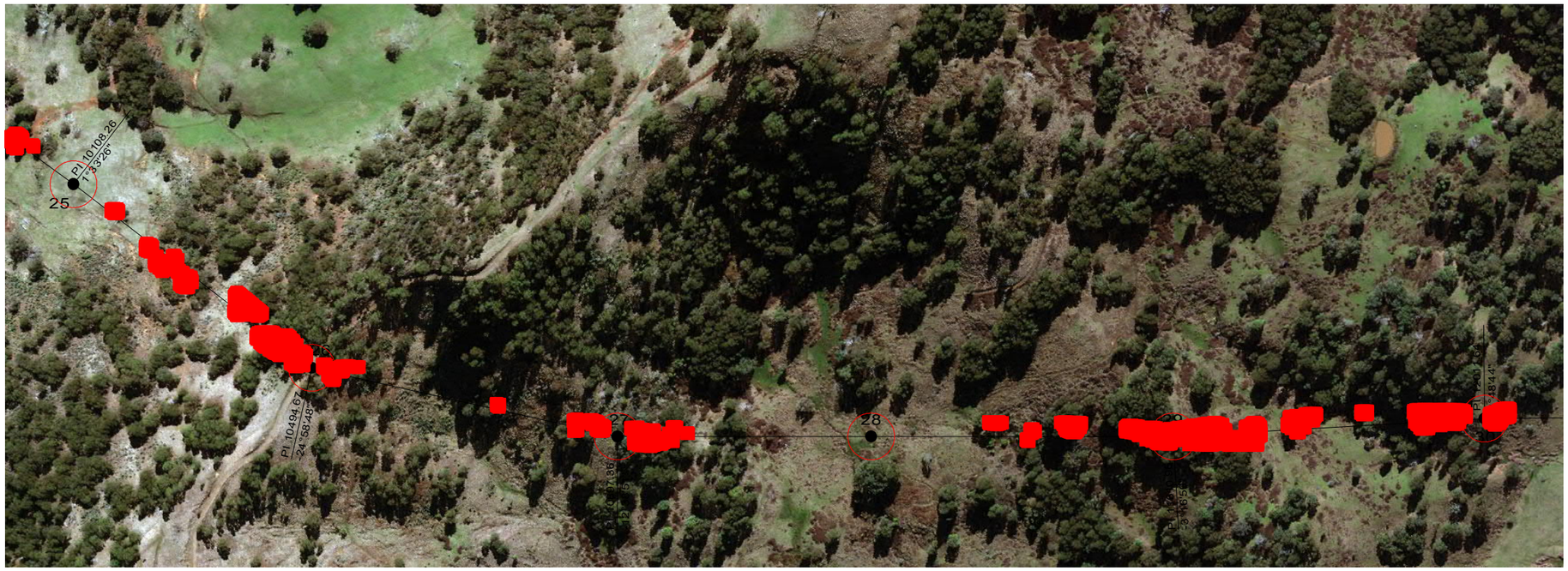

North

PROJECT

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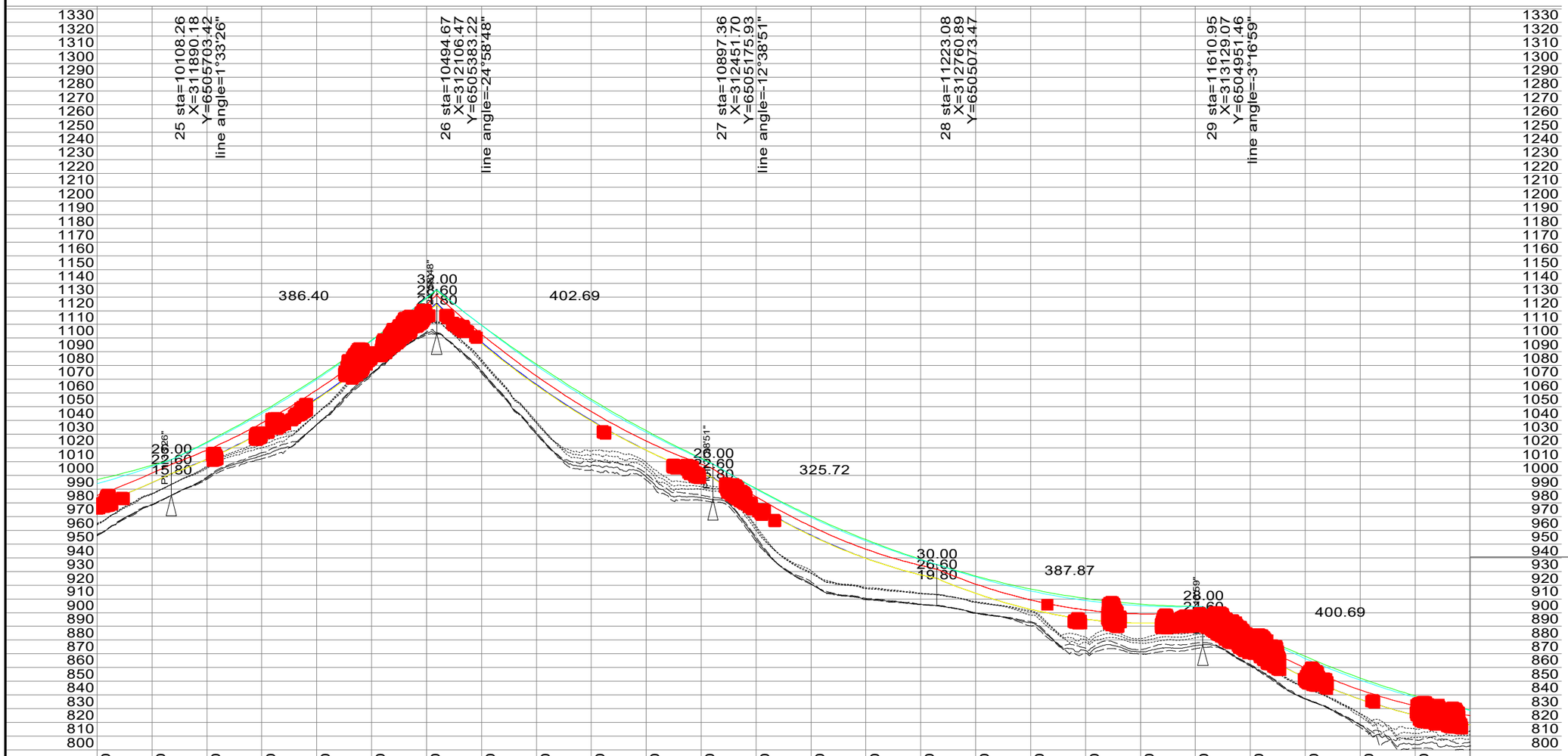
VEGETATION CLEARING
330 kV CONCEPT DESIGN
LINE PROFILE

SHEET NUMBER

SHEET 6 OF 13



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100.0 m Horiz. Scale

50.0 m Vert. Scale

PLS-CADD Drawing

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ISSUE/REVISION

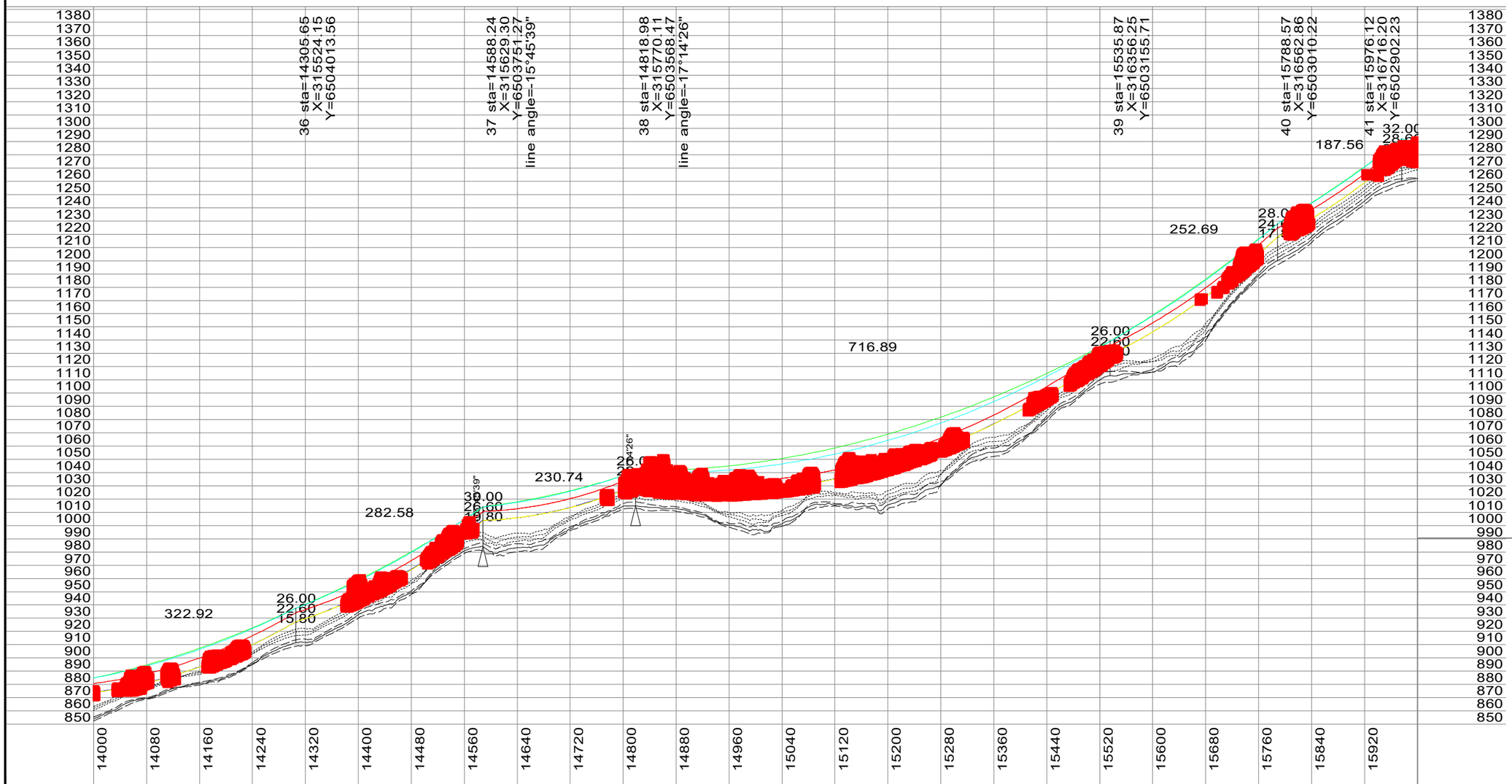
I/R	DATE	DESCRIPTION
0	13/08/2021	CONCEPT VEGETATION CLEARING

NOTES:
1. TWIN CONDUCTOR LEMON ACSR/GZ STRUNG AT 20% CBL @ 15 °C, DISPLAYED AT 85 °C.
2. OPGW & OHEW STRUNG AT 18% CBL @ 15 °C, DISPLAYED AT 50 °C.
3. GROUND CLEARANCE LINE DISPLAYED @ 8.0 m.
4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONCEPT VEGETATION CLEARING REPORT.
5. VEGETATION CLEARANCE IS ASSESSED WITH CONDUCTORS AT 500 Pa @ 50 °C, AS WELL AS 85 °C NO WIND.
6. REQUIRED VEGETATION CLEARING IS SHOWN AS RED MARKERS, AS WELL AS RED CIRCLES AT STRUCTURE LOCATIONS WITH DIAMETER 60 m.

100.0 m Horiz. Scale

50.0 m Vert. Scale

PLS-CADD Drawing



PROJECT

HILLS OF GOLD WIND FARM

CLIENT

CONSULTANT

AECOM

PROJECT NUMBER

60633842

SHEET TITLE

VEGETATION CLEARING
330 kV CONCEPT DESIGN
LINE PROFILE

SHEET NUMBER

SHEET 8 OF 13

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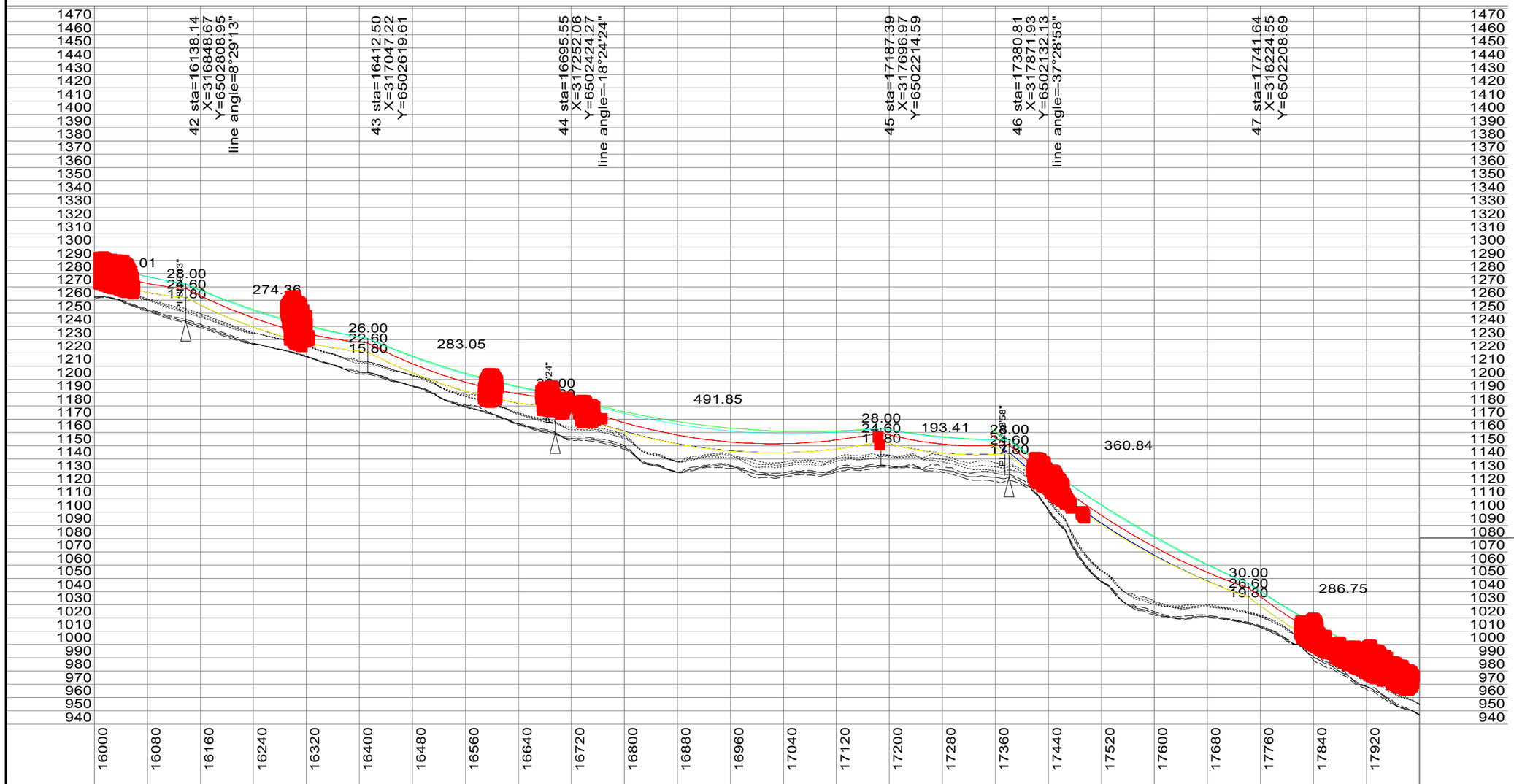

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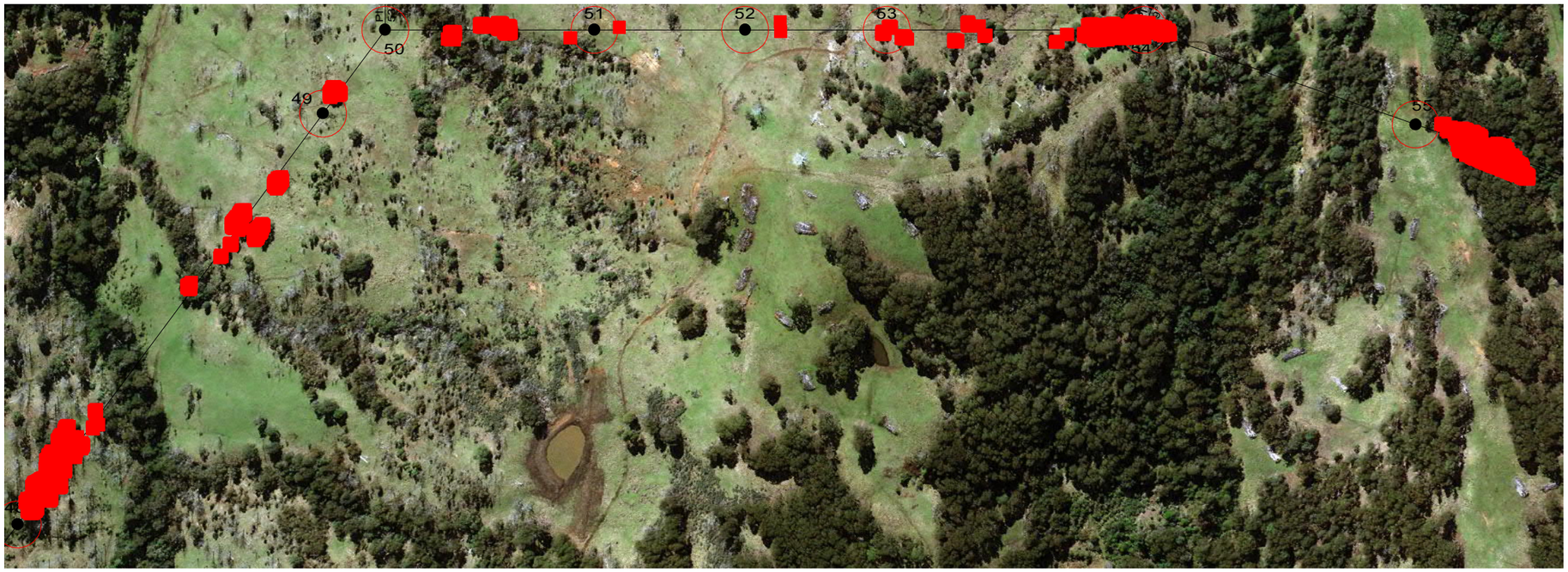

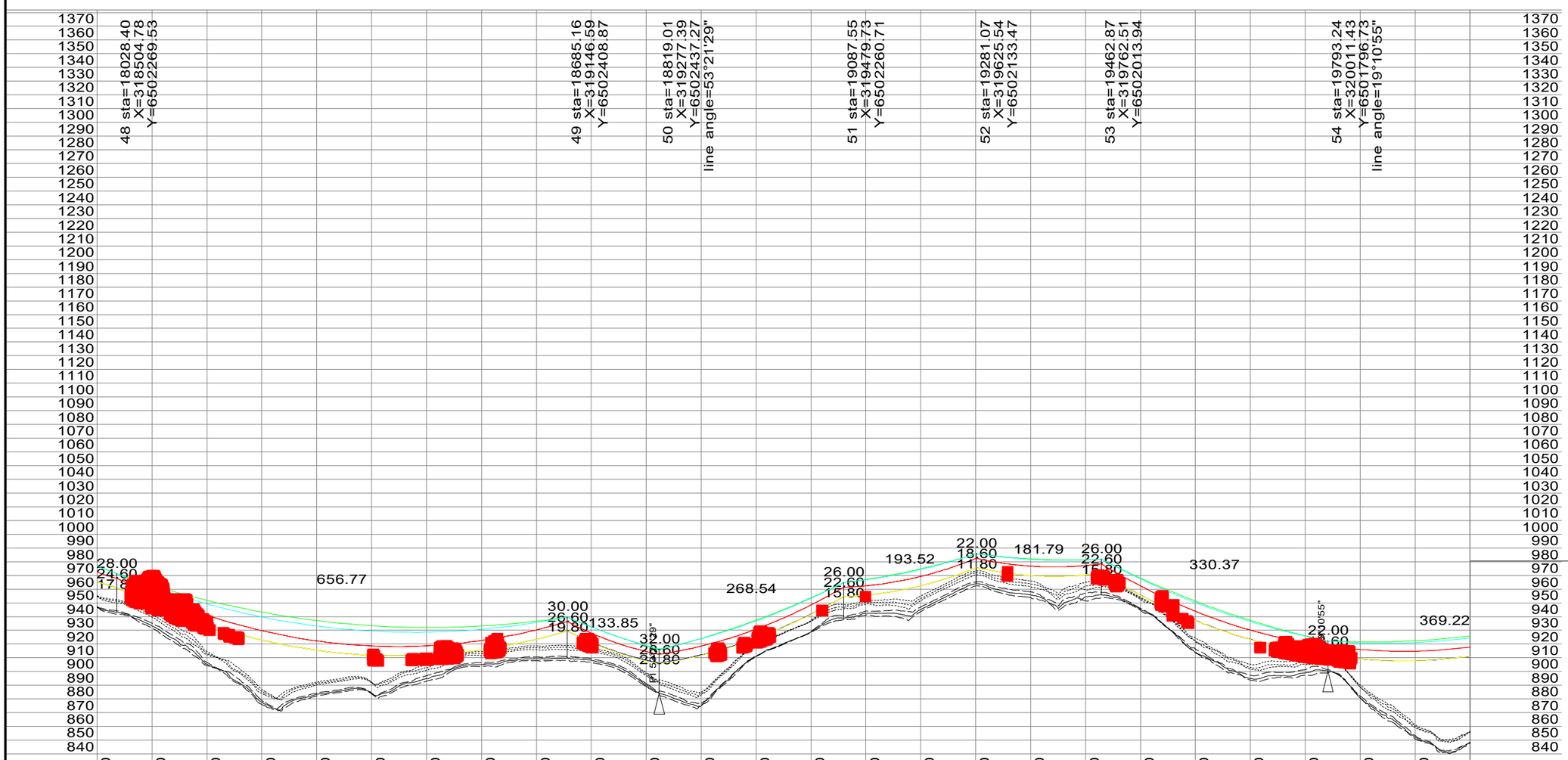

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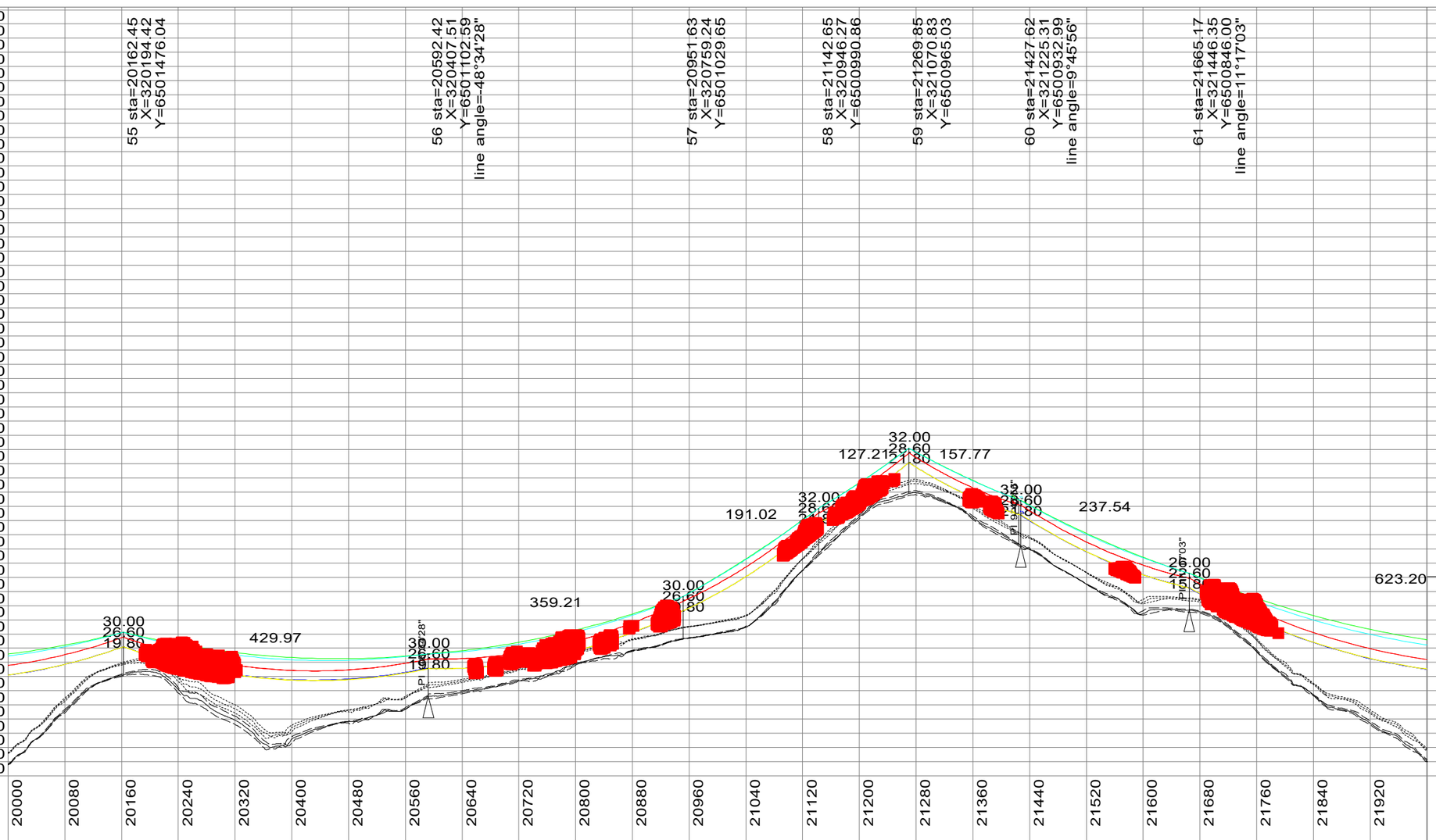

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100.0 m Horiz. Scale

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PLS-CADD Drawing

62 sta=22288.36
X=321970.39
Y=6500508.72

63 sta=22479.81
X=322131.38
Y=6500405.11

64 sta=22582.41
X=322217.66
Y=6500349.58
line angle=12°26'12"

65 sta=22788.89
X=322363.14
Y=6500203.07

66 sta=23000.39
X=322512.17
Y=6500052.98
line angle=11°02'33"

501.03
211.50
206.47
191.45
102.60
22.00
18.60
11.80
32.00
28.00

67 sta=23501.42
X=322926.76
Y=6499771.65
line angle=29°47'23"

68 sta=23623.58
X=323048.55
Y=6499762.35
line angle=7°49'58"

69 sta=23850.51
X=323275.07
Y=6499776.05
line angle=72°44'14"

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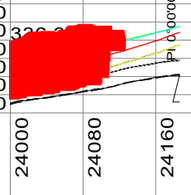
1920 1910 1900 1890 1880 1870 1860 1850 1840 1830 1820 1810 1800 1790 1780 1770 1760 1750 1740 1730 1720 1710 1700 1690 1680 1670 1660 1650 1640 1630 1620 1610 1600 1590 1580 1570 1560 1550 1540 1530 1520 1510 1500 1490 1480 1470 1460 1450 1440 1430 1420 1410 1400 1390



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