APPENDIX

B

Biodiversity Technical Report

PART 1 OF 6

Main Report

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Inland Rail North Star to NSW/QLD Border

Appendix B – Terrestrial Biodiversity Technical Report

Australian Rail Track Corporation

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Contents

Appendices

Figures

Tables

Abbreviations

Abbreviation	Explanation
AEP	Annual exceedance probability
AIAM	Adverse Impacts Assessment Methodology
AOI	Area of Influence
ARTC	Australian Rail Track Corporation Limited
AUSRIVAS	Australian River Assessment System
BAM	Biodiversity Assessment Method
BAM C	Biodiversity Assessment Method Calculator
BBS	Brigalow Belt South
BC Act	Biodiversity Conservation Act 2016 (NSW)
BCAR	Biodiversity Certificate Assessment Report
BOS	Biodiversity Offsets Scheme
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
Ch	Chainage
CMA	Catchment Management Authority Area
DBH	Diameter at Breast Height
DIWA	Directory of Important Wetlands in Australia
DPI	Department of Primary Industries (DPI)
DPIE	Department of Planning, Industry and Environment (Formerly OEH)
DNG	Derived Native Grassland
DotEE	Commonwealth Department of the Environment and Energy (formerly DotE)
DotE	Commonwealth Department of the Environment (superseded)
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (superseded)
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
FFJV	Future Freight Joint Venture
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater dependent ecosystems
GIS	Geographical Information System
ha	hectares
Hr	hour
HTE	High Threat Exotic
km	kilometres
KTP	Key threatening process
IBRA	Interim Biogeographic Regionalisation for Australia
KMA	Koala Management Area

Abbreviation	Explanation
LGA	Local Government Area
m	metre
MNES	Matters of National Environmental Significance
NPW Act	National Parks and Wildlife Act 1974 (NSW)
NS2B	North Star to Border Project
NSW	New South Wales
NSW EES	New South Wales Environment, Energy and Science
NV Act	*Native Vegetation Act 2003* (NSW) (Repealed, superseded by the LLS Act and SEPP)
OEH	NSW Office of Environment and Heritage (Currently DPIE)
PCT	Plant Community Type
PMST	Protected Matters Search Tool
RDP	Rapid Data Points
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy 2017
SMP	Site Management Plan
SSI	State Significant Infrastructure
SSD	State Significant Development
TEC	Threatened Ecological Community
TSC Act	Threatened Species Conservation Act 1995 (NSW) (Repealed, superseded by the BC Act)
TSPD	Threatened Species Profile Database
TSR	Travelling Stock Route
VEC	Vulnerable Ecological Community
VIS	Vegetation Information System
WoNS	Weed of National Significance

Glossary

Term	Explanation
Adverse impact	Adverse impacts are defined as those impacts that result in an unwanted and unanticipated result of taking a particular action. In an environmental context, an adverse impact means any change in the physical or biological conditions of the natural environment that results in a detrimental effect upon flora, fauna, air, water, minerals, or other natural characteristic of the area.
BAM calculator (BAM C)	An online application of the BAM which uses the rules and calculations outlined in the BAM, and allows the used to apply the BAM at a site and observer the results of the assessment. Refer https://www.lmbc.nsw.gov.au/bamcalc.
Biodiversity	▪ Biodiversity is the variety of all living things; the different plants, animals, micro-organisms, the genetic information they contain and the ecosystems they form.
Biodiversity assessment method (BAM)	A prescribed method for assessing vegetation community health and structure as outlined in Section 6 of the BC Act 2016, that provides a consistent method for the assessment of biodiversity on a proposed development or major project, or clearing site, guidance on how a proponent can avoid and minimise potential biodiversity impacts, and the number and class of biodiversity credits that need to be offset to achieve a standard of 'no net loss' of biodiversity.
Biodiversity Conservation Act 2016 status	The BC Act categorises threatened species within NSW under one of four statuses': **Vulnerable** ▪ Face a very high risk of extinction in NSW in the medium-term future **Endangered** ▪ Face a very high risk of extinction in Australia in the near future **Critically endangered** ▪ Facing an extremely high risk of extinction in Australia in the immediate future **Presumed extinct** ▪ There is no reasonable doubt that the last member of the species in Australia has died
Bioregion	A bioregion as defined in An Interim Biographic Regionalisation of Australia (IBRA) (Thackway and Cresswell 1995).
Critical habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an endangered species, an endangered population or an endangered ecological community that is critical to the survival of the species, population or ecological community. Critical habitat is listed under the FM Act and/or the EPBC Act
Cumulative impacts	When numerous projects occur within a region they can cause cumulative impacts. Cumulative impacts: ▪ May differ from those of an individual project when considered in isolation ▪ May be positive or negative ▪ Have a severity and duration that depends on the spatial and temporal overlap of projects occurring in a region.
Direct impacts	Impacts that result from a direct interaction between integral proposal activities and the ecological receptor (e.g. land clearing resulting in vegetation and habitat loss)
Ecological community	An ecological community is a naturally occurring group of native plants, animals and other organisms living in a unique habitat.
Ecological receptor	An ecological receptor is a feature, area or structure or grouping of the aforementioned that may be affected by direct or indirect changes to the environment.
Ecosystem credit	A measurement of the value of threatened ecological communities, threatened species habitat for species that can be reliably predicted to occur with a PCT, and PCTs generally. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values as a biodiversity stewardship site.

Term	Explanation
EPBC Act conservation status	Under the EPBC Act, listed species and threatened ecological communities are assigned a conservation status of extinct in the wild, critically endangered, endangered or vulnerable. Migratory species are also listed as Migratory. Definitions of these terms under the Act are as follows: **Extinct in the wild** ■ It is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range or, ■ It has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a timeframe appropriate to its lifecycle and form **Critically endangered** ■ It is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria **Endangered** ■ It is not critically endangered, and ■ It is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria **Vulnerable** ■ It is not critically endangered or endangered, and ■ It is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria **Migratory** Migratory species are those animals that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations. Examples of migratory species are species of birds (e.g. albatrosses and petrels), mammals (e.g. whales) or reptiles. Listed migratory species are those listed in the: ■ Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) ■ China-Australia Migratory Bird Agreement (CAMBA) ■ Japan-Australia Migratory Bird Agreement (JAMBA) ■ Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied
High constraint area	An area that support a relatively high number of ecological receptors and/or receptors with relatively high sensitivity, that is at risk from the proposal activity.
High threat exotic	A weed species which has been designated under NSW legislation (Biosecurity Act 2015) as high risk for input into the BAM C.
IBRA subregion	Are more localised and homogenous geomorphological units in each IBRA bioregion. This report covers IBRA subregions.
Indirect impacts	Impacts that are not a direct result of proposal activities but tend to occur away from the original impact area via a complex pathway (e.g. soil disturbance during construction promoting weed and/or pest invasion that reduces habitat quality). In accordance with the EPBC Act, indirect impacts may include the following: ■ Downstream or downwind impacts, such as impact on wetlands or ocean reefs from sediment, fertilisers or chemical which are washed or discharged into river systems ■ Upstream impacts such as impacts associated with the extraction of raw materials and other inputs which are used to undertake the action ■ Facilitated impacts which result from further actions (including actions by third parties) which are made possible or facilitated by the action.
Key Threatening Process	A process or event which adversely affects threatened species, populations of a species or ecological community or it may cause species, populations of a species or ecological communities to become threatened i.e. invasion of weeds or cane toads.
Microchiropteran bats	This report uses the term Microchiropteran bats (microbats) to refer to small mostly insectivorous bats that use echolocation to navigate and find food. The microbats constitute the suborder Microchiroptera within the order Chiroptera.

Term	Explanation
Migratory	Species listed as migratory under the EPBC Act. Refer to definitions of EPBC Act conservation status, for meaning of migratory under the Act
Native vegetation (BC Act)	Native vegetation means any of the following types of plants native to New South Wales: ■ Trees (including any sapling or shrub or any scrub) ■ Understorey plants ■ Groundcover (being any type of herbaceous vegetation) ■ Plants occurring in a wetland. Native vegetation extends to any plant (both living and dead) that is endemic to NSW regardless of it's location.
Negative impact	An impact that is considered to result in an unfavourable or adverse change to an ecological receptor.
Non-native vegetation	Vegetation that does not meet any PCT description and is not mapped as remnant vegetation, usually planted crops or non-native pastures. Vegetation which does not meet the definition of native vegetation under the BC Act
Patch	A patch is an area of native vegetation within the subject land that: a) Occurs on the subject land, and b) Includes native vegetation that has a gap of less than 100 m from the next area of moderate to good condition native vegetation (≤ 30 m for non-woody ecosystems). Where vegetation does not meet this requirement (e.g. low-quality vegetation) a patch is not recorded. A patch may extend onto neighbouring land that is not part of the subject land. It is used as a filter to predict if threatened species are likely to occur or use habitat within the subject land.
Permanent impact	The impact will last longer than 21 years
Plant community type (BC Act)	Is a vegetation classification system which classify plant community types on the basis of inherent attributes and characteristics of the vegetation structure, growth form and plant species. It is not restricted to a geographical region or vegetation condition
Proposal	The amount and area of works being proposed to occur
Segmented	In this report the term 'segmented' (also segment) has been used as a proxy for 'staged', in the context of credits and offset obligations
Serious and irreversible impact (SAII)	The BC Regulation defines a SAII as: 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: ■ It will cause a further decline of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline ■ 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 ■ 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 ■ 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 (refer BAM).
Significant impact	In accordance with the EPBC Act, a significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
Spatial extent	The scale of potential impacts used to determine the magnitude of impacts and defined by three qualitative categories i.e. widespread, regional and local
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Species Profile Database.
Species polygon	The area of the subject land within which a species is considered to be present is mapped and forms the species polygon for that species under the BAM

Term	Explanation
Study area	A term used in the BAM to define the area within a 500 m buffer from the disturbance footprint of the alignment, and 1,500 m from the disturbance footprint of the borrow pits
Subject land	A term used in the BAM to define the disturbance footprint subject to assessment
Threatened ecological community	Threatened ecological communities (TECs), which include endangered ecological communities, are defined and listed under both the *NSW Biodiversity Conservation Act 2016* and EPBC Act 1999. In both cases the plant community types (PCTs) and TECs are different classifications that have been developed independently of each other.
Threatened species (NSW)	In NSW a species in considered threatened if a) there is a reduction in its populations size b) it has a restricted geographical distribution or c) there are few mature individuals. A species may be listed under the BC Act 2016 as: ■ Vulnerable ■ Endangered ■ Critically endangered, or ■ Presumed extinct. How threatened a species is in NSW depends on: ■ The extent of its population reduction ■ The size of its geographical distribution, or ■ The number of mature individuals. Populations of a species and ecological communities can also be listed as threatened
Vegetation zone	Areas of the same PCT with the same broad condition state, mapped in accordance with Subsection 5.3.1 of the BAM.
Wetland	Wetlands are defined in NSW as areas of land covered or saturated with water. Wetlands can be covered with fresh, brackish or salt water that's generally still or slow moving. The water can also sit just below the surface. Many wetlands in inland NSW can be dry for 10 years or longer before being flooded after heavy rainfall and then stay wet for several years. This allows wetland plants and animals to regenerate and reproduce.

Executive summary

This report has been prepared by the following accredited assessors shown in Table 1 below.

Table 1 Accredited assessors

Person	BAM accreditation	Signature
Sarah Glauert	BAAS17097	
Dr Oliver Robertson	BAAS20007	

This Terrestrial Biodiversity Technical Report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued 13 March 2020 (Application number SSI-9371). The structure and content of the report has been specifically designed to meet the requirements of the *Biodiversity Conservation Act 2016* (NSW) (BC Act) and has been prepared in accordance with the minimum requirements of the Biodiversity Assessment Method (BAM) so as to satisfy the requirements of a Biodiversity Development Assessment Report (BDAR) (refer Sections 1-6 and Section 9). For ecological receptors outside of the jurisdiction of the BC Act, assessment pathways are consistent with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (terrestrial threatened flora and fauna species and threatened ecological communities) and other relevant regulatory provisions (refer Section 7). The purpose of this report is to gain primary approvals to allow the proposal to proceed.

Table 2 Checklist indicating compliance with Biodiversity Assessment Method and location of information

BDAR reporting requirement as per Appendix 10 of the BAM	Location within this document
Introduction including operational and construction footprint	Section1.1.1 and Section 1.1.2
Site Map	Figure 1.1
Location Map	Figure 1.1
Identification of landscape features including IBRA bioregion and subregion identification	Section 4.1.1.1 and Appendix A
Native vegetation including class, type, area, and species relied on for PCT identification, TEC status, percent cleared value of PCT	Section 4.1.1.3, Section 4.2.2 and Section 4.2.9
Map of PCTs, PCT zones, Patch size (to> 100ha) and plot locations	Figure 3.5 and Appendix A Map C.3
Map of TECs	Appendix A Map C.5
Field Plot data sheets	Appendix A and supplied to DPIE
Description of survey effort	Section 3.4.6, Section 3.4.7 and Appendix A, Appendix B, Appendix D and Appendix F
Vegetation integrity scores	Section 6 and Table 6-1
Candidate species	Section 4.2.4.3 and Table 4-12
Table of ecosystem credit species and associated PCTs	Section 4.2.3 and Table 4-8
Justification for any exclusions of ecosystem credit species	Section 4.2.3 and Table 4-9
Table of species credit species, biodiversity risk rating and associated PCTs,	Section 4.2.4 and Table 4-10
Justification for any exclusions of species credit species	Section 4.2.5 and Table 4-11
Species credit species polygon maps	Section 4.2.6, Appendix A and Appendix F
Targeted survey effort	Section 3.4, Table 3-11 and Appendix F
Table of species habitat features and abundance on site	Table 4-16
Demonstration of efforts to avoid and minimise impacts upon biodiversity values	Section 5.3

BDAR reporting requirement as per Appendix 10 of the BAM	Location within this document
Table of measures to be implemented before, during and after construction	Table 5-2 and Table 5-3
Map of final project footprint including construction and operation	Figure 1.1
Identification of SAII	Section 6.1.4
Map of any SAII	Appendix A Map C.7 (flora) and Appendix F Map D.2 (fauna)
Identification of impacts requiring offset, impacts not requiring offset and areas not requiring assessment	Section 6.1.2
Map of impacts requiring offset	Appendix A Map C.6
Map of areas not requiring offset	Appendix A Map C.6
Map of area not requiring assessment	Appendix A Map C.6
Impact summary	Section 6 and Section 10
Table of PCTs requiring offset and the number of ecosystem credits required	Table 6-1
Table of threatened species requiring offset and the number of species credits required	Table 6-2
Table of paddock tree credits required	Table 6-4
Table of credit classes and matching credit profile	Table 4-5, Table 4-9 and Table 6-4

ARTC propose to construct the North Star to Border (NS2B) section of Inland Rail ('the proposal'), which is a key component of the wider Inland Rail network between Melbourne and Brisbane. Key features of the proposal include 25 km of new track within the existing, non-operational Boggabilla rail corridor, approximately 5 km of new track within a greenfield rail corridor, one crossing loop, one maintenance siding and three associated turn outs. It will also involve the construction of 39 culvert locations and 11 bridge crossings, 63 rail crossing locations, and ancillary works. Ancillary facilities will include borrow pits and laydown areas temporarily required during the construction phase. The design response to key environmental features has been developed in line with engineering constraints for a feasible rail design. The rail design is based on avoiding and minimising environmental and social impacts, minimising disturbance to existing infrastructure and meeting engineering design criteria.

The subject land is situated within the New England North West region of NSW and traverses the Brigalow Belt South bioregion defined by the Interim Biogeographic Regionalisation for Australia (IBRA). The subject land has been significantly modified by agricultural land use, where the clearing of native vegetation has been extensive. Current dominant land cover types include exotic pasture grasslands, irrigated and dryland crops, and fallow fields. Large tracts of remnant vegetation are rare within the subject land, with the majority of remaining native vegetation occurring in small fragments, often in a highly degraded state. Some connectivity is provided by riparian vegetation along drainage lines.

The information within the report has been provided in segments to allow for offsetting to be delivered in a staged manner prior to impacts occurring. All works associated with the alignment including laydown areas, the camp and access tracks have been reported as the 'alignment'. Each site related to a potential borrow pit has been assigned a number and been reported as such i.e. Borrow Pit 1 and includes impacts only occurring should that Borrow pit be required as part of the works.

All potential borrow pits have been included in this report though it is envisioned that not all borrow pits will be used. Therefore, not all credits within this report are expected to be required to be retired. This report has followed the precautionary principle and assumed the largest potential impact will occur (i.e. worst-case scenario).

The subject land provides habitat for six TECs and 84 threatened species listed under the BC Act, including four TECs and 19 threatened species listed under the EPBC Act, as well as areas identified by the NSW Government as important environmental values.

The proposal assessment framework has been designed to provide an objective approach to identifying the proposal's environmental constraints and potential impacts to ecological receptors.

The table below outlines the maximum possible impact areas associated with the project and credits required under BAM for BC Act listed ecological receptors, divided into segments for offset purposes. The ecosystem and species credits identified in the table below are required for BC Act listed ecological receptors. Some of these ecological receptors are also listed under the EPBC Act.

It is important to note that not all Borrow pits are likely to be activated for the project. However, in line with the precautionary principle and in order to show all possible impacts and cumulative effects this report assumes all Borrow pits will be used throughout the development of this project.

Table 3 **Area of impact, impacted PCTs and Biodiversity Assessment Methodology credits required for each segment of the proposal**

Segments	Native vegetation impacted (ha)	Non-native vegetation impacted (ha)	Total area impacted (ha)	PCTs impacted	Ecosystem credits	Species credits
Alignment total	326.8	161.7	488.5	27, 35, 36, 52, 53, 56, 98, 192, 244, 247, 628	7,755	54,426
Borrow Pit 1	4.6	0.6	5.2	147	126	126
Borrow Pit 2	18.7	NA	18.7	35, 418	223	1,415
Borrow Pit 4	0	10	10	-	0	0
Borrow Pit 5	20.1	7.7	27.8	192	293	1,128
Borrow Pit 7	47.3	16.9	64.2	35, 56	1,011	6,212
Borrow Pit 8	21.1	2.8	23.9	56	787	7,673
Borrow Pit 9	50.1	4.7	554.8	35, 418	1,427	13,361
Borrow Pit 11	19.4	3.2	22.6	35	520	3,550
Borrow Pit 13	2.5	16.4	18.9	98	36	49
Borrow Pit 25	6.0	19.7	25.7	35, 418	72	627
Borrow Pit 26	5.3	3.0	8.3	35	129	818
Total	**521.9**	**246.7**	**1268.65**	**27, 35, 36, 52, 53, 56, 98, 147, 192, 244, 247, 418, 628**	**12,379**	**89,385**

Multiple terrestrial ecological receptors were identified within the subject land, these were assessed under different methodologies dependent upon how they are regulated:

- Threatened species, TECs, and plant community types regulated under the BC Act were assessed under the BAM
- Threatened species and TECs regulated under the EPBC Act (including ecological receptors also regulated under the BC Act) were assessed in accordance with the SIAM, which considered ecological receptor sensitivity and the magnitude of potential related impacts upon the specific ecological receptor.

Informed by the outcomes of the desktop and field assessments, identification of potential impacts from proposal activities upon the receptors was undertaken as mentioned above.

The construction and operation of the proposal has the potential to impact on receptors via the following mechanisms (predominantly associated with the construction phase):

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species by invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors

- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light impacts
- Increase in litter (waste)
- Erosion and sedimentation
- Disturbance to specialists breeding and foraging habitat
- Trampling of threatened species
- Fallen timber and bush rock collection and removal
- Fertiliser drift
- Increased fire risk.

Impact assessment under the BAM identified potential serious and irreversible impacts (SAII) for one Plant Community Type (PCT) and two species-credit species as listed below:

- PCT 35 – Brigalow – Belah open forest/woodland known to occur – 101.8 ha
- Pale imperial hairstreak (*Jalmenus eubulus*) – 78.6 ha of potential habitat
- *Platyzoma microphyllum* (Braid fern) – 11.4 ha of potential habitat.

Impact assessment under the SIAM, identified significant impacts on four terrestrial threatened fauna species. Significantly impacted species, and the corresponding magnitude of potential impacts are listed below:

- Curlew sandpiper (*Calidris ferruginea*) - Moderate
- Dunmall's snake (*Furina dunmalli*) - High
- Red goshawk (*Erythrotriorchis radiatus*) - Moderate
- Spot-tailed quoll (*Dasyurus maculatus*) - Moderate

Potential cumulative impacts of the proposal include:

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species by invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light impacts
- Increase in litter (waste)
- Erosion and sedimentation
- Disturbance to specialists breeding and foraging habitat
- Trampling of threatened species
- Fallen timber and bush rock collection and removal
- Fertiliser drift

- Increased fire risk.

The significance of the predicted cumulative impacts as a result of the proposal and other similar projects are likely to be highest on the following ecological receptors:

- Threatened Ecological Communities listed under the EPBC Act and/or BC Act (6 TECs)
- Threatened flora and fauna listed under the EPBC Act and/or BC Act (85 species)
- The Great Artesian Basin.

There is the potential for some proposal activities to have an irreversible and/or permanent impact upon some ecological receptors, even after the implementation of all mitigation measures.

During the detailed design (post-EIS approval phase) of the proposal, sensitive ecological receptors identified during the EIS will be subject to further investigation to assess where impacts to these receptors may be reduced (through design refinement), and to confirm the final magnitude of the significant adverse residual impacts upon the identified ecological receptors. Reductions in impacts may require a BDAR modification to amend offset calculations under the BAM. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable through mitigation and the unavoidable residual adverse impacts are offset. Specific mitigation measures include:

- Disturbance footprints are limited to that required to construct and operate the works
- Design is developed to minimise impacts to waterways, riparian vegetation and in-stream flora and habitats
- Fauna crossing opportunities will be co-located with waterway crossing structures to maintain habitat connectivity across the landscape
- Watercourse crossing structures (including culverts and bridges) are designed in accordance with design considerations for fish friendly waterway crossings within Australia
- Construction areas including compounds, stockpiles, fuel storage, laydown areas and staff parking should be defined outside the tree protection zone
- The total number of borrow pits required for the proposal will be revised from the total number of borrow `pits assessed in the BDAR. Where possible borrow pits will be preferentially selected / located to minimise biodiversity impacts.

As a result of the proposal, a total of up to 101,476 biodiversity credits may require offsetting in accordance with the BAM guidelines. In addition, offsets may also be required for ecological receptors listed under the EPBC Act that are predicted to be subject to significant residual impacts following the application of mitigation measures. Offsets under the EPBC Act will be amended following the detailed design phase.

A bilateral agreement has been signed between the Australian Government and NSW which means that some offset obligations can be calculated in BAM credits for EPBC Act receptors also listed under the BC Act, however it is still the prerogative of the Australian Government not to accept the specific application of the offset. The Commonwealth Minister or a delegate will determine this on a case by case basis. Credits for species-credit species can compound for habitats that support multiple species-credit species and require offsets for each species. Alternatively, the significant adverse residual impacts to dual listed receptors may be offset under the EPBC Act.

1 Introduction

1.1 Proposal description

The Australian Government has committed to delivering Inland Rail, an interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales and Toowoomba in Queensland. Inland Rail is a significant piece of nation transport infrastructure. It will enhance Australia's existing rail network and serve the interstate freight market.

The Inland Rail route, which is approximately 1,700 kilometres (km) long, will involve:

- Using the existing interstate rail corridor through Victoria and southern NSW
- Upgrading approximately 400 km of existing corridor, mainly in western NSW
- Providing approximately 600 km of new corridor in northern NSW and southeast QLD
- Inland Rail has been divided into 13 sections, 7 of which are located in NSW.

In 2015, Australian Rail Track Corporation (the proponent) developed a ten-year programme to deliver Inland Rail by 2025. ARTC was created in 1997 after the Australian and State governments agreed to the formation of a 'one stop shop' for all operators seeking access to the national interstate rail network. The proponent is seeking approval to construct and operate the North Star to NSW/QLD border section of Inland Rail (the proposal). The proposal consists of approximately 25 km of upgraded track between North Star and a greenfield deviation around Whalan Creek, and 5 km of new track between Whalan Creek and the NSW/QLD border. The proposal is a key component of the wider Inland Rail network between Melbourne and Brisbane.

1.1.1 Key proposal features

The proposal consists of the key features listed in Table 1-1 and are shown in Figure 1.1. The construction phase of the proposal will involve laydown areas, temporary access tracks, borrow pits, a mobile concrete batching plant, and a construction camp.

Table 1-1 Key features of the proposal

Aspect	Description
New track	▪ Approximately 25 km of new track within the existing non-operational Boggabilla rail corridor ▪ Approximately 5 km of new track within a greenfield rail corridor.
Crossing loop and turnouts	▪ One crossing loop, designed to accommodate trains up to 1,800 m long ▪ Turnouts will be provided on either end of the crossing loop to allow trains to be guided from one track to another.
Bridges	▪ Eleven new bridges ▪ This includes an approximately 1.8 km long viaduct over the Macintyre River and Whalan Creek, which are major watercourses. The viaduct is located in both NSW and QLD; therefore, it will be assessed under *the NSW Environmental Planning and Assessment Act 1979* (EP&A Act) by this Terrestrial Biodiversity Technical Report, and under the *State Development and Public Works Organisation Act 1971* by the NSW/QLD border to Gowrie EIS. Approval from both States is required before construction of the viaduct can commence.
Drainage	▪ Reinforced concrete pipe culverts and reinforced concrete box culverts. Scour protection measures will be installed as required around culverts to avoid erosion where required. ▪ Embankment and catch drains adjacent to the proposed alignment to divert surface runoff the nearest bridge or culvert location.
Level crossings	▪ Work on new and existing level crossings ▪ Signalling and communications infrastructure.

Aspect	Description
Ancillary works	▪ Ancillary infrastructure including signalling and communications infrastructure, signage, fencing and utilities.
Borrow pits	▪ Ten potential borrow pits, new and existing with estimated potential material quantities ranging from <112,000m^3 to 3,600,000m^3

1.1.2 Descriptions of key features of the proposal

1.1.2.1 Permanent footprint

The proposal is in accordance with the following parameters:

- Generally, aligns with the existing non-operational Boggabilla rail corridor between North Star (Chainage (Ch) 0.9 km) and the greenfield deviation (Ch 25.7 km)
- A strip of land at least 10 m wide has been allowed on either side of the earthworks footprint to accommodate track-side infrastructure such as fencing, drainage, etc.
  - Encompasses the ultimate footprint of:
    - New track and associated earthworks
    - Bridge and drainage structures, including scour protection around culverts
    - Level crossings
    - Road realignments
    - Possible upgrades to adjacent roads and infrastructure
    - Rail maintenance access road, including access points, passing bays and turnarounds
    - Fencing and signage.

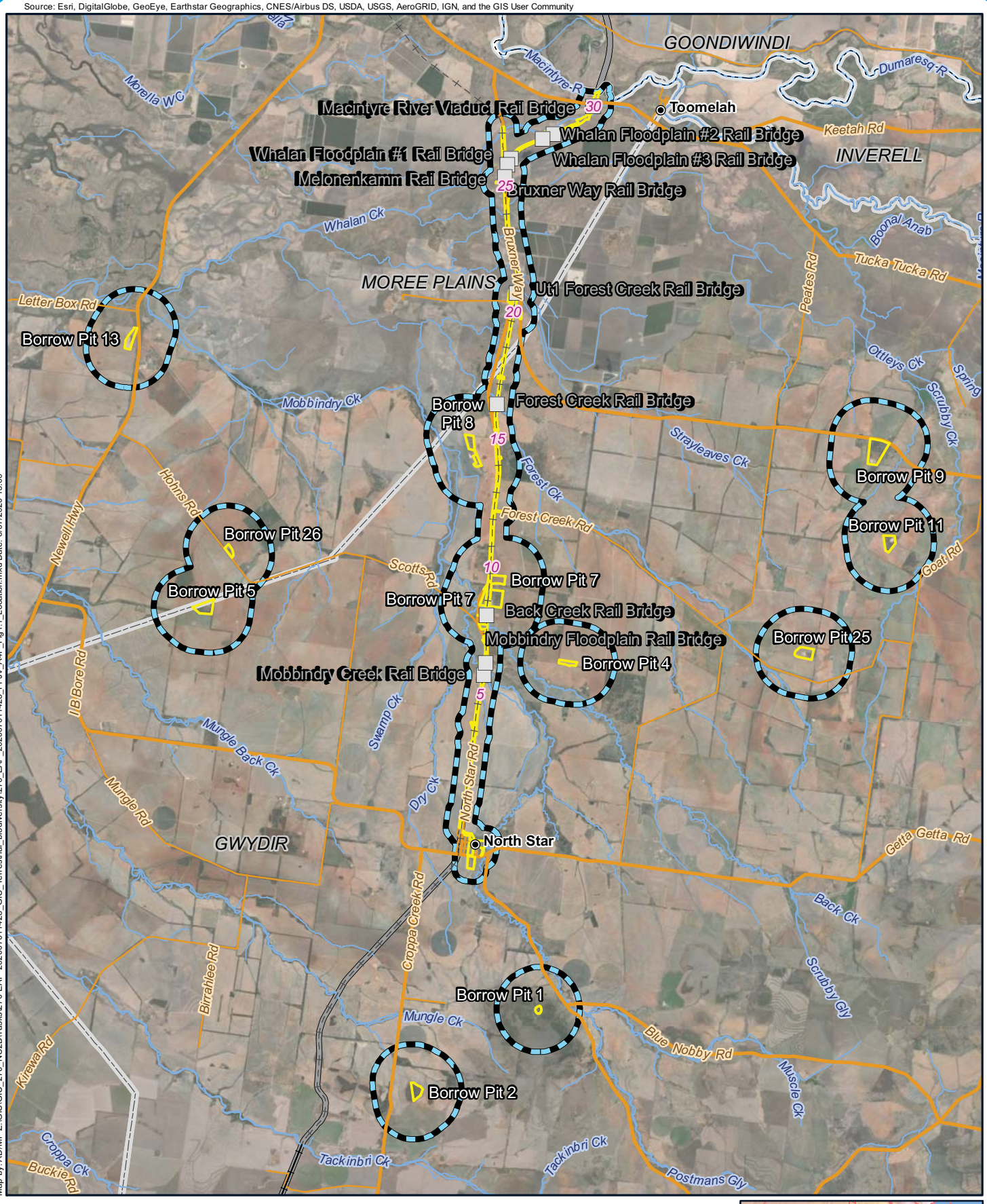
The width of the permanent footprint varies along the proposed alignment depending on the shape and size of the features listed above. A minimum width of 40 m has been adopted for the permanent footprint; however, the width of the permanent footprint increases to approximately 200 m in the vicinity of the Bruxner Highway realignment to allow for realignment.

1.1.2.2 Temporary footprint

Areas of temporary disturbance are proposed including:

- Laydown areas
- Access tracks
- Workers camp at North Star
- Borrow pits.

These areas are considered temporary because they are only required during the construction phase of the proposal and are needed for construction purposes. The impacts relating to the laydown areas, access tracks and workers camp have been reported as part of the ‘alignment’ for the project area. The impacts relating to the Borrow pits and access tracks related to the Borrow pits have been reported individually for each potential Borrow pit area i.e. Borrow pit 1 or Borrow pit 8.


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
GOONDIWINDI
INVERELL
MOREE PLAINS
GWYDIR
Macintyre River Viaduct Rail Bridge
Whalan Floodplain #1 Rail Bridge
Whalan Floodplain #2 Rail Bridge
Whalan Floodplain #3 Rail Bridge
Melonenkamm Rail Bridge
Bruxner Way Rail Bridge
Ut1 Forest Creek Rail Bridge
Forest Creek Rail Bridge
Back Creek Rail Bridge
Mobbindry Floodplain Rail Bridge
Mobbindry Creek Rail Bridge
Borrow Pit 13
Borrow Pit 8
Borrow Pit 26
Borrow Pit 5
Borrow Pit 7
Borrow Pit 4
Borrow Pit 9
Borrow Pit 11
Borrow Pit 25
Borrow Pit 1
Borrow Pit 2
Toomelah
North Star
Macintyre R
Dumaresq R
Whalan Ck
Mobbindry Ck
Forest Ck
Strayleaves Ck
Swamp Ck
Dry Ck
Mungle Back Ck
Mungle Ck
Tackinbri Ck
Croppa Creek Rd
Bruxner Way
Newell Hwy
Peates Rd
Keetah Rd
Tucka Tucka Rd
Boonal Anab
Ottleys Ck
Scrubby Ck
Spring
Goat Rd
Getta Getta Rd
Back Ck
Scrubby Gly
Blue Nobby Rd
Muscle Ck
Postmans Gly
Letter Box Rd
Hohns Rd
Forest Creek Rd
Scotts Rd
IB Bore Rd
Mungle Rd
North Star Rd
Birrahlee Rd
Kirewa Rd
Croppa Ck
Buckie Rd
Morella WC
Map by: AD/MF Z:\GIS\GIS_270_NS2BTTasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig1.1_Location.mxd Date: 6/07/2020 15:00
Legend
Bridges
Chainage (km)
Localities
Existing rail (operational)
Existing rail (non-operational)
Adjoining alignments
Major roads
Minor roads
NSW/QLD border
Watercourses
Local Government Areas
Study area
Subject land
Toowoomba
Brisbane
Ipswich
Grandchester
Warwick
Goondiwindi
Narrabri
A4 scale: 1:200,000
0 1 2 3 4 5km
Future Freight
Integrating Community, Environment and Engineering
Date: 21/01/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56
North Star to NSW/QLD border
Figure 1.1:
Proposal location and context

1.1.2.3 New track

Track within the existing non-operational Boggabilla rail corridor is considered unsuitable for reuse due to its' alignment. Therefore, the proposal consists of:

- Approximately 25 km of new, single line, standard gauge track within the existing non-operational Boggabilla rail corridor, between North Star (Ch 0.9 km) and the greenfield deviation (Ch 25.7 km)
- Approximately 5 km of new, single line, standard gauge track within a greenfield rail corridor, between the greenfield deviation (Ch 25.7 km) and the NSW/QLD border (Ch 30.6 km).

Key features of the new track include:

- Single line – trains travelling in both directions share the same track
- Standard gauge – gauge refers to how far apart the rails on a railway track are spaced. Standard gauge indicates that the rails will be spaced 1.435 metres (m) apart
- Greenfield rail corridor – this is a section of new track within a new rail corridor.

The track structure will consist of rails, fasteners, rail pads and concrete sleepers, which are laid on a trackbed of ballast. Collectively, these elements are referred to as 'permanent way'. The new track is designed to support 21 tonne axle load intermodal (i.e. container) trains up to 1,800 m long and 6.5 m high. Tonne axle load refers to the total weight felt by the track due to passing trains. Depending on the tonne axle load, train speeds will vary between 80 kilometres/hour (km/hr) and 115 km/hr.

1.1.2.4 Borrow pits

Borrow pits are required during the construction phase of the proposal and are needed to supply fill material, including general fill and rock ballast. A total of 11 borrow pits, new and existing were investigated for potential use. Each borrow pit has an estimated potential material quantity ranging from <112,000 m^3 to 3,600,000 m^3. The borrow pits are located up to 14.5 km from the permanent footprint. The total number of required borrow pits will be revised during the detailed design phase. The impacts relating to the Borrow pits and access tracks required for the Borrow pits have been reported individually for each potential Borrow pit area i.e. Borrow pit 1 or Borrow pit 8.

1.1.2.5 Crossing loop and maintenance siding

The proposal includes one crossing loop, known as the Boonal crossing loop. As the proposal is for single line track, the Boonal crossing loop will allow trains travelling in opposite directions to pass each other.

The Boonal crossing loop is an approximately 2.2 km section of single line, standard gauge track, running roughly parallel to the main track. The optimised location of the crossing loop is between Ch 22.7 km and Ch 24.9 km. During the feasibility design phase, the location of the crossing loop was chosen on account of following factors:

- Preliminary operational modelling undertaken by ARTC for the wider Inland Rail Programme demonstrated that installing a crossing loop in this location would minimise train travel times in both directions
- Placing the crossing loop in this location minimises construction works as it is a relatively straight section of track, clear of structures and level crossings.

The Boonal crossing loop is able to accommodate trains up to 1,800 m long. It is connected to the main track at both ends via low-speed (80 km/hr) turn outs.

A one-ended, single line, standard gauge siding will be incorporated into the Boonal crossing loop for maintenance purposes. It is approximately 500 m long and will be connected to the southern end of the Boonal crossing loop via a low-speed (40 km/hr) turn out. Connecting to the southern end is preferred over the northern end due to the straighter, flatter alignment, and lower embankment heights.

1.1.2.6 Bridges

Bridges are required so that water, vehicles, and in some cases, stock and pedestrians may cross the proposed rail corridor. Two types of bridges are proposed:

- Rail over water
- Rail over road.

The type of bridge proposed depends on a range of factors, including the local topography, road usership, rail and road alignments at the crossing point, and access requirements. Bridges have been provided at all major watercourse crossings along the proposed alignment to minimise impacts to the local riverine system, and to avoid having to divert watercourses.

A total of 11 new bridges are proposed. An approximately length for each bridge is included in Table 1-2.

Table 1-2 Proposed bridges

Chainage of the southern-most end of the bridge (km)	Bridge	Approximate bridge length
Ch 5.7	Mobbindry Creek Rail Bridge	112 m
Ch 6.1	Mobbindry Floodplain Rail Bridge	182 m
Ch 8.1	Back Creek Rail Bridge	70 m
Ch 16.3	Forest Creek Rail Bridge	154 m
Ch 20.7	UT1 Forest Creek Rail Bridge	136 m
Ch 25.2	Melonenkamm Rail Bridge	160 m
Ch 25.7	Bruxner Highway Rail Bridge	114 m
Ch 26.0	Whalan Floodplain #1 Rail	183 m
Ch 27.5	Whalan Floodplain #2 Rail	126 m
Ch 28.0	Whalan Floodplain #3 Rail	126 m
Ch 29.3	Macintyre River Viaduct	1,750 m

1.1.2.7 Macintyre River viaduct

The includes an approximately 1.8 km long viaduct that crosses Whalan Creek, Tucka Tucka Road and the Macintyre River. Approximately 1.2 km of the viaduct is located in NSW, while the remaining 0.6 km is located in Queensland, where the NSW/QLD border is defined by the centre point of the Macintyre River.

During the feasibility design phase, the design of the Macintyre River viaduct was informed by geotechnical and flooding studies. Initially, three separate bridge structures were proposed over Whalan Creek, Tucka Tucka Road, and the Macintyre River. However, an iterative flood assessment of the design has resulted in a single viaduct structure that minimises upstream flooding impacts.

1.1.2.8 Culverts

Culverts are structures that allow water, whether in a watercourse or drainage line, to pass under the proposed alignment. During the feasibility design phase, proposed designs and locations for culverts were developed based on:

- Addressing hydrologic, hydraulic and geotechnical constraints associated with the proposal
- Minimising potential flooding impacts by:
  - Locating culverts at low points along the proposed alignment in order to prevent upstream water ponding
  - Ensuring that the inside base of culverts is level with the natural surface

- Designing culverts to withstand a 100-year flood event (i.e. 1% annual exceedance probability (AEP))
- Maintaining existing patterns of flow across the floodplain so as not to divert or concentrate flows.

Culverts associated with the proposal will be a mix of reinforced concrete pipe culverts and reinforced concrete box culverts. Scour protection measures will be installed as required around culverts, on disturbed stream banks, and around waterfront land (defined as the bed of any river, lake or estuary and the land within 40 m of the river banks, lake shore or estuary mean high water mark, *Water Management Act 2000*) to prevent erosion.

A total of 48 culvert locations were identified during the feasibility design phase. The number of culverts and their locations will be further refined during the detailed design phase in order to minimise potential impacts, especially flooding impacts.

1.1.2.9 Road rail interfaces

Road rail interfaces are points at which the proposed alignment intersects a road. Treatments for road rail interfaces can be categorised as grade separated crossings, level crossings or closures:

- **Grade separated crossings** – road and rail cross each other at different heights so that traffic flow is not affected. Grade separations are either road over rail, or rail over road.
- **Level crossings** – road and rail cross each other at the same level. Level crossings have either passive or active controls to guide road users:
  - **Passive** – have static warning signs (e.g. stop and give way signs) that are visible on approach. This signage is unchanging with no mechanical aspects or light devices.
  - **Active** – have static warning signs as well as flashing lights and automatic boom gates
- **Closure** – existing road rail interfaces may be closed, consolidated into fewer crossing points, relocated or diverted to where there is lower operational demand. Closures will only occur where the impact of diversions or consolidations is considered acceptable, or the existing location is not considered safe and cannot reasonably be made safe.

There are no existing signalling or communications systems within the proposed alignment. New signalling and communications infrastructure will be installed at the crossing loop and active level crossings, enabling active controls to tie into the wider Inland Rail network.

In the future, ARTC's Advanced Train Management System is proposed to manage signalling and communications for the wider Inland Rail network. Communication (voice and data) will occur between Network Control Centres and locomotives operating on the Inland Rail network.

1.1.2.10 Road realignments

The proposal involves a minor realignment of Bruxner Highway. Bruxner Highway is a main road pursuant to the *Roads Act 1993*. It is a two lane, two-way road with a posted speed limit of 100 km/hr.

In order to achieve flood immunity, the elevation of the proposal must be significantly higher than Bruxner Highway at the point where the proposal intersects Bruxner Highway. Therefore, a rail over road grade separation with a minimum vertical clearance of 5.4 m is proposed at the point of intersection.

At the point where the proposal intersects the existing Bruxner Highway, the skew angle is approximately 75 degrees. Maintaining this skew angle would involve constructing a bridge with excessively long, non-standard spans.

A more practical skew angle is 45 degrees. To achieve a 45-degree skew angle, it is proposed to realign Bruxner Highway to the east, and then back to the existing Bruxner Highway on a slight curve.

As part of the reconfiguration, the elevation of Bruxner Highway will be maintained or slightly increased. This will maintain or improve flood immunity at this location.

1.1.2.11 Earthworks

The proposed alignment traverses the Macintyre River floodplain for approximately 14 km. To achieve flood immunity, the majority of the proposal is elevated on a fill embankment. The embankment height is typically less than 2 m; however, around the realigned Bruxner Highway and in the lead up to the Macintyre River Viaduct, the embankment height increases to approximately 7.5 m.

Embankments have been designed and constructed to minimise erosion during flood events. The steepness of embankments will be minimised as much as possible to encourage vegetation growth, which will further prevent erosion.

No significant cuttings (i.e. > 10 m deep) are proposed. However, where practicable, materials won from excavations and cuttings will be assessed for re-use as embankment fill. If unsuitable for reuse, this material may be formed into permanent spoil mounds within the rail corridor. Features of the spoil mounds include:

- Located as close as possible to the source of excavated material
- Maximum height of 2 m
- May be located on both sides of the track
- Would be stabilised as required
- Gaps in the spoil mounds would be provided to allow water to drain away from the track.

The exact location, sizing and design of spoil mounds will be determined during the detailed design phase, with consideration given to the results of hydraulic modelling and sight distances. Mounds would not be located in areas where they would impact on flooding or drainage, or in areas where they will impact extant vegetation communities or wildlife habitat (i.e. they will be located in cleared areas).

1.1.3 Fencing and signage

The purpose of fencing is to protect the proposed alignment from trespass and prevent stock on adjoining properties from accessing the rail corridor. Standard rural fencing, consistent with the existing rural landscape, is proposed between the rail corridor and adjoining properties, generally located at the corridor boundary.

Fencing will generally be provided around culverts. Gates will be installed for accessing culverts for inspection and maintenance.

Fencing will continue to bridge abutments. However, to avoid locating fencing in major watercourses and floodplains, the rail corridor will not be fenced underneath bridges. In specific cases, fencing will be provided across waterways to prevent stock on adjoining private properties from accessing the rail corridor.

Signage is also proposed, especially at level crossings.

1.2 Operation of the proposal

The proposal will form part of the rail network managed and maintained by ARTC. Train services will be provided by a variety of operators. Trains will be a mix of grain, bulk freight and other general transport trains.

Inland Rail as a whole will be operational once all 13 sections are complete, which is currently estimated to be in 2025.

The proposal will involve operation of a single rail track with crossing loops, to accommodate double stacked freight trains up to 1,800 m long and 6.5 m high. Train speeds will vary according to axle loads and track geometry and will range from 80 to 115 km/hr. It is estimated that the proposal will run an annual average of about 32 train services per day in both directions (northbound and southbound) in 2025. This is then likely to increase to up to 47 per day in both directions in 2039 with current proposed infrastructure.

1.3 Maintenance of the proposal

During the operation phase standard maintenance activities will be undertaken, including:

- Bridge and culvert inspections
- Sleeper replacement
- Rail welding and grinding
- Ballast dropping and cleaning
- Track tamping and reconditioning
- Signalling systems and equipment maintenance.

1.4 Purpose and scope of this report

The purpose of this report is to meet the requirements of the Secretary's Environmental Assessment Requirements (SEARs) issued 13 March 2020 (Application number SSI-9371) and suitably inform the EIS in order to obtain primary project approvals.

This technical report has been prepared to address the SEARs that are associated with biodiversity. The structure and content of the report has been specifically designed to meet the requirements of the *Biodiversity Conservation Act 2016* (NSW) (BC Act) and provide sufficient information to satisfy the requirements of the Biodiversity Assessment Method (BAM) and BDAR (refer Sections 1-6 and Section 9), whist still assessing matters of national environmental significance (MNES) in accordance with the EPBC Act, and relevant guidelines (refer Section 7). Only MNES that are listed in the SEARs as EPBC Act controlling provisions are considered in this report (i.e. listed threatened species and communities). Key Threatening Processes and their applicability to the project are discussed in Section 6.4. The report will also address offset requirements and inform the feasibility of the proposal accordingly. Further details on the assessment approach are provided in Section 3.2. The assessment of aquatic ecological receptors is contained in a separate Aquatic Biodiversity Technical Report (refer EIS Chapter 11: Biodiversity and EIS Appendix S: Aquatic Biodiversity Technical Report).

The specific components of the BDAR and their location within the report is detailed in Table 3-2. The assessment of MNES ecological receptors is contained within Section 7, including desktop results, significant impact assessment and provision of disturbance areas that constitute a significant adverse residual impact upon habitat for MNES. Cumulative impact to ecological receptors regulated under the BC Act and the EPBC Act are combined (refer Section 8).

2 Legislative, policy standards and guidelines

2.1 Commonwealth and State legislation

This section describes the legislative, policy and management framework for the proposal, including:

- Legislative framework which applies to the assessment of ecological receptors applicable to the proposal at the Commonwealth and State levels, providing the statutory context for which the assessment has been undertaken
- Statutory approvals required as a result of potential impacts to terrestrial and aquatic ecology
- The approach to environmental offsets for significant residual impacts on BC Act listed ecological receptors and MNES.

An overview of the Commonwealth and State legislation that is relevant to environmental aspects of the proposal, is presented in Table 2-1.

Table 2-1 Legislation, policies, standards and guidelines relevant to the proposal

Legislation, policy or guideline	Intent and relevance to the proposal	Relevant report section
Commonwealth legislation		
Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)	The EPBC Act is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the Act as matters of national environmental significance (MNES). There are nine MNES to which the EPBC Act applies, these are: ■ World heritage properties ■ National heritage places ■ Wetlands of international importance ■ Listed threatened species and ecological communities ■ Migratory species ■ Commonwealth marine areas ■ Great Barrier Reef Marine Park ■ Nuclear actions ■ A water resource, in relation to coal seam gas and large coal mining development. The proposal has been referred (EPBC number: 2018/8222) to the Department of Agriculture, Water and the Environment (DAWE) and was determined to be a controlled action by the department on 12th June 2018 because the department considers that the proposed action has the potential to significantly impact MNES and must therefore assess the significance of any potential impacts on MNES threatened species and communities. The EPBC Act controlling provisions for the proposed action are: ■ Listed threatened species and communities (section 18 and 18A). All MNES protected under the triggered controlling provisions are potentially relevant. The department considers that the proposed action has the potential to significantly impact the following: ■ Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered ■ Coolibah – Black box woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions – endangered ■ Natural grasslands on basalt and fine-textured alluvial plans of northern New South Wales and southern Queensland – critically endangered ■ Weeping myall woodlands – endangered ■ White box-Yellow box-Blakely's red gum grassy woodland and derived native grassland – critically endangered ■ Squatter pigeon (southern) (*Geophaps scripta scripta*) – vulnerable ■ Painted honeyeater (*Grantiella picta*) – vulnerable ■ Murray cod (*Maccullochella peelii*) – vulnerable ■ Large-eared pied bat (*Chalinolobus dwyeri*) – vulnerable ■ Corben's long-eared bat (*Nyctophilus corbeni*) – vulnerable	Refer Sections 7.1, 7.4.2 and 7.5.1. Aquatic species refer to the Aquatic Biodiversity Technical Report Appendix S of EIS

Legislation, policy or guideline	Intent and relevance to the proposal	Relevant report section
	▪ Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (*Phascolarctos cinereus*) – vulnerable ▪ *Cadellia pentastylis* (Ooline) – vulnerable ▪ *Dichanthium setosum* (Bluegrass) – vulnerable ▪ Homopholis belsonii (Belson's panic) – vulnerable ▪ *Tylophora linearis* (Slender tylophora*)* – endangered ▪ Five-clawed worm-skink (*Anomalopus mackayi*) – vulnerable ▪ Adorned delma (*Delma torquata*) – vulnerable ▪ Dunmall's snake (*Furina dunmalli*) – vulnerable. Note that this may not be a complete list and it is the responsibility of the proponent to ensure any protected matters under this controlling provision are assesed for the Commonwealth decision-maker's consideration. Migratory species are not a controlling provision for the proposal. The Bilateral agreement made under section 45 of the EPBC Act relating to environmental assessment (the assessment bilateral agreement) is relevant to the proposal. The assessment bilateral agreement allows the Commonwealth Minister for the Environment to rely on specified environmental impact assessment processes of the State of New South Wales in assessing action under the EPBC Act. While offset obligations can be calculated in BAM credits for EPBC Act projects, the Australian Government may not accept the specific application of the offset rules for projects approved before Amending Agreement No. 1 is signed. The Commonwealth Minister or a delegate will determine this on a case by case basis. It has been noted in the SEARs that – "*A number of offsets options under the NSW Biodiversity Conservation Act 2016 will be acceptable for EPBC Act approval purposes. It is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action i.e. 'like for like'. Like-for-like includes protection of native vegetation that is the same EEC or habitat being impacted, or funding to provide a direct benefit to the matter being impacted i.e. threat abatement, breeding and propagation programs or other relevant conservation measures"*.	
EPBC Act Environmental Offsets Policy (2012)	Where the proposal is determined to have a significant 'residual impact' on a MNES offsets will need to be determined and approved by the DAWE. Offsets are required under the EPBC Act to compensate for any residual impacts to MNES once avoidance and mitigation measures have been considered (DSEWPaC 2012). An offset must deliver an overall conservation outcome that improves or maintains the viability of the MNES and should be tailored specifically to the attribute of the MNES that is to be affected. An offsets package is defined in the EPBC Offsets Policy (DSEWPaC 2012) as a suite of actions that a proponent undertakes in order to compensate for the residual significant impact of a proposal. An offsets package can comprise of a combination of direct offset and other compensatory measures. Direct offsets are actions that deliver a measurable conservation gain for an impacted protected matter. Conservation gains may be achieved by: ▪ Improving existing habitat for the protected matter; ▪ Creating new habitat for the protected matter; ▪ Reducing threats to the protected matter;	Refer Sections 6.3.2 and 7.5.1

Legislation, policy or guideline	Intent and relevance to the proposal	Relevant report section
	▪ Increasing values of a heritage place; and/or ▪ Averting the loss of a protected matter or its habitat that are under threat. Where the proposal is determined to have a significant 'residual impact' on a MNES offsets will need to be determined and approved by the DAWE.	
State legislation, policies and guidelines (NSW)		
Environmental Planning and Assessment Act 1979 (EP&A Act)	The EP&A Act provides a statuary basis for planning and environmental assessment in NSW. The EP&A Act provides a framework for environmental planning and development approvals and includes provisions to ensure that the potential environmental impacts of a development are assessed and considered in the proposal approval process. The objective of this Act that are relevant to biodiversity are as follows: ▪ To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment ▪ To protect the environment, including the conservation of native animals and plants (including threatened species), ecological communities and their habitats. The proposal is subject to assessment under Division 5.2 of the EP&A Act as it is State Significant Infrastructure. This report forms part of the assessment under the Act.	Refer Section 3.3
Biodiversity Conservation Act 2016 (BC Act)	The BC Act came into effect on the 25 August 2017 and repealed the *Threatened Species Conservation Act 1995* (TSC Act), the *Native Vegetation Act 2003* (NV Act) and components of the *National Parks and Wildlife Act 1974* (NPW Act) The purpose of the BC Act is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development (described in *the Protection of the Environment Administration Act 1991*) and Section 516A of the EPBC Act), and in particular: ▪ To conserve biodiversity at bioregional and State scales, and ▪ To maintain the diversity and quality of ecosystems and enhance their capacity to adapt to change and provide for the needs of future generations, and ▪ To improve, share and use knowledge, including local and traditional Aboriginal ecological knowledge, about biodiversity conservation, and ▪ To support biodiversity conservation in the context of a changing climate, and ▪ To support collating and sharing data, and monitoring and reporting on the status of biodiversity and the effectiveness of conservation actions, and ▪ To assess the extinction risk of species and ecological communities, and identify key threatening processes, through an independent and rigorous scientific process, and ▪ To regulate human interactions with wildlife by applying a risk-based approach, and ▪ To support conservation and threat abatement action to slow the rate of biodiversity loss and conserve threatened species and ecological communities in nature, and ▪ To support and guide prioritised and strategic investment in biodiversity conservation, and	Refer Sections 3.2.1, 3.3, 4, 6.1, 8 and 9

Legislation, policy or guideline	Intent and relevance to the proposal	Relevant report section
	▪ To encourage and enable landholders to enter into voluntary agreements over land for the conservation of biodiversity, and ▪ To establish a framework to avoid, minimise and offset the impacts of proposed development and land use change on biodiversity, and ▪ To establish a scientific method for assessing the likely impacts on biodiversity values of proposed development and land use change, for calculating measures to offset those impacts and for assessing improvements in biodiversity values, and ▪ To establish market-based conservation mechanisms through which the biodiversity impacts of development and land use change can be offset at landscape and site scales, ▪ To support public consultation and participation in biodiversity conservation and decision-making about biodiversity conservation, and ▪ To make expert advice and knowledge available to assist the Minister in the administration of this Act. From 25 August 2017, provisions in the TSC Act dealing with assessment of impacts on threatened species, populations and ecological communities were repealed and replaced by provisions in the BC Act. The BC Act requirements for impact assessment are significantly different as they introduce the Biodiversity Offsets Scheme (BOS).	
Biodiversity Conservation Regulation 2017 (BC Regulation)	Provides further regulation under the BC Act, particularly related to: ▪ The protection of native animals and plants ▪ The declaration of areas of outstanding biodiversity value ▪ The listing criteria for threatened species and ecological communities, ▪ Private land conservation agreements ▪ The biodiversity offsets scheme established by the Act and the Biodiversity Stewardship Payments Fund under the scheme ▪ Biodiversity assessments and approvals under the Environmental Planning and Assessment Act 1979 ▪ The biodiversity certification of land ▪ Public consultation ▪ The Biodiversity Conservation Trust ▪ Regulatory compliance mechanisms ▪ The retention, destruction or disposal of seized animals, plants or other things under the Act ▪ Criminal proceedings ▪ Other matters.	Refer Sections 3.2.1, 6 and 9
Local Land Services Act 2013 (LLS Act)	The LLS Act provides a governance framework and statutory corporation (Local Land Services) responsible for the delivery and management of local land services in the social, economic and environmental interests of the state. The LLS Act defines Category 1 – Exempt Land. Category 1 areas are exempt from assessment under the BAM and include areas used for perennial and seasonal horticulture and irrigated cropping. There is no Category 1 land within the subject land.	Refer Section 3.2

Legislation, policy or guideline	Intent and relevance to the proposal	Relevant report section
Biosecurity Act 2015	Under the *Biosecurity Act,* all native and non-native plants are regulated with a general biosecurity duty "*to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.*" Declared weeds are known to occur within the proposal area and will be considered in weed mitigation measures.	Refer Sections 4.2.1, 4.2.8 and 5.2.1.4
Biodiversity Assessment Method (BAM)	The BAM is the assessment manual that outlines how an accredited person assesses impacts on biodiversity at development sites and stewardship sites. It is a regulatory document that provides: ■ A consistent method for the assessment of biodiversity on a proposed development or major project, or clearing site, ■ Guidance on how a proponent can avoid and minimise potential biodiversity impacts, and ■ The number and class of biodiversity credits that need to be offset to achieve a standard of 'no net loss' of biodiversity. An accredited assessor must apply the BAM. The assessor documents the results of the biodiversity assessment in a Biodiversity Development Assessment Report (BDAR). The BDAR identifies how the proponent proposes to avoid and minimise impacts, any potential impact that could be characterised as serious and irreversible according to specified principles and the offset obligation required to offset the likely biodiversity impacts of the development or clearing proposal, expressed in biodiversity credits. Vegetation assessments and biodiversity assessments contained in this report have been completed by an accredited assessor.	Refer Sections 3,4,5,6.1 and 8

3 Methods

3.1 Introduction

The assessment of biodiversity components for the proposal listed under the BC Act was undertaken using the BAM (refer Table 3-1). Where an ecological receptor was not assessed under the BAM, different assessment pathways were applied to according to the relevant legislation such as EPBC and FM Acts, as required for compliance with the SEARs. All ecological receptors assessed under the FM Act are covered in the Aquatic Biodiversity Technical Report (Appendix S of the EIS).

All ecological receptors regulated under the BC Act, impact significance was assessed using methodologies prescribed by the BAM (as required under the *Biodiversity Conservation Act 2016*) (refer Section 3.2.1), and for ecological receptors regulated under the EPBC, assessments were undertaken in accordance with a Significant Impact Assessment Methodology (SIAM) (refer Section 7).

An ecological receptor is a feature, area or structure that may be affected by direct or indirect changes to the environment, including ecological receptors identified by the SEARS such as threatened species and ecological communities. Sections 3.2.1 and 7.1 describe the BAM and SIAM methodologies in more detail. All identified ecological receptors were assessed for cumulative impacts (refer Section 3.2.2).

Table 3-1 Assessment methodologies with corresponding legislation and relevant ecological receptors

Assessment methodology	Legislation associated with ecological receptor	Ecological receptor
Biodiversity Assessment Method (BAM) (refer Section 3.2.1)	*Biodiversity Conservation Act 2016* (BC Act)	Threatened flora and fauna
		Habitat for threatened species
		BC Act listed TECs
		Native vegetation
SIAM using magnitude and sensitivity (refer Section 7.1)	*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Threatened flora and fauna (EPBC Act)
		EPBC Act listed TECs
Cumulative impact assessment (refer Section 3.2)	BC Act and EPBC Act	Threatened flora and fauna
		Habitat for threatened species
		TECs
		Native vegetation

3.2 Overview of assessment methodologies

3.2.1 Biodiversity Assessment Method

The BAM sets out the requirements for a repeatable and transparent assessment of terrestrial biodiversity values on land in order to:

- Identify areas of non-native vegetation which do not require further assessment
- Identify the biodiversity values on land subject to proposed development, clearing, or land in a biodiversity certification assessment area, or land proposed as a biodiversity stewardship site
- Determine the impacts of proposed development, or clearing or biodiversity certification on biodiversity values

- Quantify and describe the biodiversity credits required to offset the residual impacts of proposed development or clearing or conferral of biodiversity certification on biodiversity values
- Quantify and describe the biodiversity credits that can be created at a biodiversity stewardship site from the improvement in biodiversity values from management actions undertaken at the site.

Where required under NSW legislation, the BAM is used to assess terrestrial biodiversity values on a proposed development site or proposed clearing site or land proposed for biodiversity certification. It must also be used to assess the biodiversity values on land proposed to be secured under a biodiversity stewardship agreement. The terms development, development footprint and development site are also taken to include clearing, clearing footprint and clearing site respectively, except where the reference is to a small area development or a major project development. The BAM defines the 'subject land' as the temporary construction footprint and is defined as the likely extent of the area needed to construct the proposal. For the purposes of this assessment and following the precautionary principle, impacts to the maximum disturbance area within the subject land, including proposed borrow pits, temporary and permanent disturbance, were assessed. This information is provided in the form a BDAR as per Appendix 10 of the BAM (refer Table 3-2).

The assessment requirements set out in the BAM enable the survey and assessment effort to be scaled depending on the level of risk posed by the impact of the development, the availability and quality of existing information such as native vegetation maps, and the area of land that is being assessed.

Table 3-2 Checklist indicating compliance with Biodiversity Assessment Method and location of information

BDAR reporting requirement as per Appendix 10 of the BAM	Location within this document
Introduction including operational and construction footprint	Section1.1.1 and Section 1.1.2
Site Map	Figure 1.1
Location Map	Figure 1.1
Identification of landscape features including IBRA bioregion and subregion identification	Section 4.1.1.1 and Appendix A
Native vegetation including class, type, area, and species relied on for PCT identification, TEC status, percent cleared value of PCT	Section 4.1.1.3, Section 4.2.2 and Section 4.2.9
Map of PCTs, PCT zones, Patch size (to> 100ha) and plot locations	Figure 3.5 and Appendix A Map C.3
Map of TECs	Appendix A Map C.5
Field Plot data sheets	Appendix A and supplied to DPIE
Description of survey effort	Section 3.4.6, Section 3.4.7 and Appendix A, Appendix B, Appendix D and Appendix F
Vegetation integrity scores	Section 6 and Table 6-1
Candidate species	Section 4.2.4.3 and Table 4-12
Table of ecosystem credit species and associated PCTs	Section 4.2.3 and Table 4-8
Justification for any exclusions of ecosystem credit species	Section 4.2.3 and Table 4-9
Table of species credit species, biodiversity risk rating and associated PCTs,	Section 4.2.4 and Table 4-10
Justification for any exclusions of species credit species	Section 4.2.5 and Table 4-11
Species credit species polygon maps	Section 4.2.6, Appendix A and Appendix F
Targeted survey effort	Section 3.4, Table 3-11 and Appendix F
Table of species habitat features and abundance on site	Table 4-16
Demonstration of efforts to avoid and minimise impacts upon biodiversity values	Section 5.3
Table of measures to be implemented before, during and after construction	Table 5-2 and Table 5-3
Map of final project footprint including construction and operation	Figure 1.1
Identification of SAII	Section 6.1.4

BDAR reporting requirement as per Appendix 10 of the BAM	Location within this document
Map of any SAII	Appendix A Map C.7 (flora) and Appendix F Map D.2 (fauna)
Identification of impacts requiring offset, impacts not requiring offset and areas not requiring assessment	Section 6.1.2
Map of impacts requiring offset	Appendix A Map C.6
Map of areas not requiring offset	Appendix A Map C.6
Map of area not requiring assessment	Appendix A Map C.6
Impact summary	Section 6 and Section 10
Table of PCTs requiring offset and the number of ecosystem credits required	Table 6-1
Table of threatened species requiring offset and the number of species credits required	Table 6-2
Table of paddock tree credits required	Table 6-4
Table of credit classes and matching credit profile	Table 4-5, Table 4-9 and Table 6-4

Impacts of development, clearing or certification on biodiversity values, or gains in biodiversity values at biodiversity stewardship sites are measured in biodiversity credits. There are two broad categories of classes of credit for the purposes of measuring impact or gain – ecosystem credits and species credits. The BAM will step through the credit class category that is created or required for certain kinds of impact or gain. Each credit is assigned attributes to determine whether a particular credit within a class is 'like' another credit in the same class for the purpose of applying the like for like rules and variation rules set out in the *Biodiversity Conservation Regulation*. A class of credits is formed where the biodiversity credit shares the same attributes. Ecosystem credits have seven shared attributes. For species credits, the only shared attribute is the name of the threatened species. Attributes are considered when determining suitable like-for-like offset credits.

The BAM incorporates three distinct stages (refer Figure 3.1). Stage 1 involves desktop and fieldwork-based assessment of biodiversity values within and adjacent to the subject land. Stage 2 involves the assessment of proposed impacts on biodiversity values identified in Stage 1. Impact assessment follows the mitigation hierarchy of avoid, minimise then mitigate. Stage 3 occurs during the detailed design phase following submission of the EIS.

Under the BAM the proponent must describe the area within the disturbance footprint plus a 500 m buffer when describing a linear alignment such as the proposed rail line. For non-linear infrastructure or development a 1,500 m buffer is required such as for the proposed borrow pit areas for this proposal. For the purposes of this report the disturbance footprint plus the required buffer areas required for the BAM assessment are hereon referred to as the study area. As it is envisaged that not all borrow pits will be utilised and that those which are, will be commissioned at different stages of the project, each borrow pit has been assessed as a separate 'project' to ensure the correct number of BAM plots and targeted surveys have occurred. This has allowed for both cumulative impacts to be assessed over the whole North Star to Border section of the alignment as well targeted assessment of the localised impacts associated with each borrow pit.

As the borrow pits have been assessed individually they have a 1,500 m buffer, where Borrow pit 7 intersects with the alignment the assessment has included a 500 m buffer for the alignment and a 1,500 m buffer for the borrow pit. The assessment for the alignment was conducted separately to that of Borrow pit 7 and as such has separate BAM plots associated with it. This will make any offsets associated only with Borrow pit 7 or the alignment easier to separate should Borrow pit 7 not be utilised for the project.

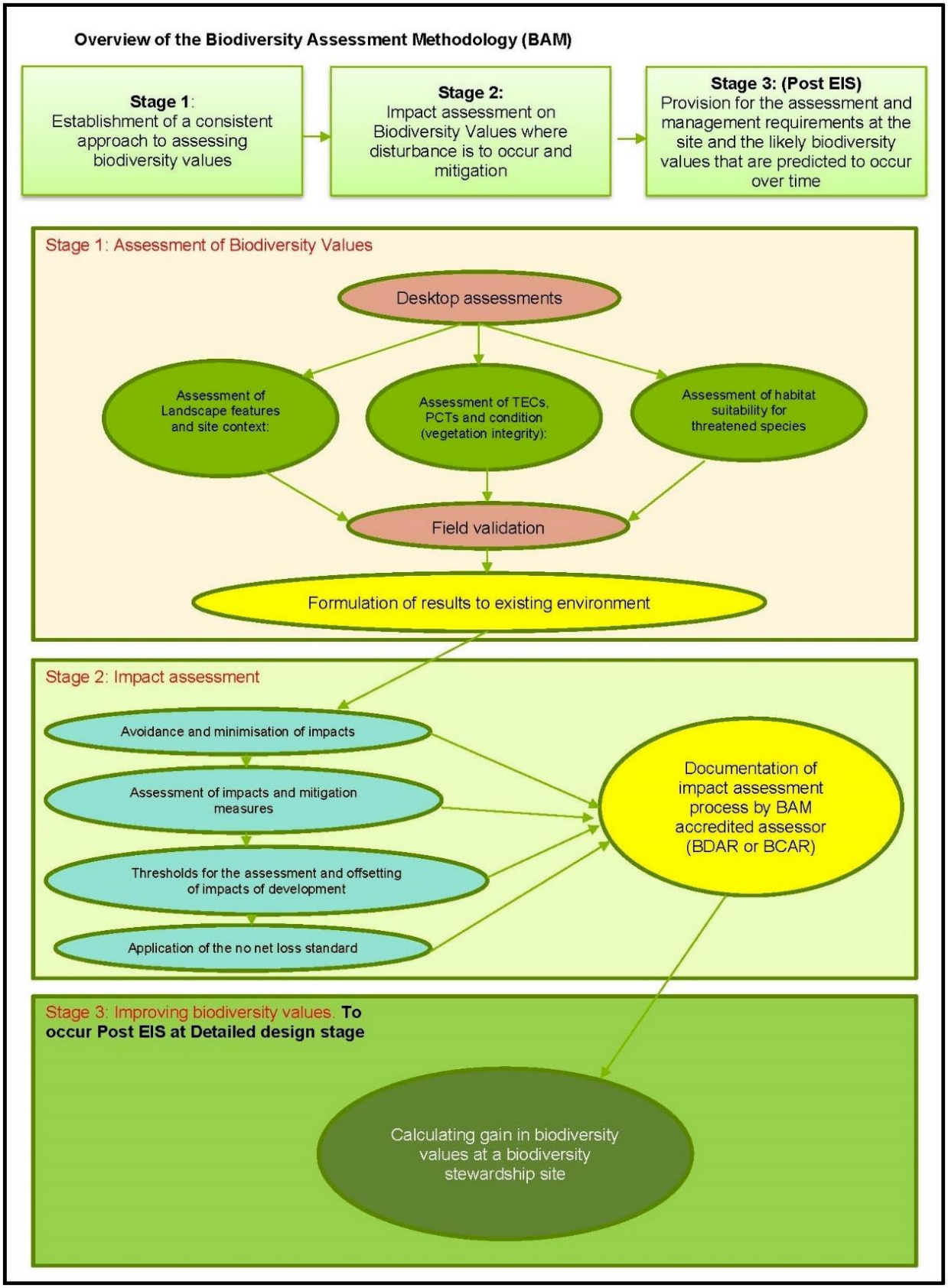


Figure 3.1 **Biodiversity Assessment Method approach**

3.2.1.1 Accredited Assessors under the Biodiversity Assessment Method

All sections of this report which relate specifically to the BAM and works associated with the proposal EIS have been completed or overseen by one or more of the following BAM accredited assessors:

- Sarah Glauert (BAM Assessor No. BAAS17097) (Primary assessor)
- Ben Roberts (BAM Assessor No. BAAS17023)
- Andrew Craig (BAM Assessor No. BAAS19022).
- Oliver Robertson (BAM Assessor No BAAS20007)

Other ecological consultants from the FFJV have undertaken work under the supervision of the BAM accredited assessors.

The outcomes of impact assessments undertaken under the BAM are typically presented in the form of a Biodiversity Development Assessment Report (BDAR) or a Biodiversity Certification Assessment Report (BCAR) which also presents the findings of Stage 1 (refer Figure 3.1). For the purposes of this Terrestrial Biodiversity Technical Report, this document will contain sufficient information to satisfy the requirements of a BDAR. The BDAR has been segmented with separate assessments for the alignment including the associated laydown areas, access tracks and camp and separate assessments for each potential borrow pit. It is anticipated that not all Borrow Pits will be required for the project. The impacts assessed in the BDAR are of a concept design using a conservative maximum footprint. During the detailed design phase it is anticipated that impacts will be revised and reduced. Specific methodologies associated with the assessment of impacts and their associated significance are detailed in Section 9 of the BAM (OEH 2017).

The sections of this Terrestrial Biodiversity Technical Report that constitute a BDAR are hereby certified as BAM compliant as of the 17 August 2020.

3.2.2 Cumulative impact assessment

When numerous projects occur in a region they can cause cumulative impacts. Cumulative impacts:

- May differ from those of an individual project when considered in isolation
- May be positive or negative
- Have a severity and duration that depends on the spatial and temporal overlap of projects occurring in a region.

This cumulative impact assessment only deals with:

- Projects that have been approved but where construction has not commenced
- Projects that have commenced construction
- Projects that have only recently been completed
- Projects that are currently being assessed as State significant infrastructure within Gwydir, Moree Plains and Inverell local government areas or Coordinated Projects in Goondiwindi local government area.

For the purpose of this assessment, the cumulative impact assessment area is defined as the spatial area of influence which is determined by each of the environmental and social issues being assessed for the proposal. The area of influence (AOI) considered in the assessment included state significant infrastructure projects within 300km.

This cumulative impact assessment has been prepared in accordance with the SEARs, which requires:

> *'An assessment of the cumulative impacts of the project considering other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed*.'

3.2.2.1 Project selection

Projects included in the cumulative impact assessment are:

- **Projects outside the overall Inland Rail programme of works.** Only state significant infrastructure projects under Division 5.2 of the EP&A Act, and other 'strategic' projects in the public domain as being planned, constructed or operated at the time the SEARs were issued, have been included in the cumulative impact assessment. Where additional projects worthy of inclusion were identified, the Secretary of the NSW Department of Planning and Environment was consulted for a determination on whether or not to include the project.
- **Inland Rail projects immediately adjacent to the proposal**. This included the Narrabri to North Star and the NSW/QLD Border to Gowrie projects of Inland Rail.

Projects that were excluded from the cumulative impact assessment are:

- Existing projects within the proposal subject land.
- Proposed projects that have not been developed to the point that their environmental assessment process has been made public.

Based on the above criteria, the projects that have been included in the cumulative impact assessment are summarised in Table 3-3. The location of each project is shown in Figure 3.2.

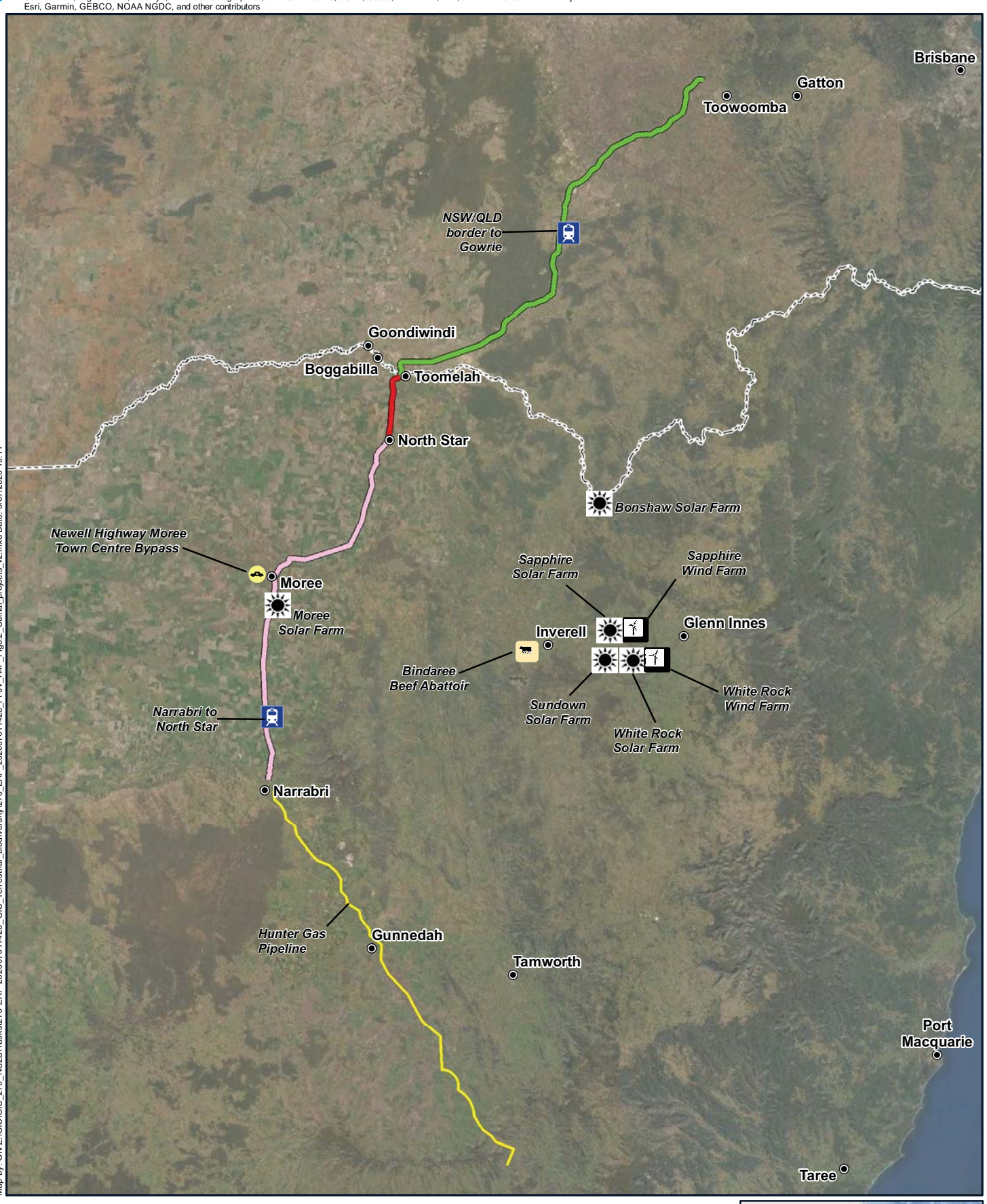
Table 3-3 Projects to be included in cumulative assessment

Project and proponent	Location	Description	EIS status	Construction dates	Construction jobs	Operation years	Operation jobs	Selection criteria	Relationship to the proposal	Distance from the proposal (km)
Border to Gowrie – Inland Rail (ARTC)	NSW/QLD Border to Gowrie	Approximately 146 km of new dual gauge track and 78 km of upgraded track from the NSW/QLD border, near Yelarbon, to Gowrie Junction, north west of Toowoomba in QLD	Project referred to Commonwealth Minister for the Environment	2021 to 2025	1,600	-	TBA	b)	Potential overlap on construction commencement for Border to Gowrie and finalisation of North Star to Border	0 (adjacent)
Narrabri to North Star – Inland Rail (ARTC)	Narrabri (NSW) to the village of North Star in NSW	An upgrade to approximately 188 km of track within the existing rail corridor and construction of approximately 1.6 km of new rail corridor	Proponent reviewing submissions	Mid 2018 to 2020	TBA	-	TBA	b)	Potential overlap of finalisation of Narrabri to North Star and commencement of North Star to Border construction	0 (adjacent)
Moree Solar Farm	10 km south of Moree, off the Newell Highway in Northern NSW	Construction of a 56 MWac/ 70.1 MWdc single axis tracking solar PV facility. Construction works currently involve the installation of the framing system which consists of the BladePiles and the NexTracker tracking systems, the JA Solar photovoltaic modules, the DC and AC wiring of the electrical equipment, the 22/66 kV on-site substation and the 66 kV transmission line	Approved by the NSW Major Projects Office on 17/07/2011	2018 to 2022	1,050	-	10 - 12	c)	Potential increase of traffic on the Newell Highway. Construction of Moree Solar Farm is scheduled around the peak visitation to Moree in autumn	79

Project and proponent	Location	Description	EIS status	Construction dates	Construction jobs	Operation years	Operation jobs	Selection criteria	Relationship to the proposal	Distance from the proposal (km)
Newell Highway Moree Town Centre Bypass	Moree	Construction of a 4.4 km two-lane bypass of the Moree town centre	Approved by the NSW Major Projects Office on 20 July 2004. Latest modification 8 approved 7 July 2010	-	-	-	-	c)	Potential increase of traffic on the Newell Highway	72
Bindaree Beef Abattoir – Rendering Plant and Bio-digester Plant	Bindaree Beef Abattoir, Inverell	The proposed project involves the installation of a wastewater treatment system (bio-digester) and new render plant facility to reduce odour and carbon emissions at its existing abattoir site. The bio-digester generates a bio-gas from waste and waste water which would then be reused at the site	Approved by the NSW Major Projects Office on 10 December 2014	12 months construction. Start date unknown	60	-	-	c)	Potential conflict or demand for construction resources if projects overlap. Increase of traffic volumes on the Gwydir and Newell Highway	104
Queensland -Hunter Gas Pipeline	Wallumbilla to Newcastle	420 km gas pipeline from the Narrabri Gas Project to Newcastle via, Gunnedah, Quirindi, Scone, Muswellbrook, Singleton and Maitland	Project determined under Part 3A – now transitioned to SSI	From approval, approximately 8 months of construction	600	-	150	c)	If construction occurs at the same time, there is potential for increase in traffic using similar routes and demand for construction resources and personnel	156
White Rock Solar Farm	20 km south-west of Glen Innes, 40 km east of Inverell NSW	Establishment of a 20-megawatt solar farm and associated infrastructure	Approved by the NSW Major Projects Office 14 June 2016	Construction forecast to take 6 months	50	25	TBA	c)	Potential increase in road traffic on the Gwydir Highway and the Newell highway	137

Project and proponent	Location	Description	EIS status	Construction dates	Construction jobs	Operation years	Operation jobs	Selection criteria	Relationship to the proposal	Distance from the proposal (km)
White Rock Wind Farm	20 km south-west of Glen Innes, 40 km east of Inverell NSW	Stage 2 of White Rock Wind Farm upgrades will consist of up to 48 turbines, producing up to 202 MW of clean renewable electricity	Approved by Major Projects Office on 10 July 2012	Late 2018	100	30	20	c)	Potential increase in road traffic on the Gwydir Highway and the Newell highway	142
Sundown Solar Farm	South of Gwydir Hwy, 30 km east of Inverell (NSW)	The project consists of a large-scale solar photovoltaic generation facility, including battery storage and associated infrastructure, with an estimated maximum capacity of up to 600 MW, enough to power over 250,000 homes	SEARs issued by Major Projects Office	2019 to 2023	-	-	-	c)	Potential increase in road traffic on the Gwydir Highway and the Newell highway	133
Bonshaw Solar Farm	Bruxner Highway, 16 km south of Bonshaw and 66 km north of Inverell (NSW)	GAIA Australia is proposing to develop a large scale solar photovoltaic generation facility and associated infrastructure with a capacity of 500 MW	SEARs issued by Major Projects Office	Mid 2019 to 2021	-	25	-	c)	Potential increase of traffic on the Bruxner Highway. North Star to Border alignment crossed the Bruxner Highway. Deconfliction at construction times may be required.	86
Sapphire Solar Farm	Project in the Kings Plains, Wellingrove and Sapphire areas, approximately 28 km east of Inverell and 18 km west of Glen Innes.	A 200 MW hybrid solar and battery power facility	Approved by the NSW Major Projects Office on 16 August 2018	2019 to 2020	200	25	150	c)	Potential increase of traffic on the Gwydir and Newell Highway	124

Project and proponent	Location	Description	EIS status	Construction dates	Construction jobs	Operation years	Operation jobs	Selection criteria	Relationship to the proposal	Distance from the proposal (km)
Sapphire Wind Farm	Project in the Kings Plains, Wellingrove and Sapphire areas, approximately 28 km east of Inverell and 18 km west of Glen Innes.	Construction of a 238 to 425 MW capacity wind farm (between 125 and 159 turbines)	Approved by the NSW Major Projects Office on 26 June 2013	TBA	-	-	-	c)	Potential increase of traffic on the Gwydir and Newell Highway	119



Legend

- Localities
- North Star to NSW/QLD border alignment
- NSW/QLD border

A4 scale: 1:2,300,000

0 10 20 30 40 50 km

Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 2
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.2:
Cumulative impact projects

3.2.2.2 Approach

The approach used to identify and assess potential cumulative impacts of this proposal provided within this technical report is summarised below.

- A review of the potential impacts identified within the EIS assessments
  - The environment at the time of the EIS SEAR is the baseline, prior impacts from past land use has not be considered
- A register of assessable projects has been collated with timelines to demonstrate the temporal relationship between projects. This has included:
  - Identification of projects outside of the Inland Rail Programme
    - Only 'state significant' or 'strategic' projects that are in the public domain as being planned, constructed or operated at the time of the EIS SEARs have been considered
    - Where additional projects worthy of consideration have arisen after the finalisation of the EIS SEARs, the Secretary of DPIE has been consulted to determine if assessment is required
  - The Inland Rail projects immediately adjacent to the project within the assessment
    - For this Project, the Narrabri to North Star Inland Rail Project and Border to Gowrie Inland rail Project have been considered
- Identification and mapping of the assessable projects and the areas of influence of the aspect being considered
  - Current operational projects and commercial or agricultural operations that are in the areas of influence around the Project are accounted for in the corresponding technical baseline studies (e.g. air, noise, social, economic, etc.)
- Where there is a potential overlap in impacts (either spatially or temporally), a cumulative impact assessment has been undertaken to determine the nature of the cumulative impact. This includes:
  - Where possible the assessment method has been quantitative in nature, but qualitative assessment has also been undertaken
  - Where quantitative assessment is possible, the significance of impact should be assessed in comparison to the same criteria or guidelines as adopted by the relevant technical impact assessments
  - Where the impacts are expressed qualitatively, the probability, duration, and magnitude/intensity of the impacts should be considered as well as the sensitivity and value of the receiving environmental conditions.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 3-4 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 3-5.

Table 3-4 Assessment matrix

Aspect	Relevance factor		
	Low	Medium	High
Probability of impact	1	2	3
Duration of impact	1	2	3
Magnitude/Intensity of impact	1	2	3
Sensitivity of receiving environment	1	2	3

Table 3-5 Impact significance

Impact significance	Sum of relevant factors	Consequence
Low	1 to 6	Negative impacts need to be managed by standard environmental management practices. Monitoring to be part of general project monitoring program.
Medium	7 to 9	Mitigation measures likely to be necessary and specific management practices to be applied. Targeted monitoring program required, where appropriate.
High	10 to 12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.

3.3 Desktop assessment – terrestrial flora and fauna

Existing information on the terrestrial biodiversity of the subject land was obtained from a range of sources, including databases, aerial photographs and maps.

Previous documents and reports relevant to the subject land were reviewed, including regional and sub-regional vegetation mapping reports, site-specific monitoring surveys, ecological surveys, and relevant ecological database searches.

Aerial imagery for the subject land was reviewed to identify land use patterns, extent of vegetation, relevant landscape/catchment matters and possible issues for the area.

As a matter of best practice, the desktop information listed below was reviewed. The review of literature included a desktop mapping (10 km buffer – referred to as the search area) and analysis exercise that examined available data for the subject land. Data sets, documents and other resources analysed included:

- NSW Environment, Energy and Science (EES) BioNet Wildlife Atlas threatened species records (accessed 7 August 2019)
- EPBC Act Protected Matters Search Tool (accessed 5 August 2019)
- Commonwealth, NSW and local legislation and planning instruments
- Ramsar and Directory of Important Wetlands in Australia (DIWA) wetlands, and drainage mapping
- State Vegetation Type Map
- Secretary's Environmental Assessment Requirements (SEARs)
- Any relevant previous ecological assessments conducted for the site or adjacent areas.

Details of the existing literature and previous study reports which have been reviewed for the desktop assessment are summarised in Table 3-6. The reports informed recent records of threatened species which may not have been updated on government databases at the time of database searches.

Table 3-6 Proposal related assessments and reports

Document title	Reference	Major findings
North Star to NSW/QLD Border Project Study Area Selection Report	ARTC 2018	▪ Alternative alignment options considered through Multi-Criteria Analysis (MCA) ▪ Preferred study area identified in May 2017 workshop Study area up to 2 km wide to allow for future alignment changes following Phase 2 Feasibility Assessment
Melbourne to Brisbane Inland Rail, 2016 Phase 1 Continuity Alignment Report, North Star to Yelarbon	WSP/PB 2017	▪ MCU comparison of east and west possible alignments ▪ Confirmation of North Star to Border investigation area (west) Investigation area includes two possible alignments to cross the Macintyre River
Melbourne to Brisbane Inland Rail, 2016 Phase 2 Preparatory Alignment Assessment Report, North Star to Yelarbon	WSP/PB 2017a	▪ 6km wide study area within the west option created to investigate possible Macintyre River crossing locations River crossing study area reduced to 2 km to allow further refinement
Narrabri to North Star Project, Environmental Impact Statement. Technical Report 2: Biodiversity Assessment Report	ARTC 2017	A Biodiversity Assessment Report identified the following offset requirements for the N2NS project: ▪ 18,826 ecosystem credits required for eight TECs ▪ 364 species credits for *Digitaria porrecta* (Finger panic grass) ▪ 2607 species credits for *Desmodium campylocaulon* (Creeping tick-trefoil) ▪ 1898 species credits for Homopholis belsonii (Belson's panic) ▪ 632 species credits for Koala (*Phasolarctos cinereus*)

3.3.1 Directory of Important Wetlands

The Directory of Important Wetlands in Australia (DIWA) identifies important wetland such as Ramsar sites. Additional detailing of inland wetlands includes permanent rivers and streams, seasonal and irregular rivers and streams, riverine floodplains, permanent freshwater lakes, seasonal/intermittent freshwater lakes and freshwater swamp forest and others.

3.3.2 Groundwater dependent ecosystems

An assessment of potential groundwater dependent ecosystems (GDEs) was undertaken via review of the following data sources:

- Relevant NSW Water Sharing Plans (which include scheduled listings of high priority GDEs)
- Bureau of Meteorology Groundwater Dependent Ecosystems Atlas.

The Bureau of Meteorology Groundwater Dependent Ecosystems Atlas was accessed to assess potential GDEs within or near the proposal site. An approximate 2 km radius around the alignment centreline was reviewed for potential GDEs as a conservative approach to assess potential impacts on ecological receptors. Detailed figures of potential GDE locations are provided elsewhere within the technical report for Groundwater (refer EIS Chapter 14: Groundwater).

3.4 Field assessments – terrestrial flora and fauna

3.4.1 Locations and timing

A representative sampling approach was employed as part of the field sampling methodology in line with the BAM guidelines. Seasonal sampling (i.e. Spring (mid-September to mid-December) and Autumn (late February to April) is recommended for taxa within this region. BAM plot surveys have occurred at the following times 1 October to 9 October 2018; 31 October to 6 November 2018; 18 June to 24 June 2019; 1 July to 7 July 2019. These surveys were conducted in accordance with the methodology described in Section 3.4.4 and included targeted searches for species credit species flora which had specified survey months that coincided with the BAM plot survey. Targeted fauna surveys for suitable species credit species occurred between 23 October to 30 October 2019. This survey included searches for species with no specified survey months, species which had October as one of the specified survey months and a detailed assessment of fauna habitat including the size and height of tree hollows at each location in order to determine if suitable breeding habitat was present for other species credit species. There have been areas with little or no overlap between survey events. To counter this, the precautionary approach has been adopted and in the absence of data to support otherwise, it has been assumed that threatened species known or predicted to occur within the region are present.

The broader landscape is currently experiencing drought to extreme drought conditions. The daily temperature as recorded at Texas Post Office (station number 041100) is closest to the survey area and daily rainfall as recorded at New Kildonan (station 041507) at the time of surveys are detailed in Table 3-7 and Table 3-8.

Table 3-7 Daily and monthly temperature observations during survey

Date	Minimum temperature	Maximum temperature
Monthly mean September 2018	**10.0**	**25.4**
1 October 2018	8.47	26.5
2 October 2018	8.1	28.0
3 October 2018	9.5	29.8
4 October 2018	13.1	25.2
5 October 2018	15.7	18.9
6 October 2018	14.3	25.7
7 October 2018	11.1	26.8
8 October 2018	12.4	28.2
9 October 2018	13.5	30.5
10 October 2018	12.2	32.2
30 October 2018	13.1	29.7
31 October 2018	14.4	32.0
Monthly mean October 2018	**13.9**	**28.6**
1 November 2018	15.2	35.
2 November 2018	16.8	32.6
3 November 2018	19.0	34.5
4 November 2018	18.2	37.2
5 November 2018	15.8	39.2
6 November 2018	23.6	40.7
Monthly mean November 2018	**15.7**	**31.6**
20 June 2019	2.2	19.5

Date	Minimum temperature	Maximum temperature
21 June 2019	-0.5	16.0
22 June 2019	-1.8	17.7
23 June 2019	-0.5	18.5
Monthly mean June 2019	**5.5**	**20.2**
3 July	6.4	24.0
4 July 2019	6.6	23.1
5 July 2019	10.9	22.0
6 July 2019	11.0	21.7
Monthly mean July 2019	**3.8**	**21.2**
23 October 2019	13.0	31.2
24 October 2019	13.1	32.1
25 October 2019	17.1	32.2
26 October 2019	18.1	34.5
27 October 2019	14.6	33.1
28 October 2019	12.5	32.2
29 October 2019	13.9	32.0
30 October 2019	17.2	28.0
Monthly mean October 2019	**13.1**	**30.6**

Table 3-8 Daily and monthly rainfall observations during survey

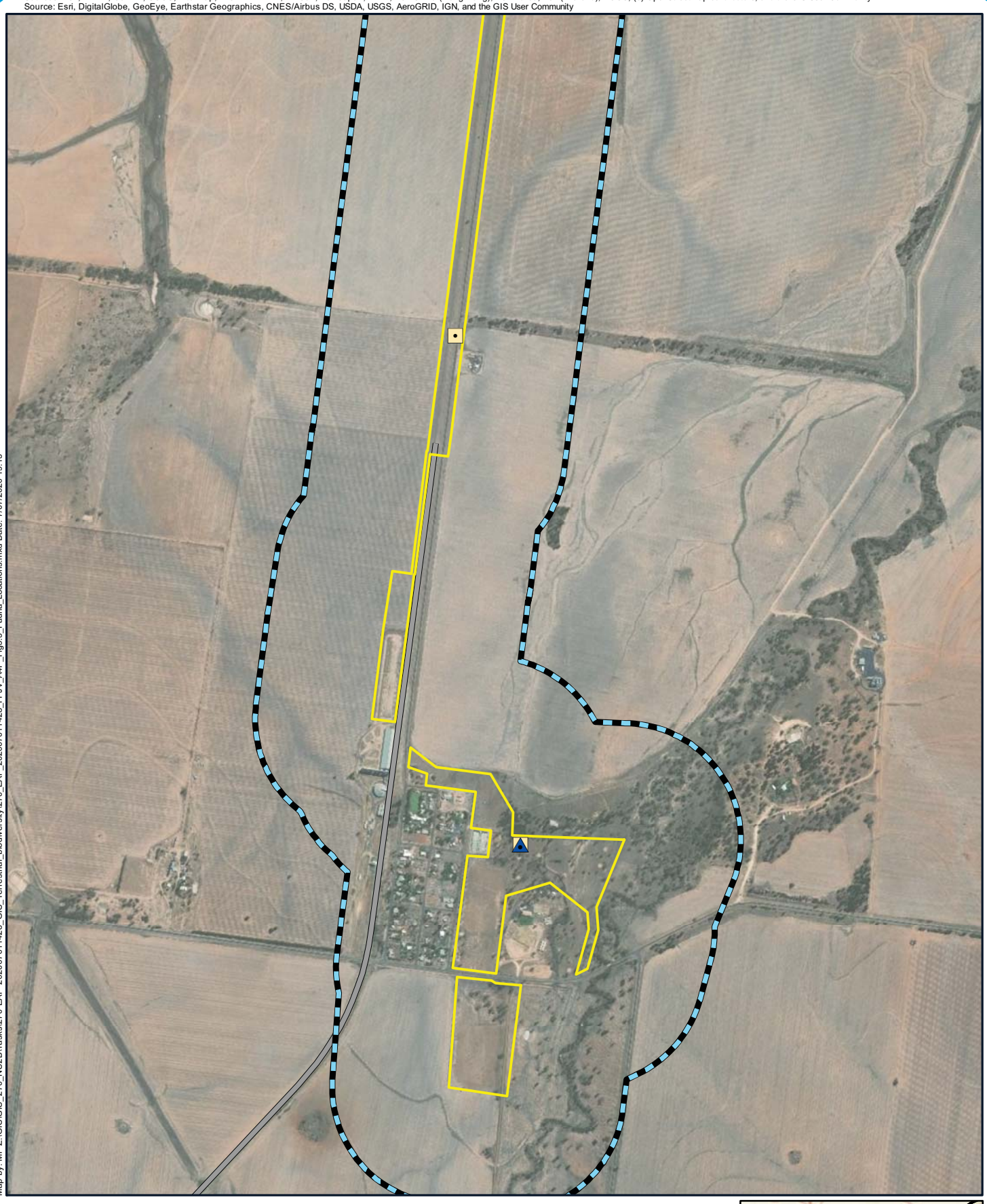
Date	Rainfall (mm)
Monthly total September 2018	**11.4**
1 October 2018	0
2 October 2018	0
3 October 2018	0
4 October 2018	0
5 October 2018	8
6 October 2018	6.6
7 October 2018	0.6
8 October 2018	0
9 October 2018	0
10 October 2018	0
30 October 2018	0.2
31 October 2018	0
Monthly total October 2018	**103.4**
1 November 2018	0
2 November 2018	0
3 November 2018	0
4 November 2018	0.8
5 November 2018	0
6 November 2018	0
Monthly total November 2018	**59**

Date	Rainfall (mm)
20 June 2019	0
21 June 2019	0
22 June 2019	0
23 June 2019	0
Monthly total June 2019	**15.4**
3 July	0
4 July 2019	0
5 July 2019	0
6 July 2019	0
Monthly total July 2019	**4**
23 October 2019	0
24 October 2019	0
25 October 2019	0
26 October 2019	0
27 October 2019	0
28 October 2019	0
29 October 2019	0
30 October 2019	0
Monthly total October 2019	**23.6**

Following the desktop assessment, ecological survey sites identified as containing features of interest and located within or directly adjacent to the study area were selected. Specifically, the following features were used to identify areas of interest:

- Areas containing a representative example of a distinct vegetation community (i.e. areas contained within mapped remnant vegetation, regrowth vegetation, and non-remnant vegetation areas)
- Areas containing landscape features that were considered likely to support threatened species when viewed from aerial photography (i.e. gilgai areas and wetlands)
- Areas known or predicted to support threatened species
- Areas identified as containing or potentially containing EPBC Act listed TECs
- Areas that have not been subject to previous ecological investigations.

The location of terrestrial survey sites is shown in Figure 3.3.



Map by: MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.3_Fauna_Locations.mxd Date: 7/07/2020 19:13

Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Adjoining alignments
- Study area

A4 scale: 1:22,000

0 110 220 330 440 550m

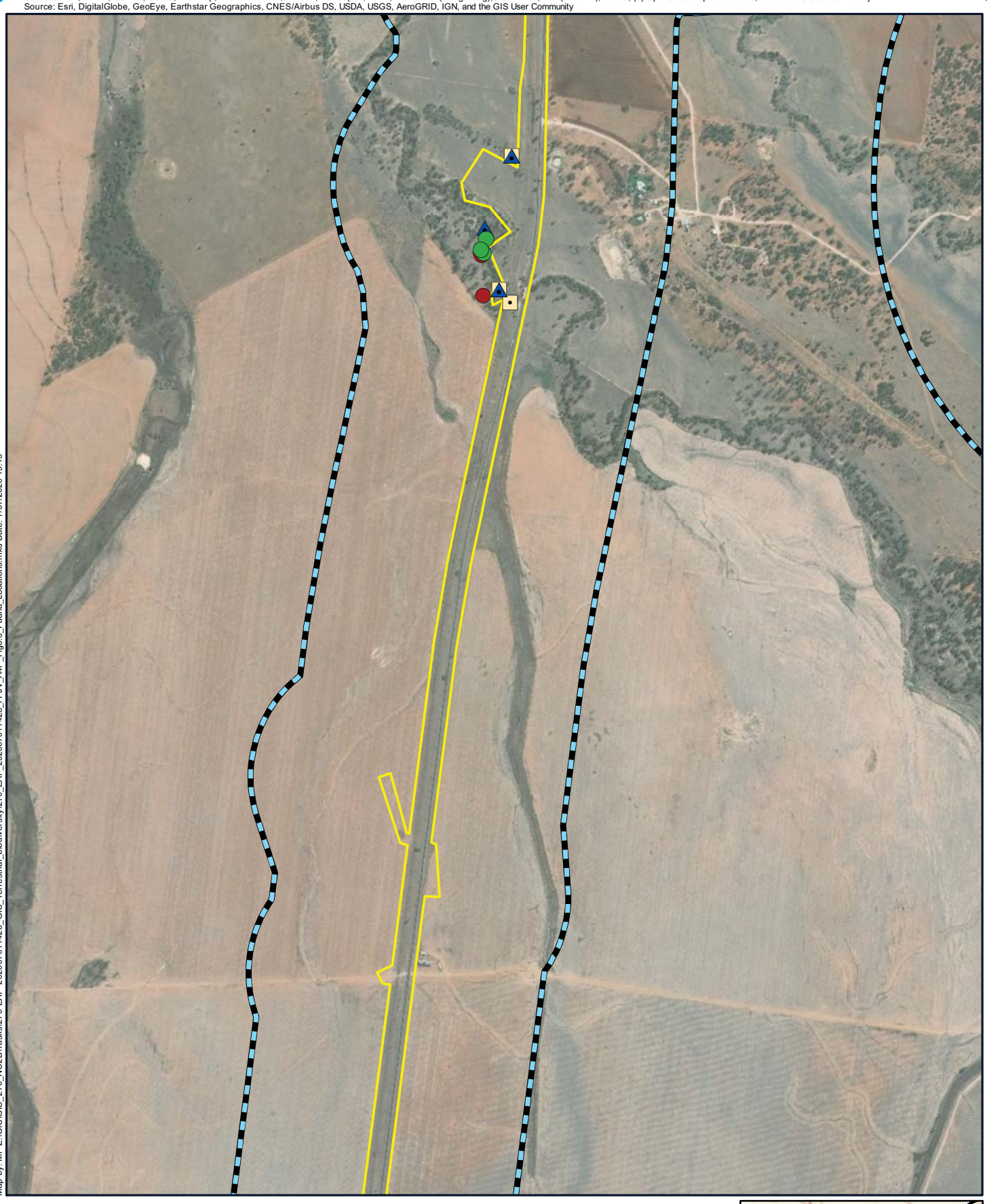
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3a: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Map by: MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.3_Fauna_Locations.mxd Date: 7/07/2020 19:13

Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:20,000

0 100 200 300 400 500m

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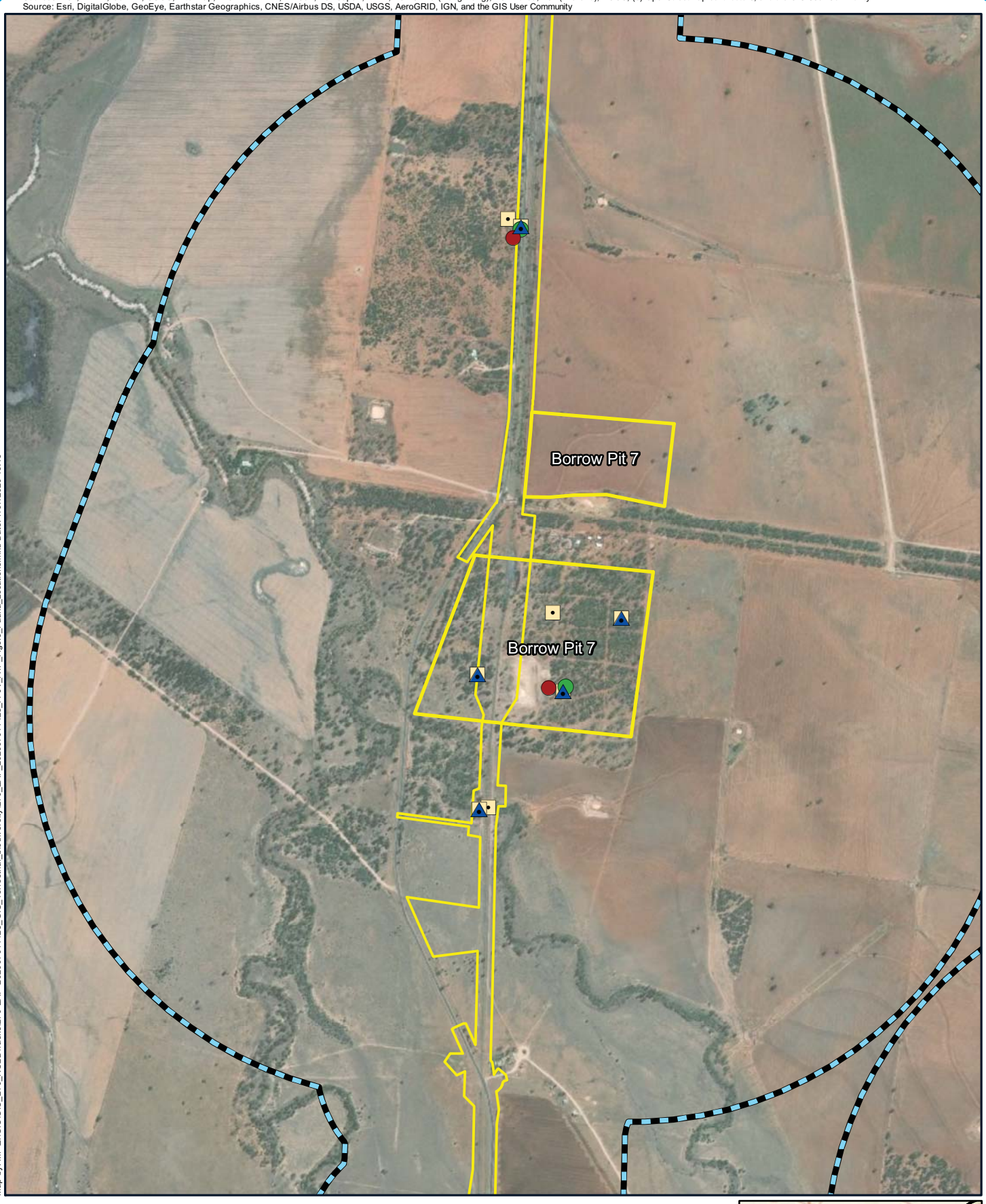
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3b: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



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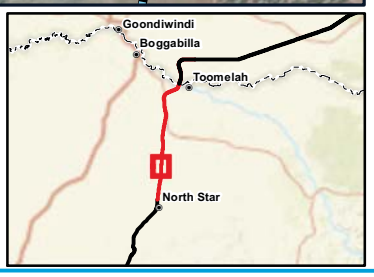
Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area



A4 scale: 1:20,000

0 100 200 300 400 500m

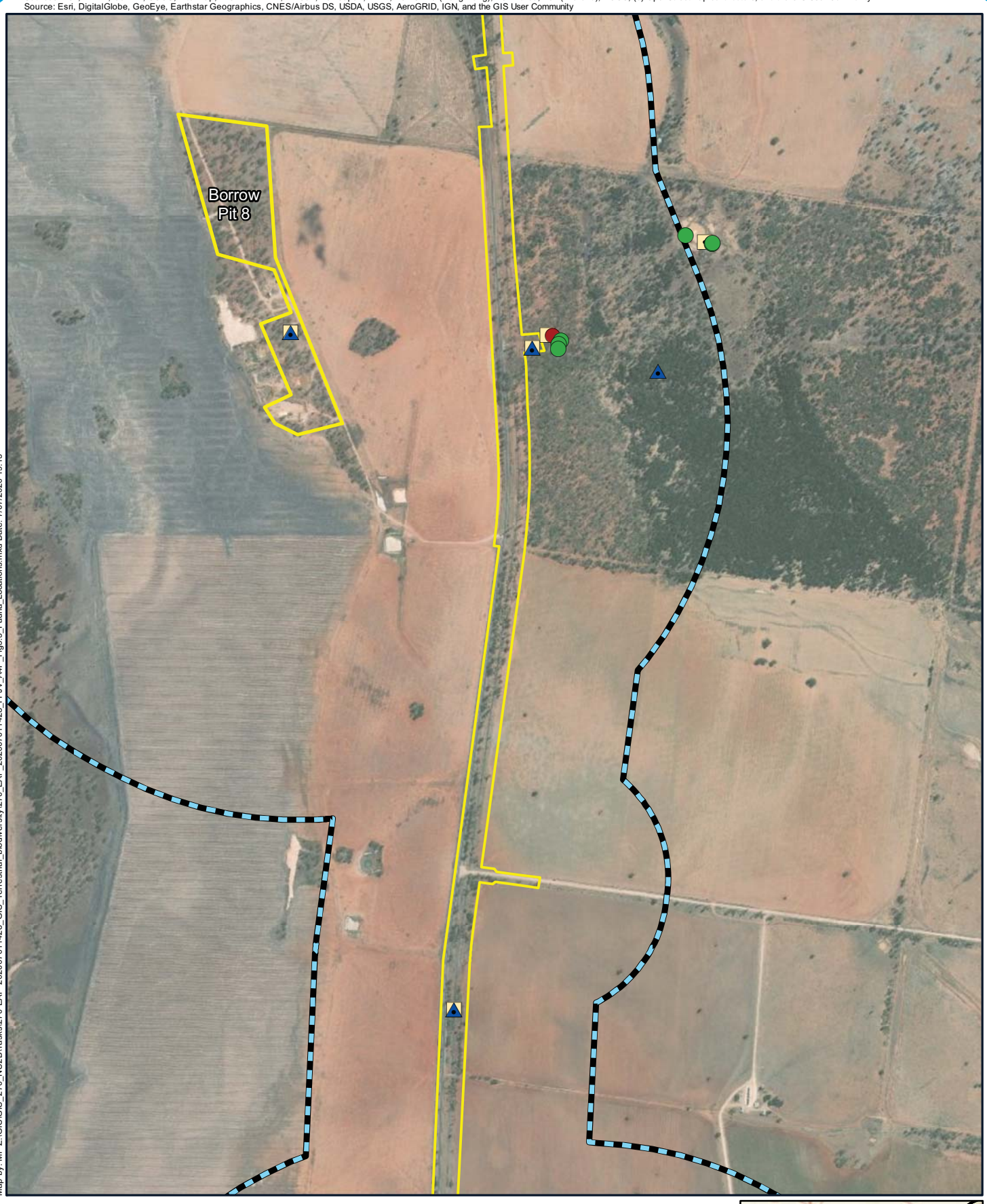
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3c: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:20,000

0 100 200 300 400 500m

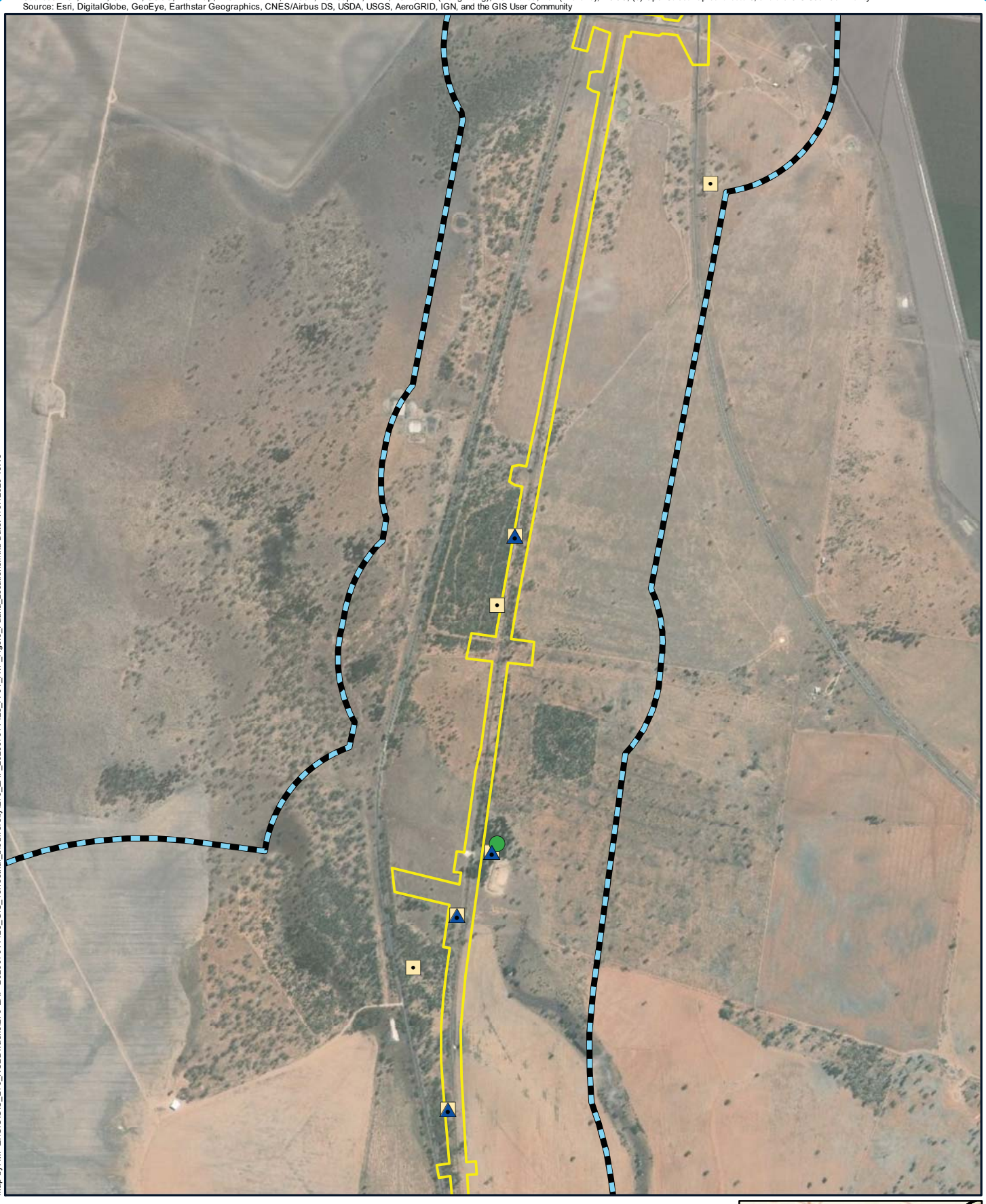
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3d: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



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Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:20,000

0 100 200 300 400 500m

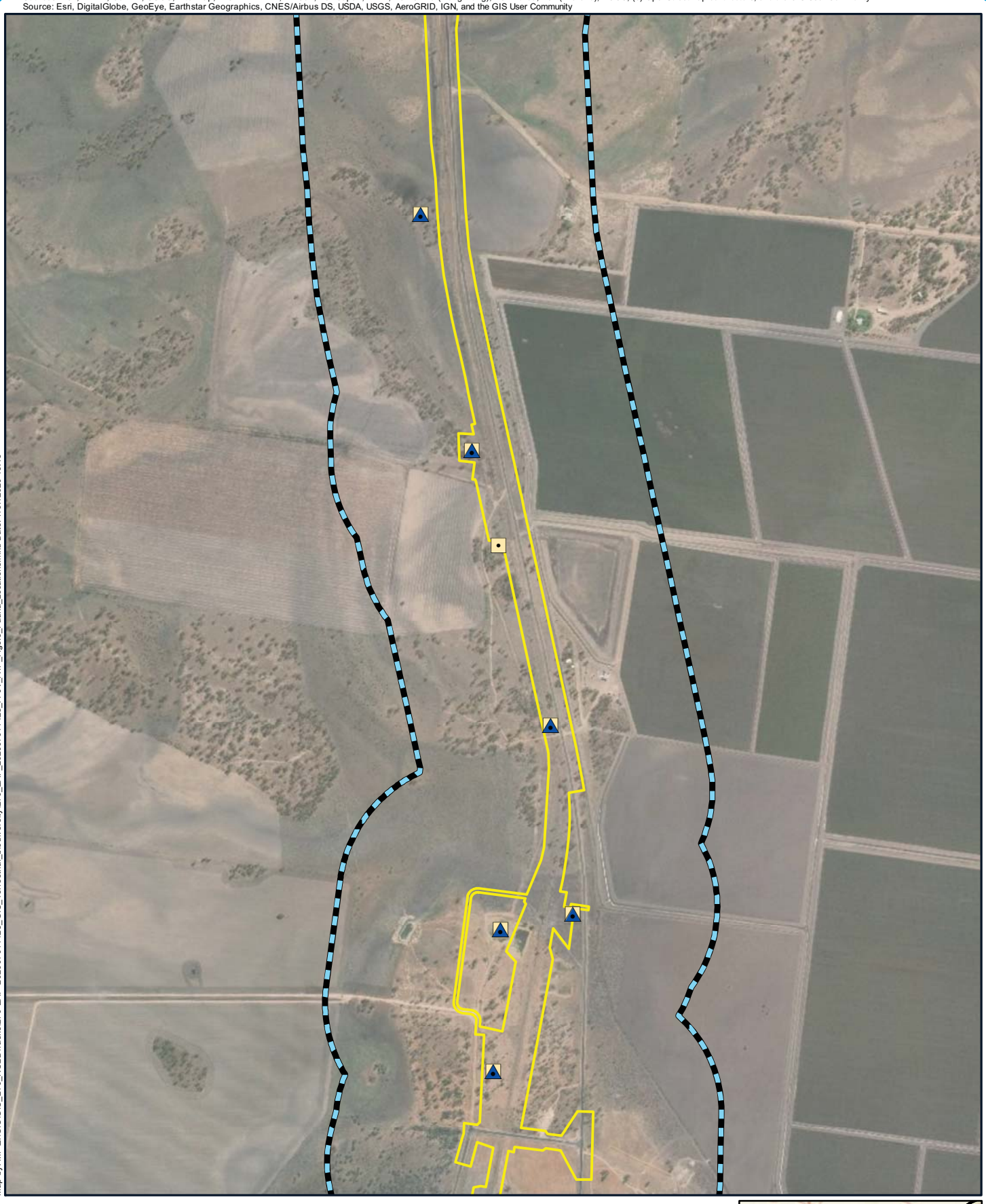
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3e: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:20,000

0 100 200 300 400 500m

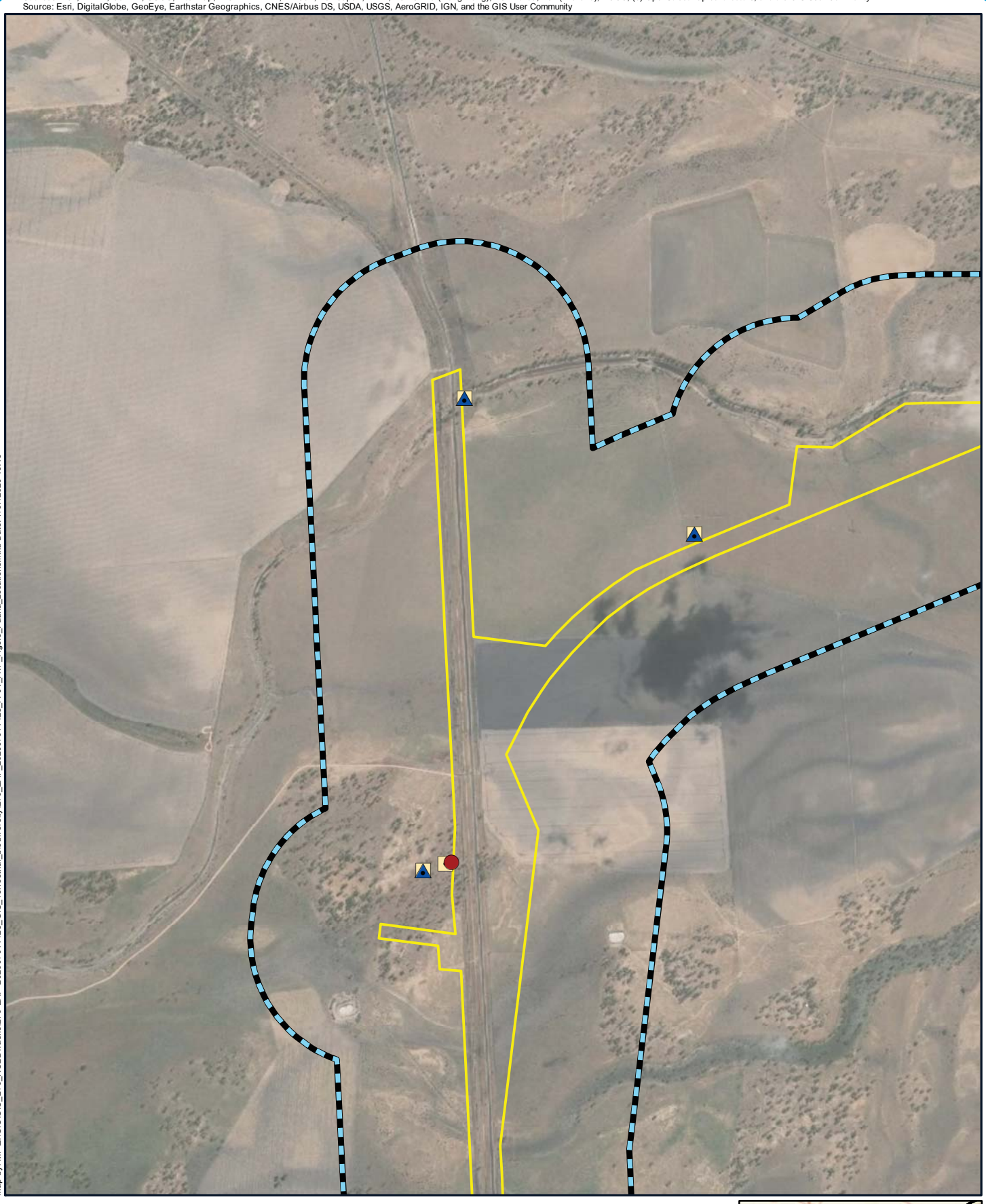
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3f: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



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Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:20,000

0 100 200 300 400 500m

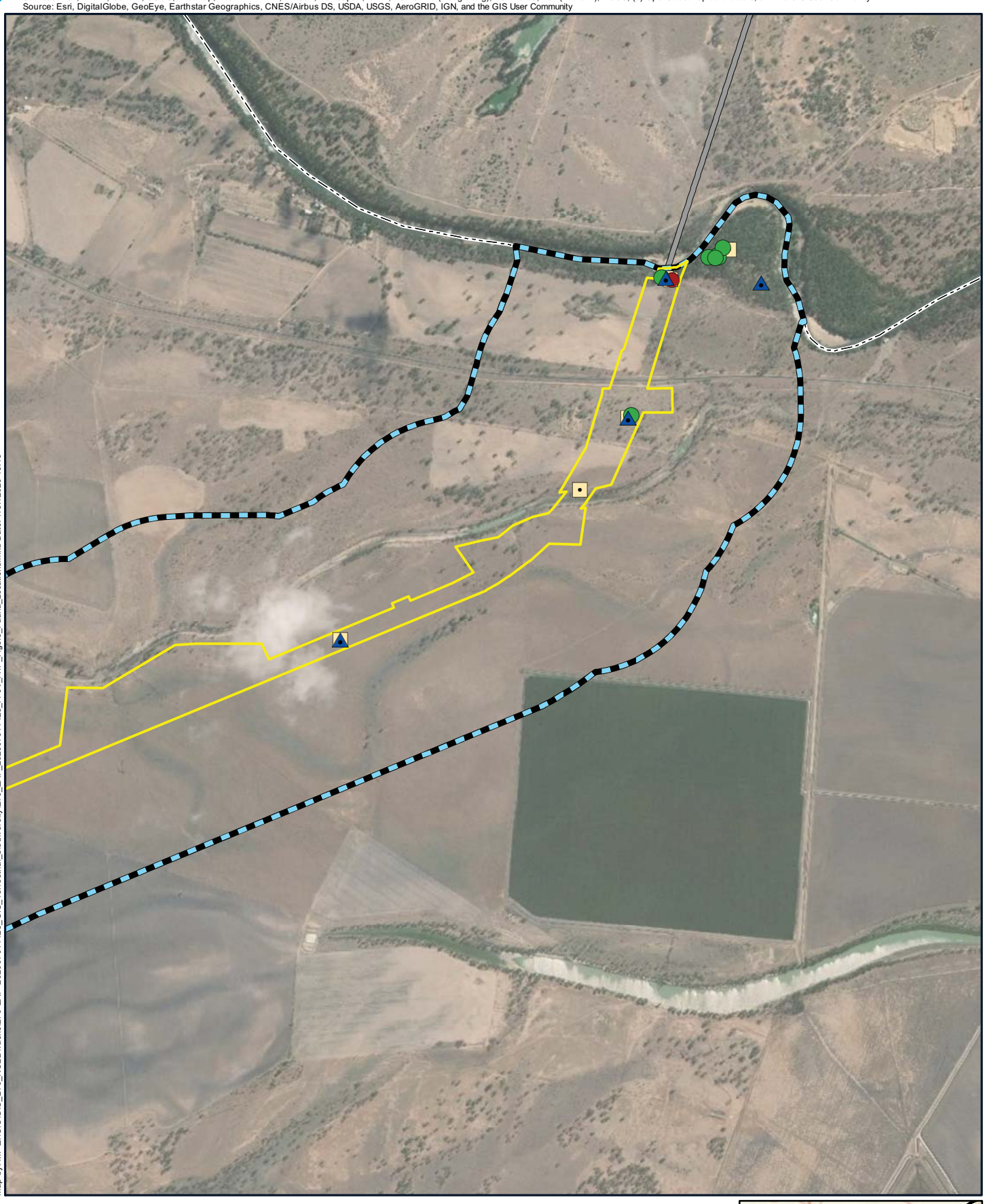
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

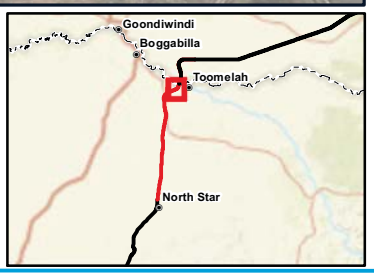
Figure 3.3g: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Map by: MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FF-JV_A4P_Fig3.3_Fauna_Locations.mxd Date: 7/07/2020 19:13

Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area
- Adjoining alignments
- NSW/QLD border



A4 scale: 1:20,000

0 100 200 300 400 500m

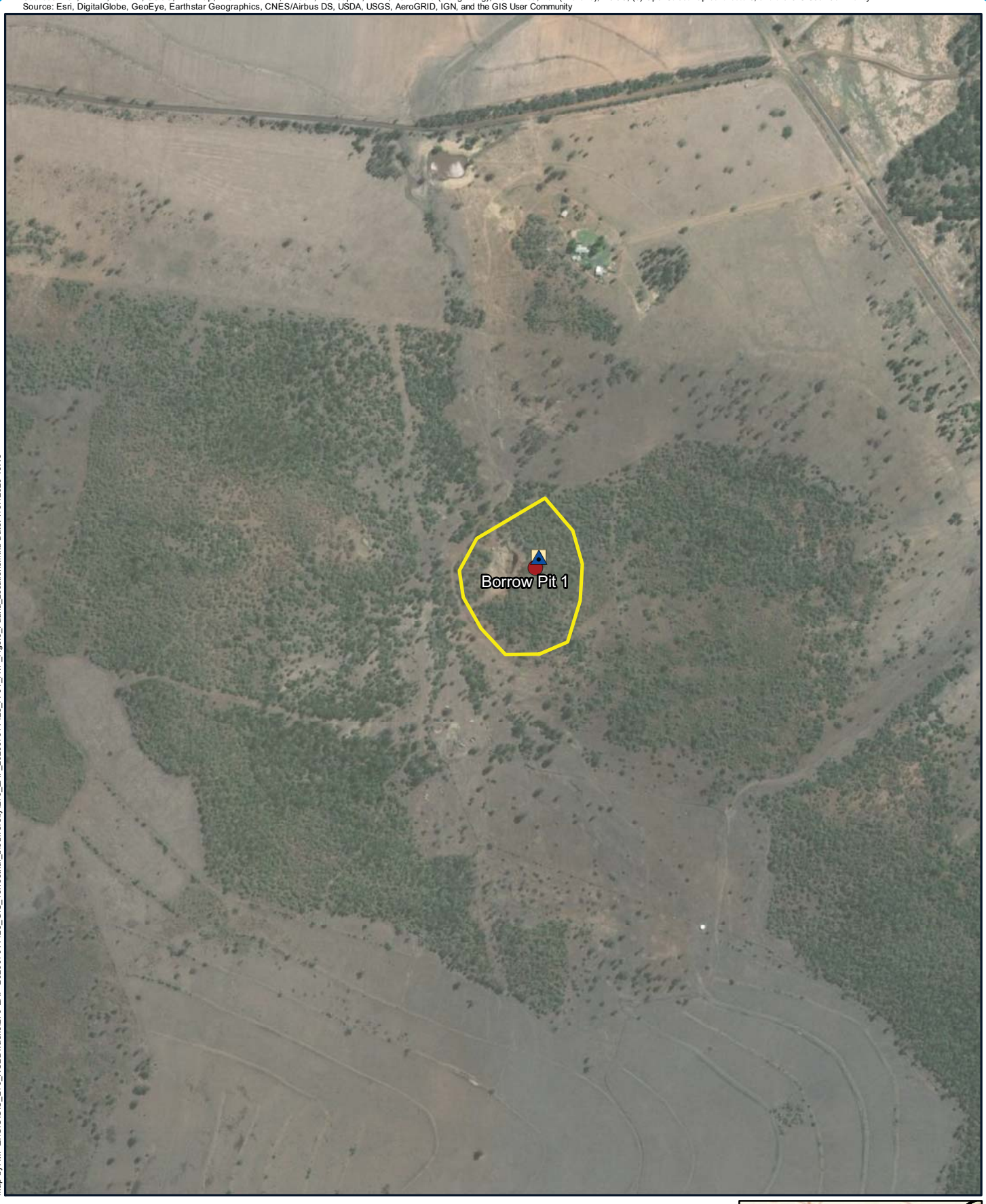
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3h: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:10,000

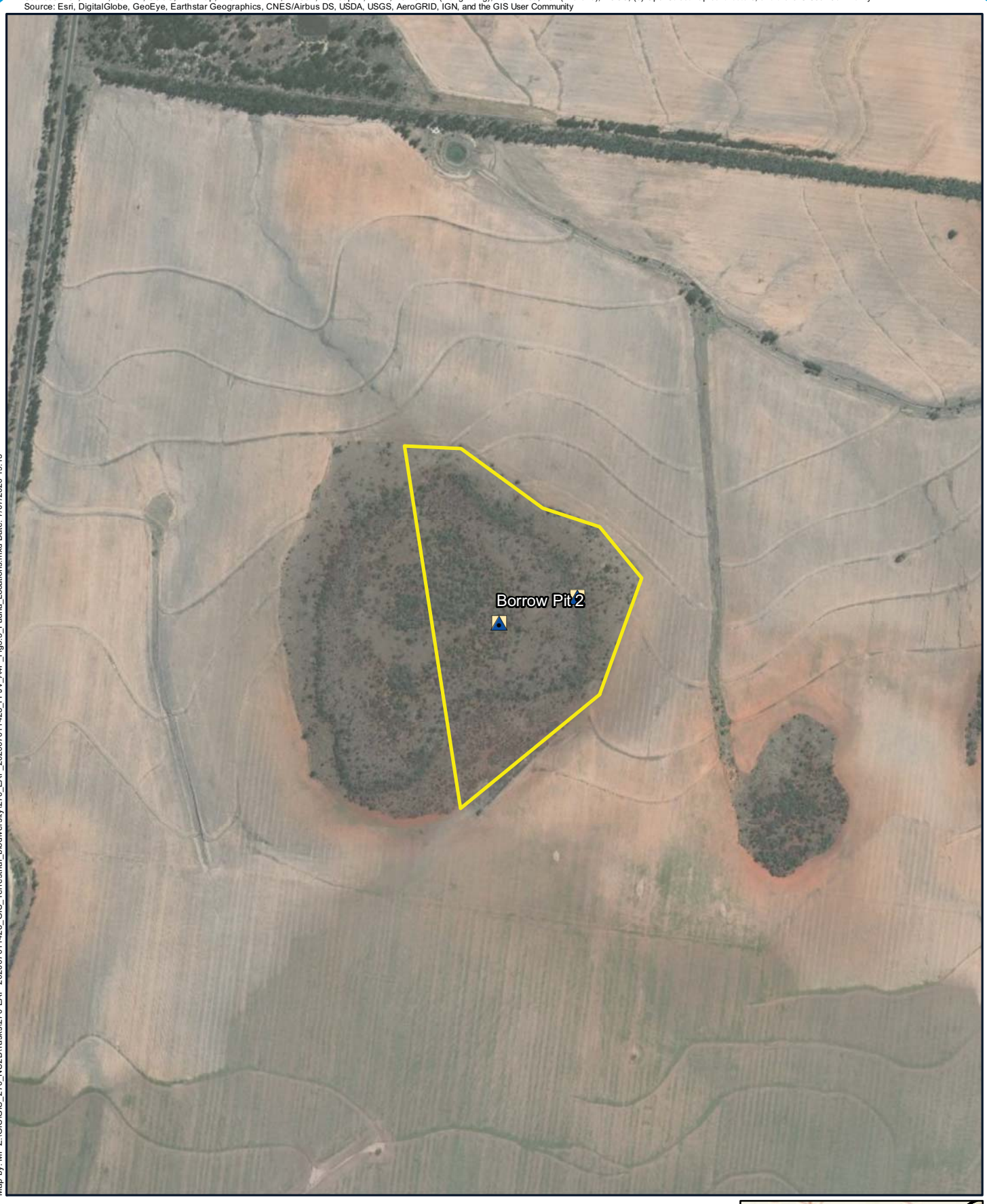
0 50 100 150 200 250m

Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3i: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:10,000

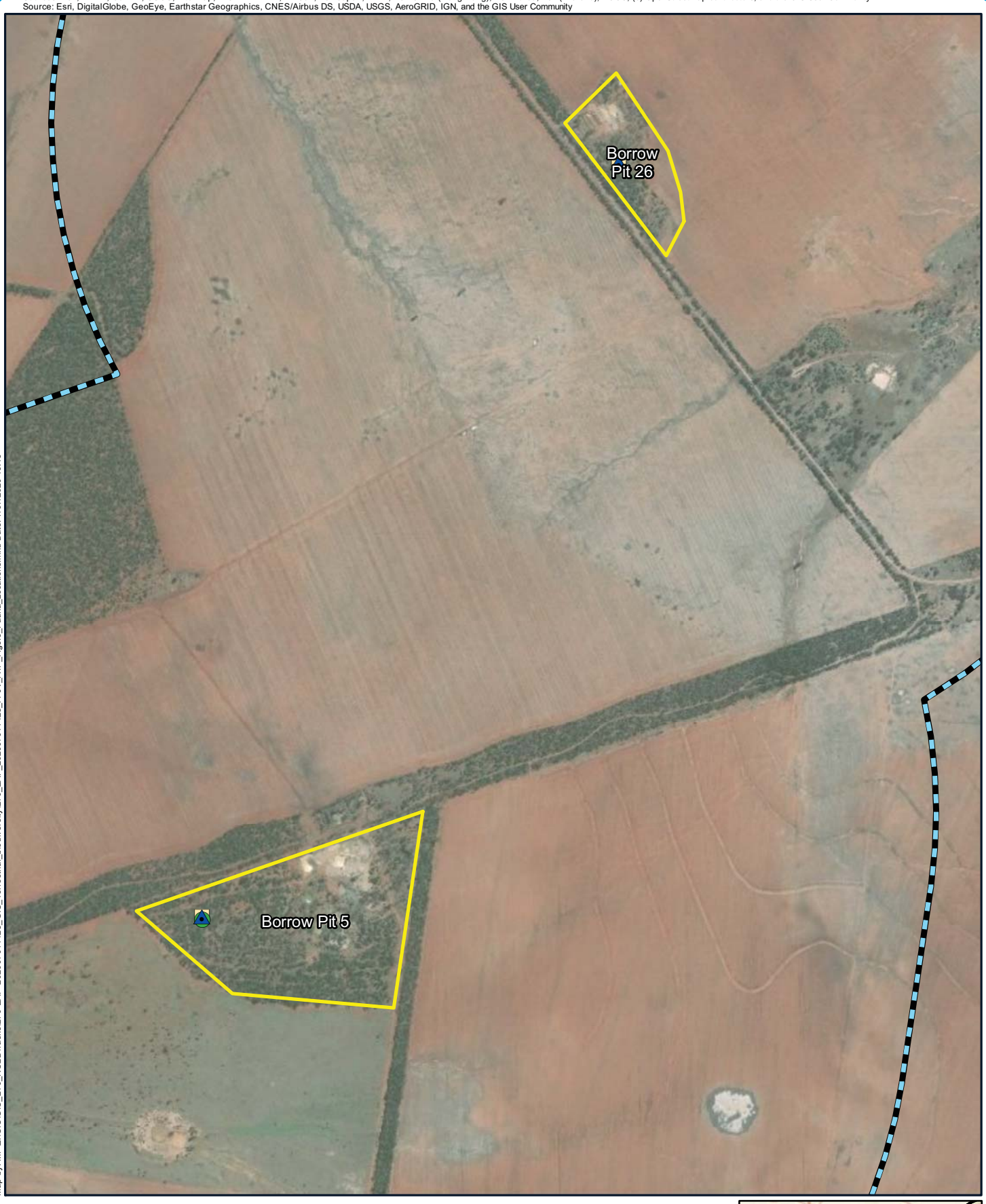
0 50 100 150 200 250m

Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3j: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:15,000

0 75 150 225 300 375m

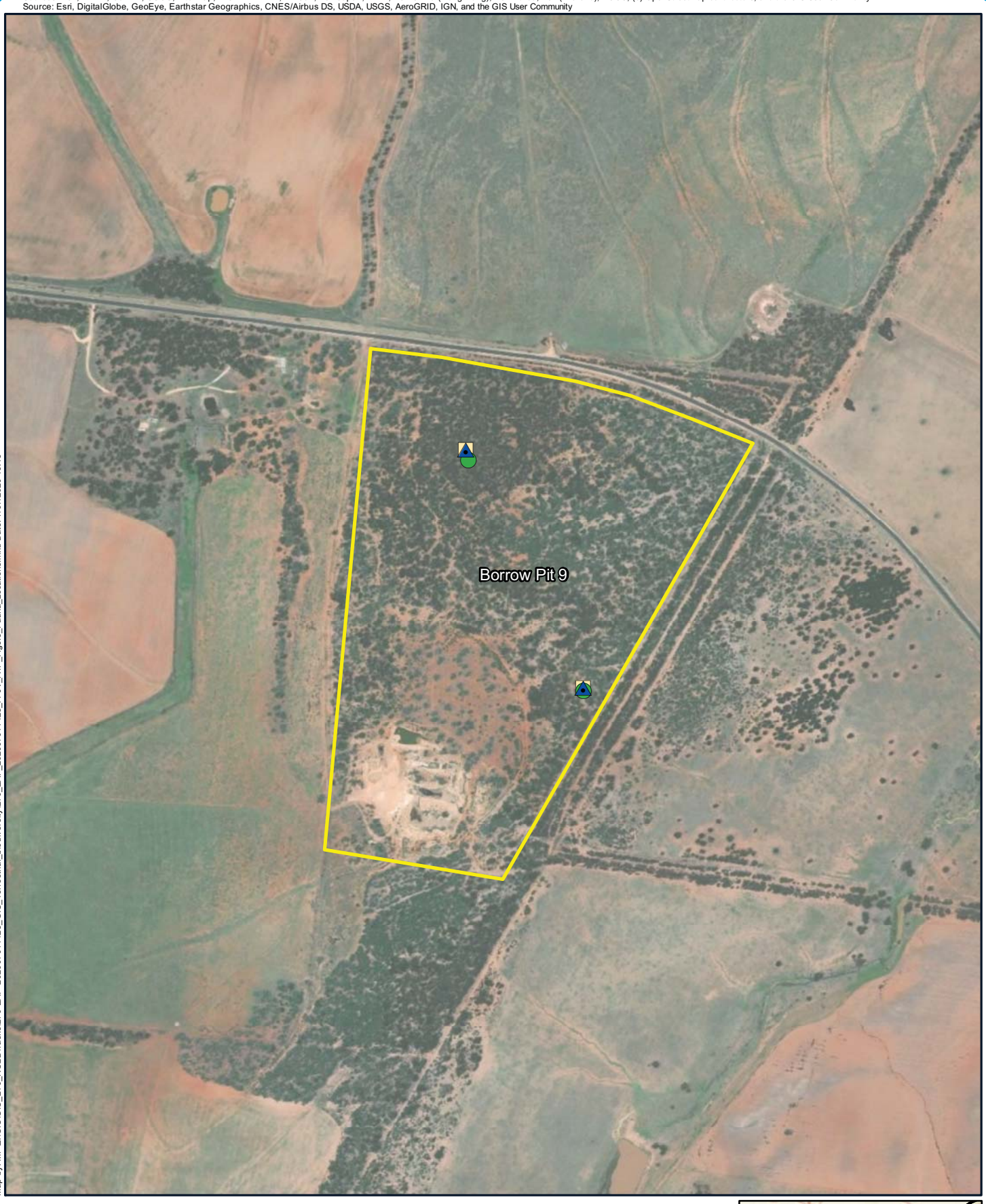
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3k: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:10,000

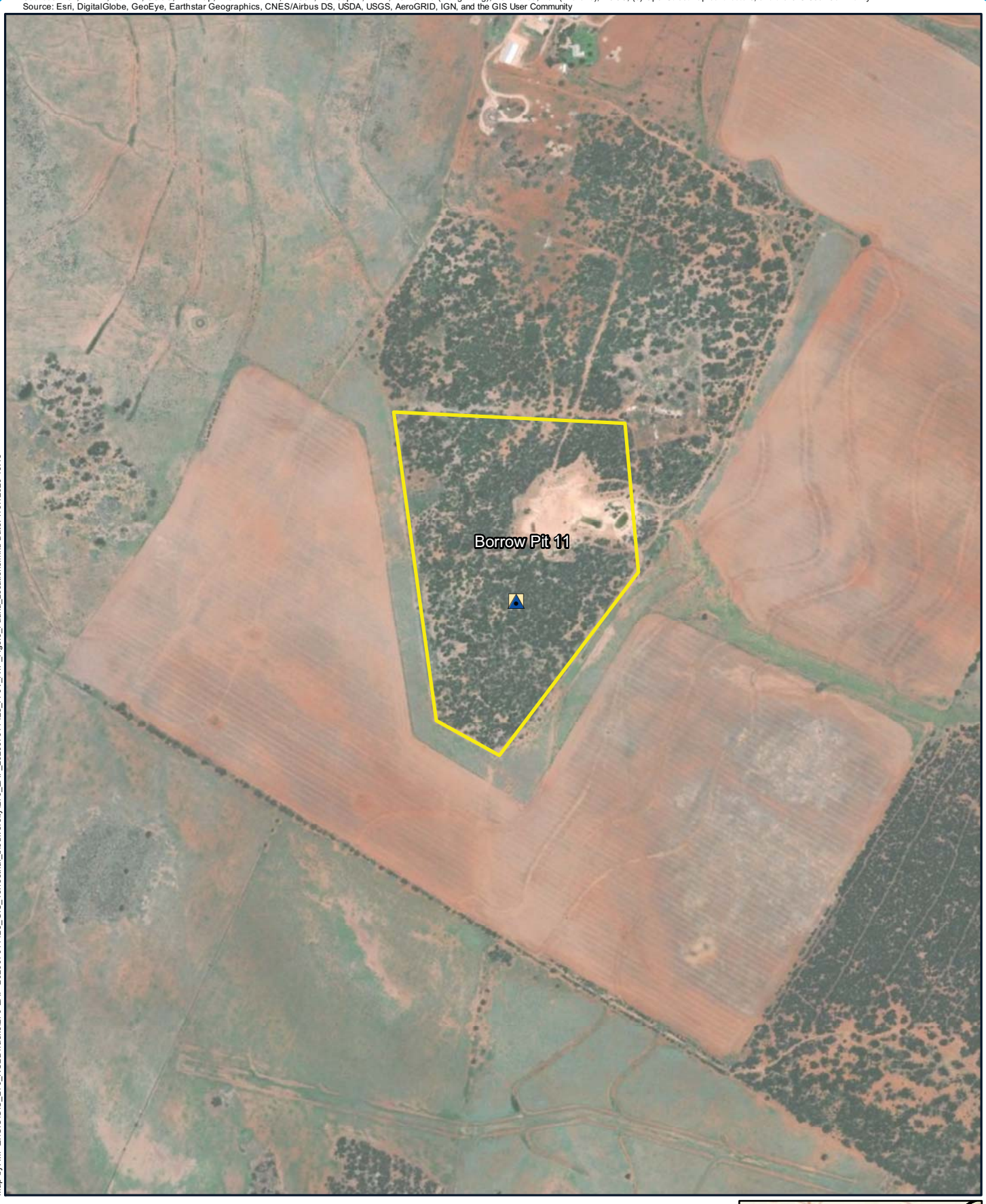
0 50 100 150 200 250m

Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3l: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Map by: MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.3_Fauna_Locations.mxd Date: 7/07/2020 19:13

Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:10,000

0 50 100 150 200 250m

Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3m: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting

Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:10,000

0 50 100 150 200 250m

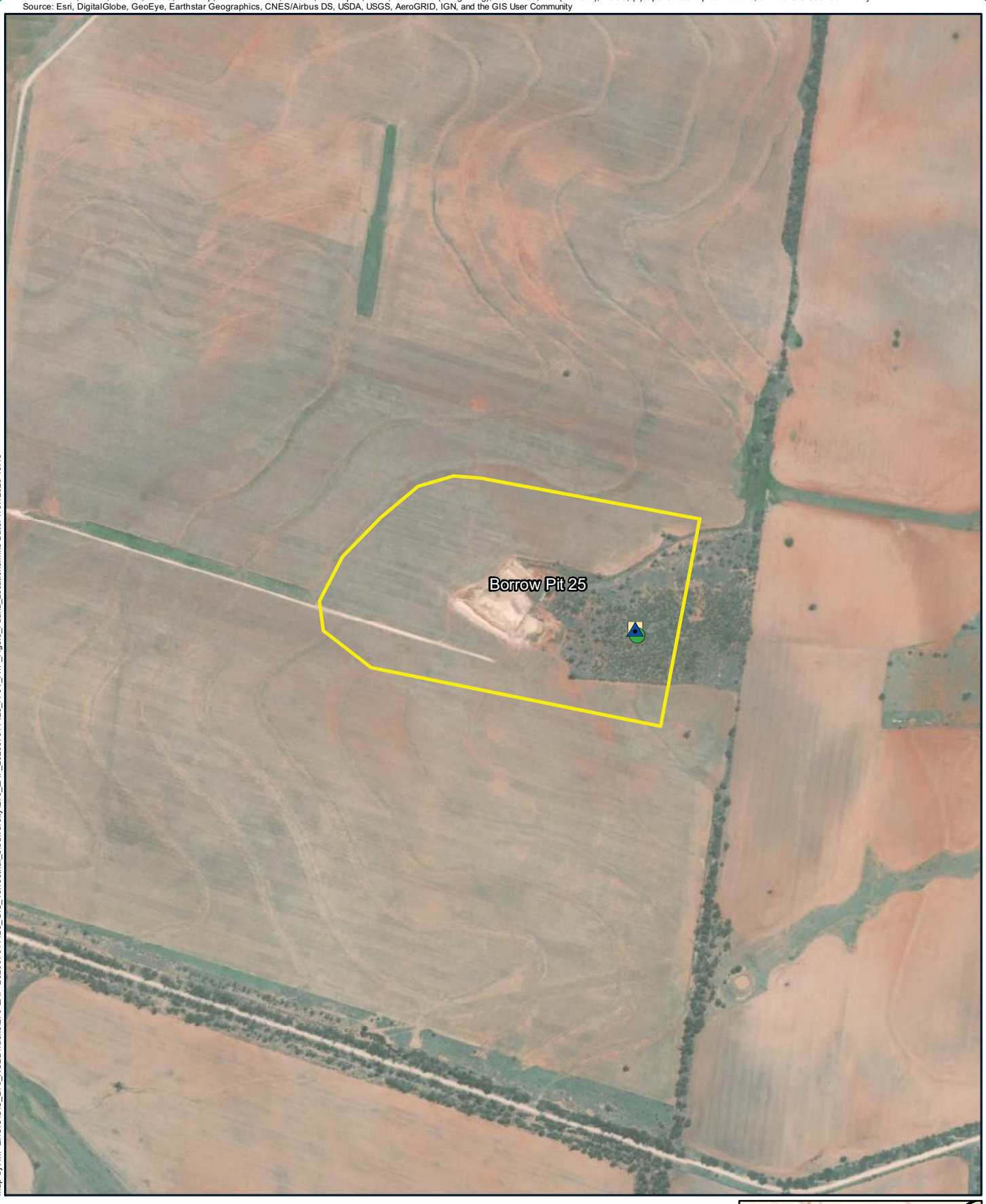
Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3n: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting



Legend

- Dawn survey/Spotlighting
- Microchiropteran bat call detection
- Camera trap
- Fauna habitat assessment
- Subject land
- Study area

A4 scale: 1:10,000

0 50 100 150 200 250m

Future Freight
Integrating Community, Environment and Engineering

Date: 03/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3o: Location of targeted fauna habitat assessments, camera traps, ultrasonic bat recorders and spotlighting

3.4.2 Landscape features and context

3.4.2.1 Identifying landscape features

Landscape features within the subject land and the 500 m (alignment) or 1,500 m (borrow pit) buffer area were determined through reviewing aerial photography and relevant GIS layers. Landscape features that were reviewed included:

- NSW Interim Biogeographic Regions of Australia (IBRA region and sub-region) – version 7
- BioNet NSW landscapes
- Rivers, streams and estuaries
- Wetlands within, adjacent to and downstream of the sites
- Connectivity of areas of habitat including areas identified as priority investment areas, flyways for migratory species
- Any relevant previous ecological assessments conducted for the site or adjacent areas
- Areas of geological significance and soil hazard features
- Areas of Outstanding Biodiversity Value
- Percent native vegetation cover
- Cleared areas.

3.4.2.2 Determining the site context

Determining the 'site context' is calculated by assessing the percent native vegetation cover and patch size in accordance with Subsections 4.3.2 and 5.3.2 of the BAM guidelines (OEH 2018b).

3.4.2.3 Percent native vegetation cover

Percent native vegetation cover is calculated by estimating the amount of native vegetation (both woody and non-woody vegetation inclusive of regrowth of species native to NSW) that remains within the buffer of the subject land and subject land itself. In accordance with Section 4.3.2.2 of the BAM, native over-storey vegetation was used to determine percent cover in woody vegetation types.

To determine native over-storey percent cover, vegetation zones containing a broad vegetation condition of high and medium were used as a proxy of vegetation containing native over-storey within the subject land. Three non-woody vegetation types occur within the subject land these include Lignum Swamp, a small Ephemeral Wetland and Native Grasslands.

3.4.3 Native vegetation, threatened ecological communities and vegetation integrity assessment

3.4.3.1 Confirmation of Plant Community Type mapping

Initial surveys to confirm and map PCTs were undertaken using a rapid vegetation assessment (Rapid Data Points (RDPs)) process. The results of this survey were compared with the NSW *Vegetation Information System* (VIS) to determine accuracy of existing mapping. Vegetation communities and potential TECs were compared with detailed descriptions of PCTs and TECs available from the NSW EES website (www.environment.nsw.gov.au). The results of this assessment were used to validate vegetation mapping and refine community boundaries. At each rapid site, the dominant canopy, midstorey and groundcover species; structural cover condition; vegetation structure; PCT; priority or environmental weed species and cover; opportunistic threatened species counts; soil texture; fire history; vegetation condition; landform element and pattern; notes; photo number; surveyor; and date was recorded.

Each of the vegetation communities described within the subject land were aligned with an equivalent PCT and TEC (where appropriate) as detailed in the BioNet Vegetation Classification database (OEH 2018b). For each vegetation community described, the dominant and characteristic species were entered into the online plant community identification tab and an initial list of PCTs was generated. The profiles for each of the possible PCTs were then interrogated and the most appropriate match assigned based on floristic, structure, soil, landform and distribution details.

Each RDP was also assessed for broad condition against one of five condition classes. These condition classes included:

- Non-native vegetation
- Scattered paddock trees: Areas within the subject land with canopy species present only and that meet the BAM scattered tree streamline assessment criteria (Appendix 1 of BAM) (i.e. cropped paddocks with canopy trees only)
- Low: Native vegetation that predominantly has one vegetation stratum present in accordance with the most appropriate PCT but occasionally has a second strata present when considered in a broader landscape context (i.e. ground layer vegetation equivalent to the subject PCT with occasional canopy trees present only)
- Medium: Native vegetation with one vegetation strata absent in accordance with the most appropriate PCT and, ≤50% cover of exotic vegetation
- High: Intact native vegetation with all vegetation strata present in accordance with the most appropriate PCT, ≤25% cover of high threat exotic weeds.

A total of 114 rapid vegetation assessments were undertaken over eight days between 21 August and 27 August 2018, and on 19 June 2019. A further 64 areas that were unable to be accessed during those times were analysed using aerial imagery interpretation. The information from these assessments was then used to refine the number of BAM plots required. Areas which were not accessible during the RDP process were available for the targeted BAM surveys which followed this process.

Final mapping of PCT locations and conditions was produced following the completion of field surveys. Where differences occur between mapped PCTs and the underlying imagery, this is due to the currency of the available aerial imagery. Most differences can be seen if the provided shapefiles are used over recent aerial/satellite imagery, any further differences are based on ground truthing which may not be easily identifiable at the mapping scale provided. The updated PCT mapping is shown in Figure 3.5.

3.4.3.2 Mapping vegetation zones

A vegetation zone is classified as 'a relatively homogenous area of native vegetation on a development site, land to be biodiversity certified or a biodiversity stewardship site that is the same PCT and broad condition state' (OEH 2018b). Following RDP and broad condition assessments, vegetation zones were mapped and established for the subject land.

Vegetation zones were mapped such that:

- Each PCT that was assessed as having a different broad condition was considered as its own separate vegetation zone
- Each vegetation zone was described to accurately reflect significant and distinct differences in condition
- The area of each vegetation zone was calculated in hectares.
- Separate vegetation zones were required for:
  - Parts of the subject land where the vegetation has a current vegetation integrity score of:
  - < 15 for a PCT representative of a critically endangered ecological community (CEEC) or an endangered ecological community (EEC)
  - < 17 for a PCT that provides habitat for threatened species or is representative of a vulnerable ecological community (VEC)
  - < 20 for a PCT that is not representative of a TEC or associated with a threatened species habitat
- Derived planted or secondary PCTs such as a derived native grassland
- Paddock tree areas.

3.4.3.3 Assessing the patch size for a vegetation zone

A patch is an area of native vegetation within the subject land that:

- Occurs on the subject land, and
- Includes native vegetation that has a gap of less than 100 m from the next area of moderate to good condition native vegetation (≤ 30 m for non-woody ecosystems). Where vegetation does not meet this requirement (e.g. low-quality vegetation) a patch is not recorded.

A patch may extend onto neighbouring land that is not part of the subject land. It is used as a filter to predict if threatened species are likely to occur or use habitat within the subject land.

Patches are classified into one of four size classes including:

- < 5 ha
- to 24 ha
- 25 to 100 ha
- 100 ha.

A total of 25 patches were identified within the subject land and these are shown in Appendix C.

3.4.4 Vegetation integrity assessment (site condition)

In addition to the rapid vegetation assessments, field surveys were undertaken by experienced and accredited botanists to comply with the BAM. The required minimum number of vegetation condition (integrity) plot/transects were undertaken in accordance with the BAM guidelines. Based on desktop assessment, a minimum of 142 plots were required for assessment. Full vegetation integrity and PCT identification data at each plot/transect was collected during surveys conducted between the 1 October to 9 October 2018, 31 October to 6 November 2018, 20 June to 21 June 2019 and 1 July 2019 to 7 July 2019.

Verification or changes of PCT mapping was conducted by comparison of existing mapping with ground truthed field observations. This included dominant vegetation species at each strata level where such stratification occurred or through filed observation of surrounding plant community types and landscape features where the PCT was not immediately obvious. Recordings were also made on signs of historical disturbance which may have contributed to changes in PCT or difficulty in distinguishing between PCTs for example selective removal of timber for fenceposts.

Assessments included measurement of composition, structure and function as listed in Table 3-9 for each vegetation zone against the benchmark data for the relevant PCT.

Table 3-9 Attributes measured to assess composition, structure and function

Growth form groups used to assess composition and structure	Attributes used to assess function
▪ Tree ▪ Shrub ▪ Grass and grass like ▪ Forb ▪ Fern ▪ Other	▪ Number of large trees ▪ Tree regeneration ▪ Tree stem size class ▪ Total length of fallen logs ▪ Litter cover ▪ High threat exotic vegetation cover ▪ Hollow bearing trees

3.4.4.1 Vegetation integrity survey plots

The minimum number of vegetation plots/transects sampled per vegetation zone followed the guidelines as shown in Table 3-10 and Figure 3.4.

Table 3-10 Required number of survey plots per vegetation zone

Vegetation zone area (ha)	Minimum number of plots/transects
< 2	1 plot/transect
> 2 to 5	2 plots/transects
> 5 to 20	3 plots/transects
> 20 to 50	4 plots/transects
> 50 to 100	5 plots/transects
> 100 to 250	6 plots/transects
> 250 to 1,000	7 plots/transects; more plots may be needed if the condition of the vegetation is variable across the zone
>1,000	8 plots/transects; more plots may be needed if the condition of the vegetation is variable across the zone

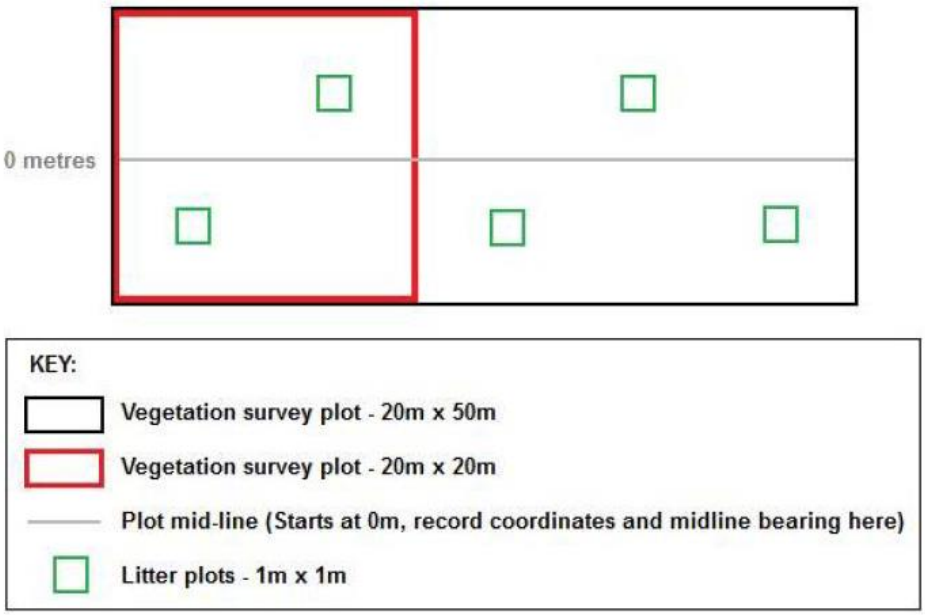


Figure 3.4 Plot layout to be used for site assessment

Source: BAM Operation Manual (2018)

Within each plot, the following elements were measured:

- Composition

  Vegetation composition was measured within a 20 x 20 m plot centred along a 50 m transect (or for linear zones, as a 10 x 40 m plot). All native and exotic plant species were recorded to genus and species (where possible) within the plot and assigned a growth form, according to the definitions within the BAM guidelines (OEH 2018b). The three most dominant native species (i.e. those that contributed most to the cover of each growth form) were identified.

- Structure

  Vegetation structure was measured within the same 20 x 20 m plot as per composition. The percent foliage cover for each growth form group of all living material was recorded to the nearest 0.1% for those species with < 10% cover, to the nearest 1% for species with > 0.9 to 10% cover and to the nearest 5% for species with 10 to 100% cover. Non-native plant species were divided into two groups, either exotic or high threat exotic and each assigned a percent foliage cover.

- Function

  Function was assessed within a 20 x 50 m plot centred along a 50 m transect (or for linear zones, as a 10 x 100 m plot). The number of large trees, their stem size class, the level of tree regeneration and length of fallen logs were recorded.

  The diameter at breast height (DBH) was recorded for each tree and categorised into one of the following size classes: < 5, 5 to 9, 10 to 19, 20 to 29, 30 to 49, 50 to 79 and +80 cm. Comparison with the benchmark DBH size determined if a tree was considered to be large. Regeneration potential was assessed based on the presence or absence of living trees with stems < 5 cm DBH.

  Logs were considered for assessment if they were greater than 10 cm in diameter, were dead and entirely or in part on the ground. Logs were measured to the nearest 0.5 m.

  Litter cover was assessed within five 1 x 1 m plots spaced equidistant apart centred along a 50 m transect (or for linear zones, along a 100 m transect). Litter was considered to include leaves, seeds, twigs, branchlets and branches (< 10 cm in diameter) and plant material that is detached from a living plant. This was measured to the nearest 5%.

  The number of trees with hollows was also recorded within the 20 x 50 m plot.

  The vegetation integrity score was calculated using the information collected above and as per the equations set out in Appendix 6 of the BAM guidelines (OEH 2018b).

- Meandering transects

  Meandering transects as described in NSW Threatened Biodiversity Survey and Assessment (OEH 2008) guidelines were undertaken through vegetation units across the subject land adjacent to BAM plots. These transects were targeting threatened and otherwise significant species and endangered populations in suitable habitat. Meandering transects enabled sampling across a much larger area than systematic plots alone, allowing the survey to achieve a combination of detailed observation and broader application. A minimum of 30 minutes was spent searching for threatened flora within the plots and surrounding landscape. After 30 minutes searches were stopped when no new species were recorded for a period of five minutes. Records along the transects supplemented floristic sampling carried out as part of the transect/plots, however the data was in the form of presence records, rather than the semi-quantitative cover abundance scores.

  Given the existing drought conditions during the survey period, the results of flora surveys are not considered sufficient to determine species-credit species to be absent.

  The location of the BAM plots conducted as part of the field works is shown in Figure 3.5 with greater detail located in Appendix A and E.

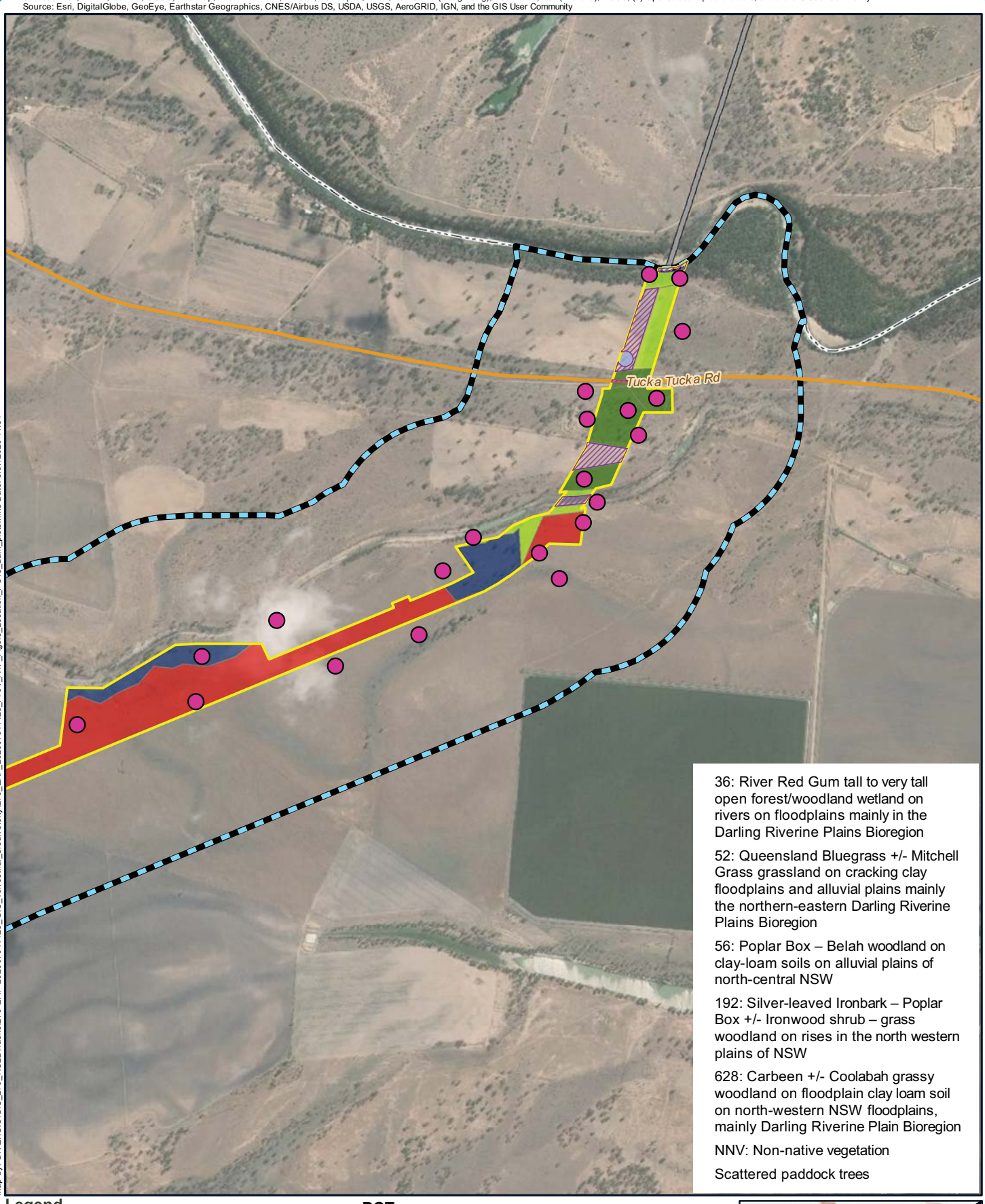
3.4.5 Threatened ecological community assessment

The Protected Matters Search Tool (PMST) identified seven EPBC listed TECs within a 10 km buffer of the subject land. These include:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Coolibah – Black box woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions
- Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland
- Poplar box Grassy woodland on alluvial plains
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Weeping myall woodlands
- White box-Yellow box-Blakely's red gum grassy woodland and derived native grassland.

TEC assessments were conducted within vegetation zones within the subject land to compare key diagnostic criteria and condition thresholds to determine the presence of the BC and EPBC Act listed TECs. These diagnostic criteria and condition thresholds can be found in Appendix C. The assessment of TECs was informed by the PMST database search results of the terrestrial ecology desktop assessment (refer Section 4.1.1.3).

With regard to the natural grasslands TEC potentially present in the study area (Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland), site assessments were completed as per the EPBC Act thresholds. However, extended drought conditions were present at the time of the site assessments, impacting the condition of these areas substantially. Detailed assessment of species diversity and composition indicated that several plots were within the benchmark conditions for the TEC while some were lacking indicator species present in plots nearby. As such, the grassland TEC has been assumed as present for the purposes of this report until such time as further detailed site assessment is possible during non-drought conditions.



36: River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

52: Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion

56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

192: Silver-leaved Ironbark – Poplar Box +/- Ironwood shrub – grass woodland on rises in the north western plains of NSW

628: Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion

NNV: Non-native vegetation

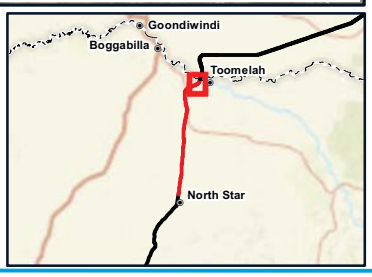
Scattered paddock trees

Legend

- BAM plots
- Major roads
- Adjoining alignments
- NSW/QLD border
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 36
- 52
- 56
- 192
- Scattered paddock trees



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0 0.25 0.5km

Future Freight
Integrating Community, Environment and Engineering

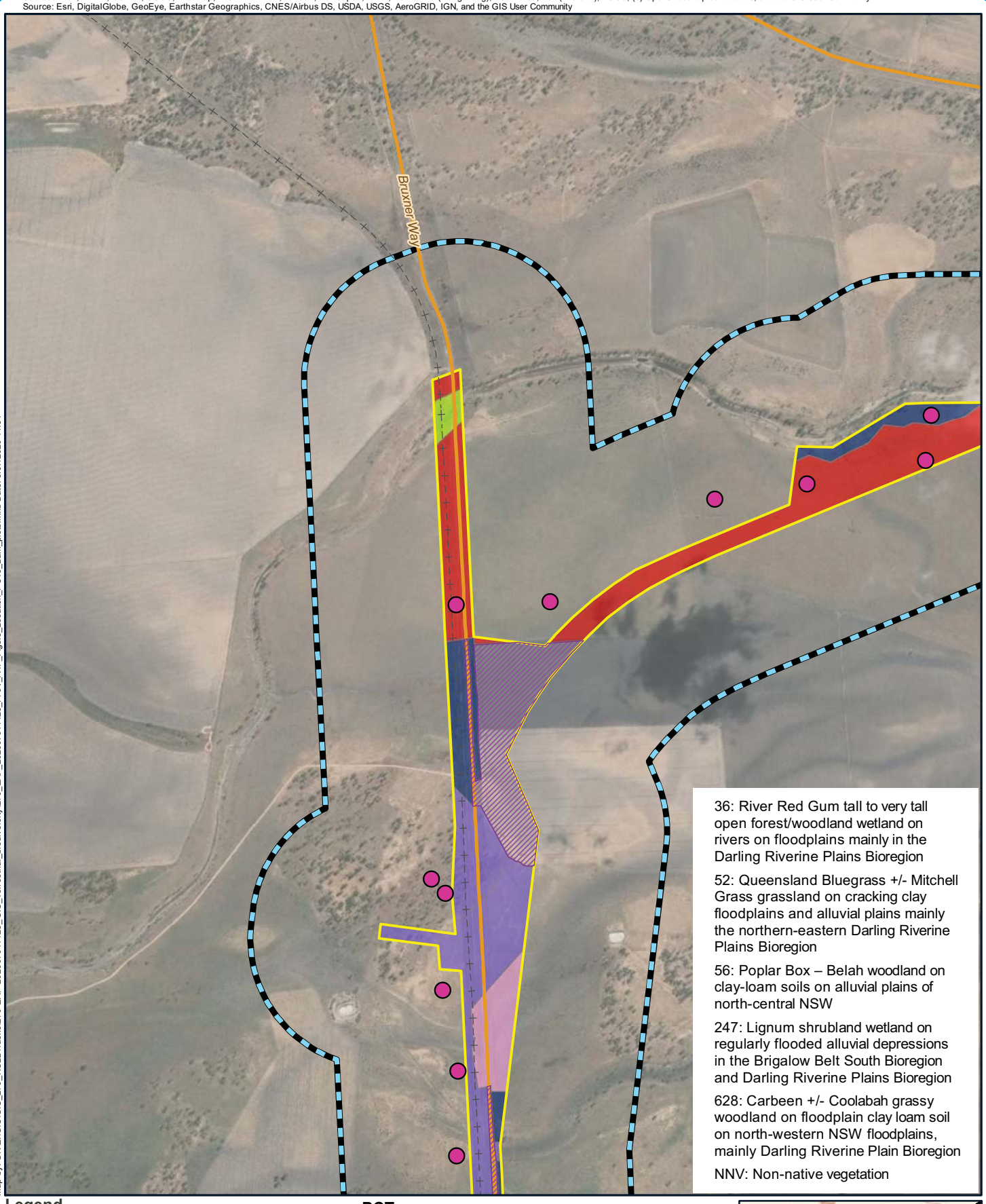
Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5a: Location of PCTs and BAM plots

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54



36: River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

52: Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion

56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

247: Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion

628: Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion

NNV: Non-native vegetation

Legend

- BAM plots
- Existing rail (non-operational)
- Major roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 36
- 52
- 56
- 247
- 628

A4 scale: 1:20,000

0 0.25 0.5km

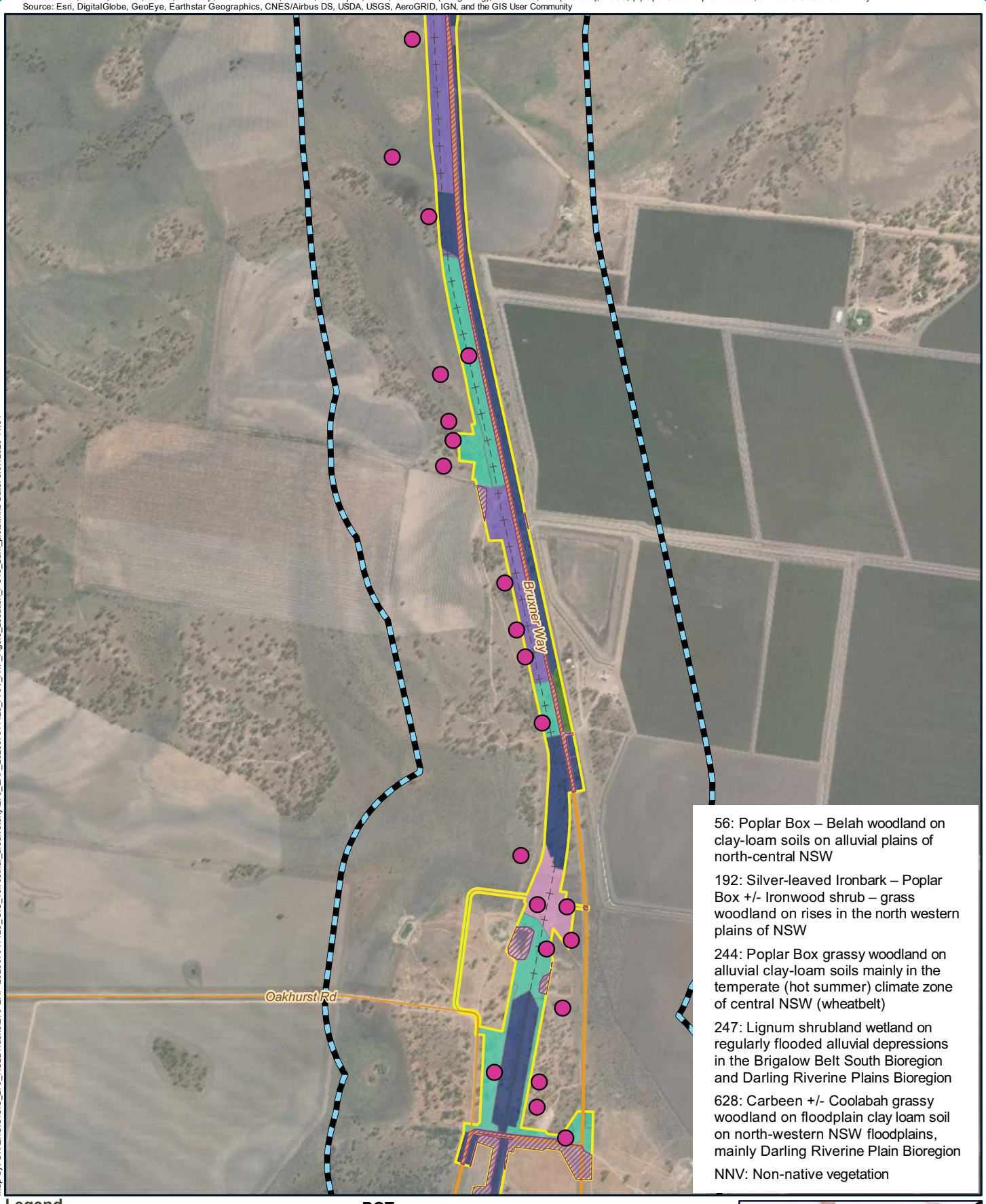
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5b: Location of PCTs and BAM plots



56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

192: Silver-leaved Ironbark – Poplar Box +/- Ironwood shrub – grass woodland on rises in the north western plains of NSW

244: Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)

247: Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion

628: Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion

NNV: Non-native vegetation

Legend

- BAM plots
- Existing rail (non-operational)
- Major roads
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 56
- 192
- 244
- 247
- 628

A4 scale: 1:20,000

0 0.25 0.5km

Future Freight
Integrating Community, Environment and Engineering

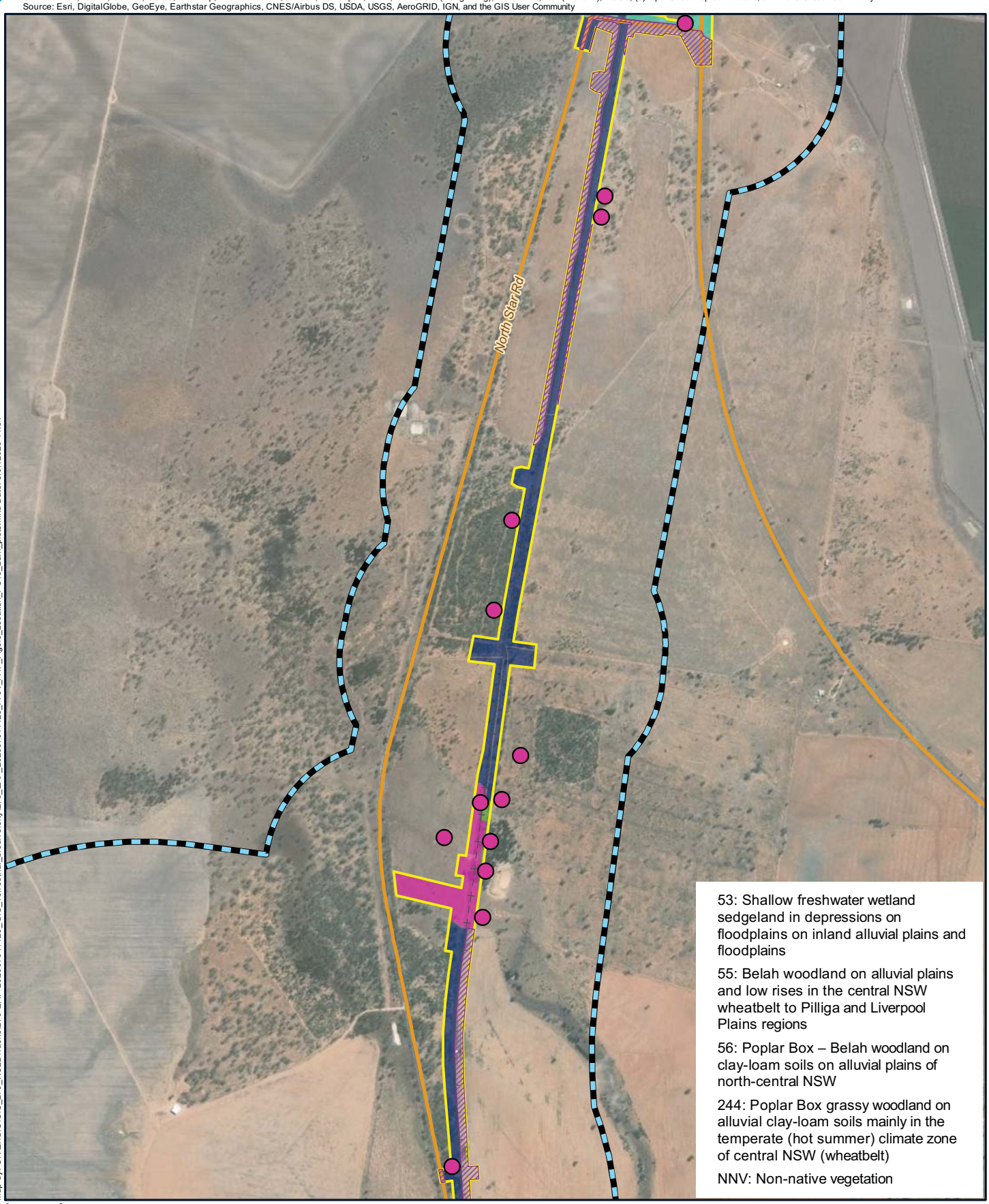
Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5c: Location of PCTs and BAM plots

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54



53: Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains

55: Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions

56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

244: Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)

NNV: Non-native vegetation

Legend

- BAM plots
- Existing rail (non-operational)
- Major roads
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 53
- 55
- 56
- 244

A4 scale: 1:20,000

0 0.25 0.5 km

Future Freight
Integrating Community, Environment and Engineering

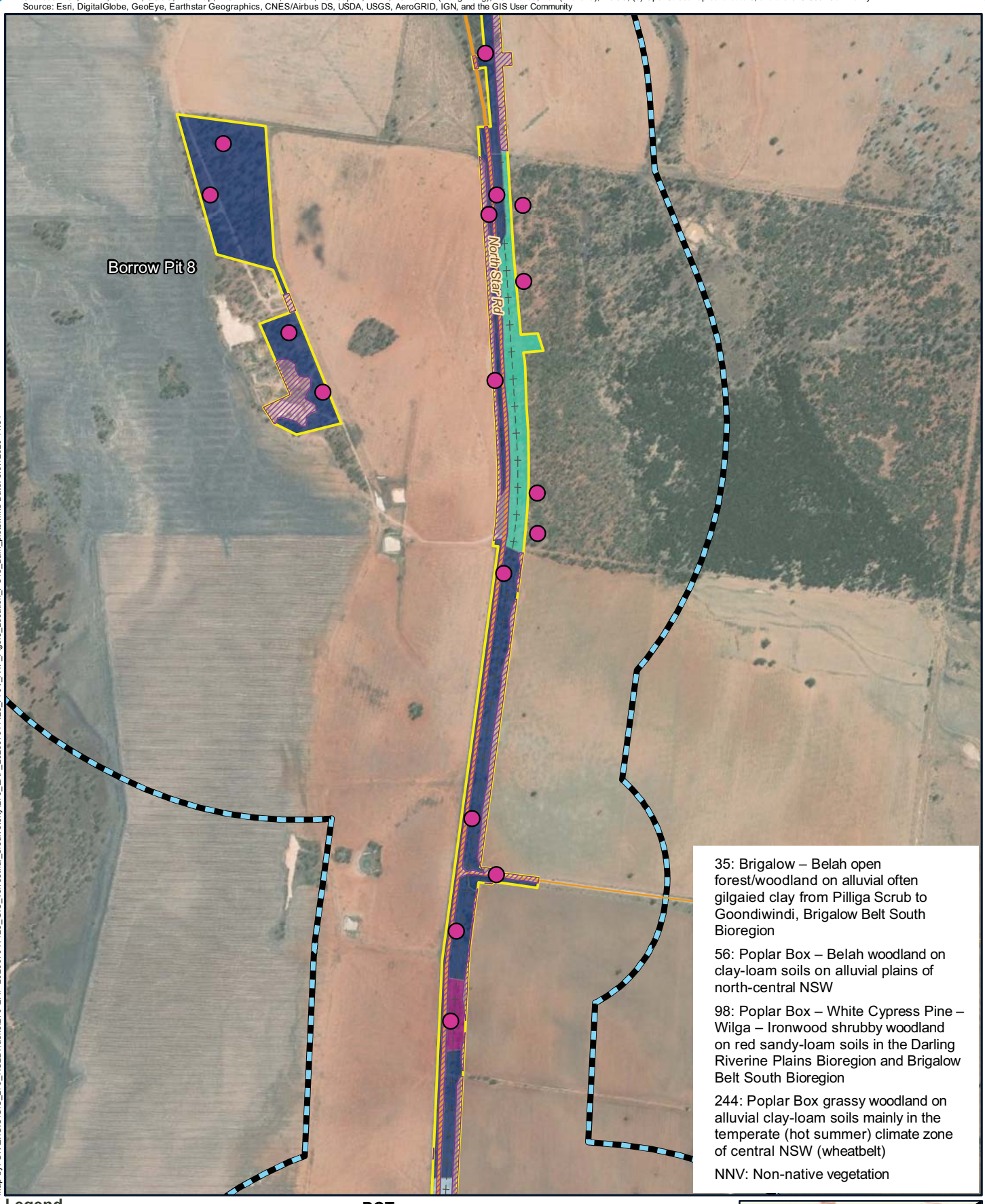
Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5d: Location of PCTs and BAM plots

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200711428_GIS_Terrestrial_biodiversity\270_EAP_20200711428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54



35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

98: Poplar Box – White Cypress Pine – Wilga – Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion

244: Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)

NNV: Non-native vegetation

Legend

- BAM plots
- Existing rail (non-operational)
- Major roads
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 35
- 56
- 98
- 244

A4 scale: 1:20,000
0 0.25 0.5km

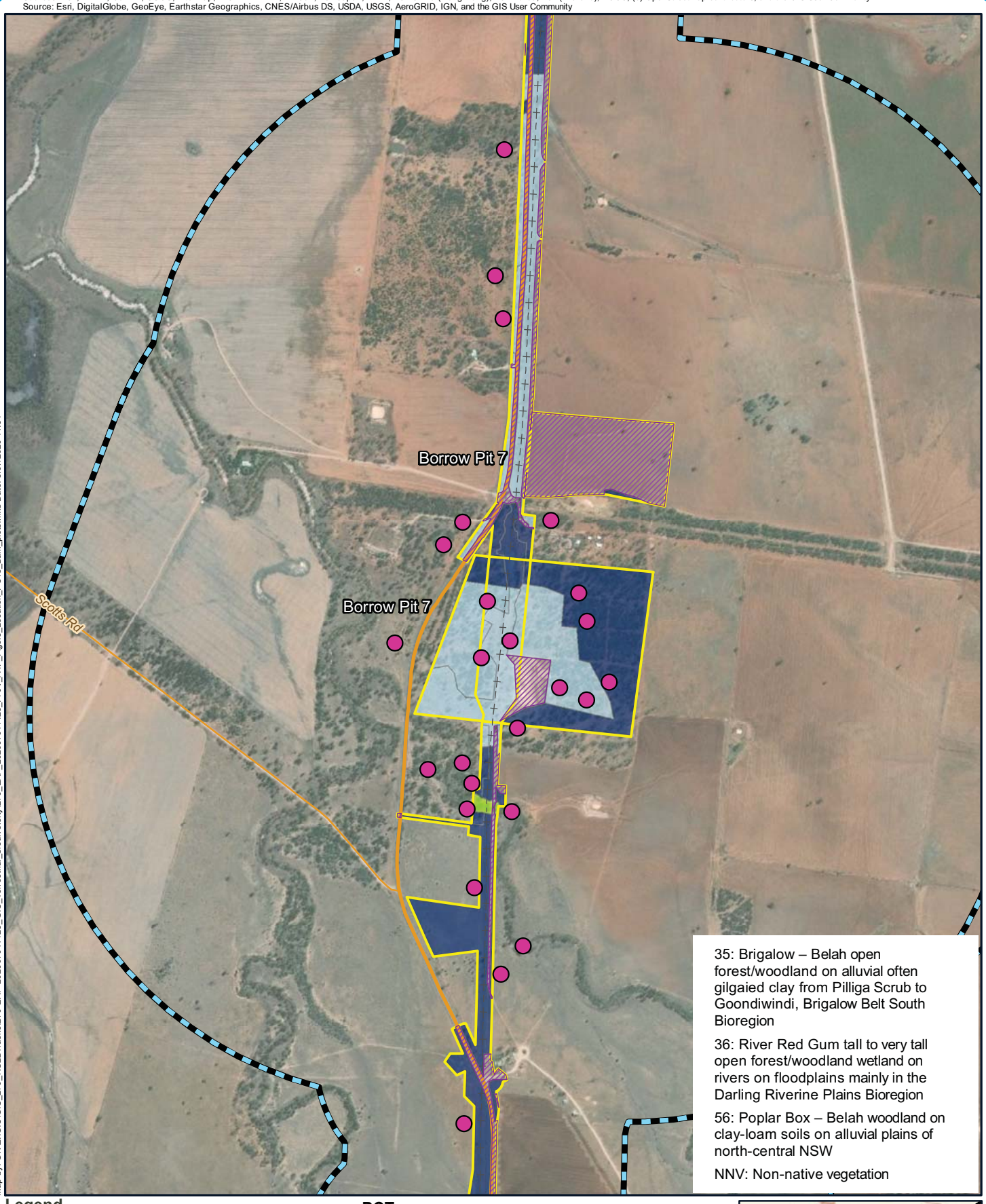
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5e: Location of PCTs and BAM plots

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54



35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

36: River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

NNV: Non-native vegetation

Legend

- BAM plots
- Existing rail (non-operational)
- Major roads
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 35
- 36
- 56

A4 scale: 1:20,000

0 0.25 0.5km

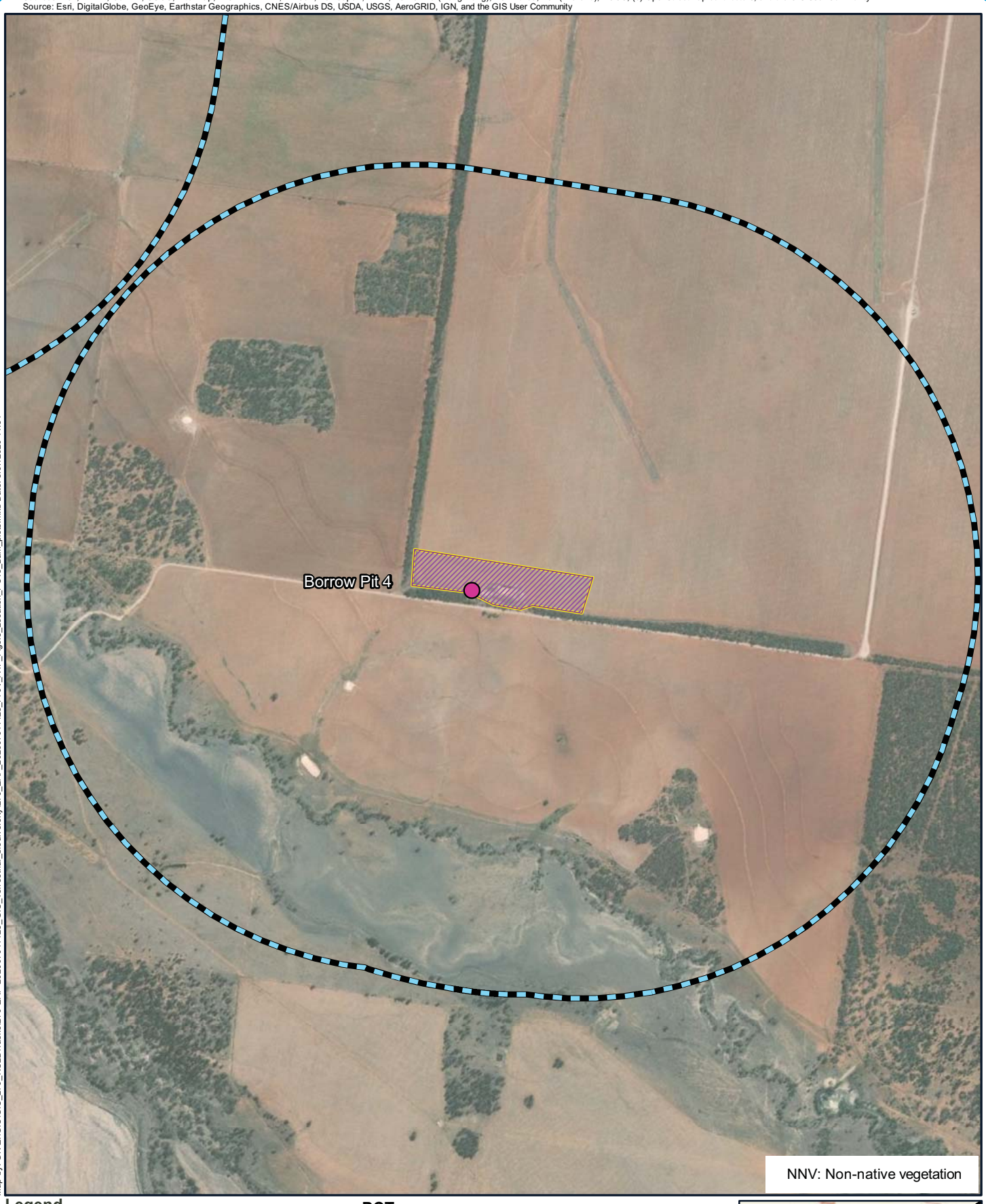
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5f: Location of PCTs and BAM plots



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Legend

- BAM plots
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)

A4 scale: 1:20,000

0 0.25 0.5km

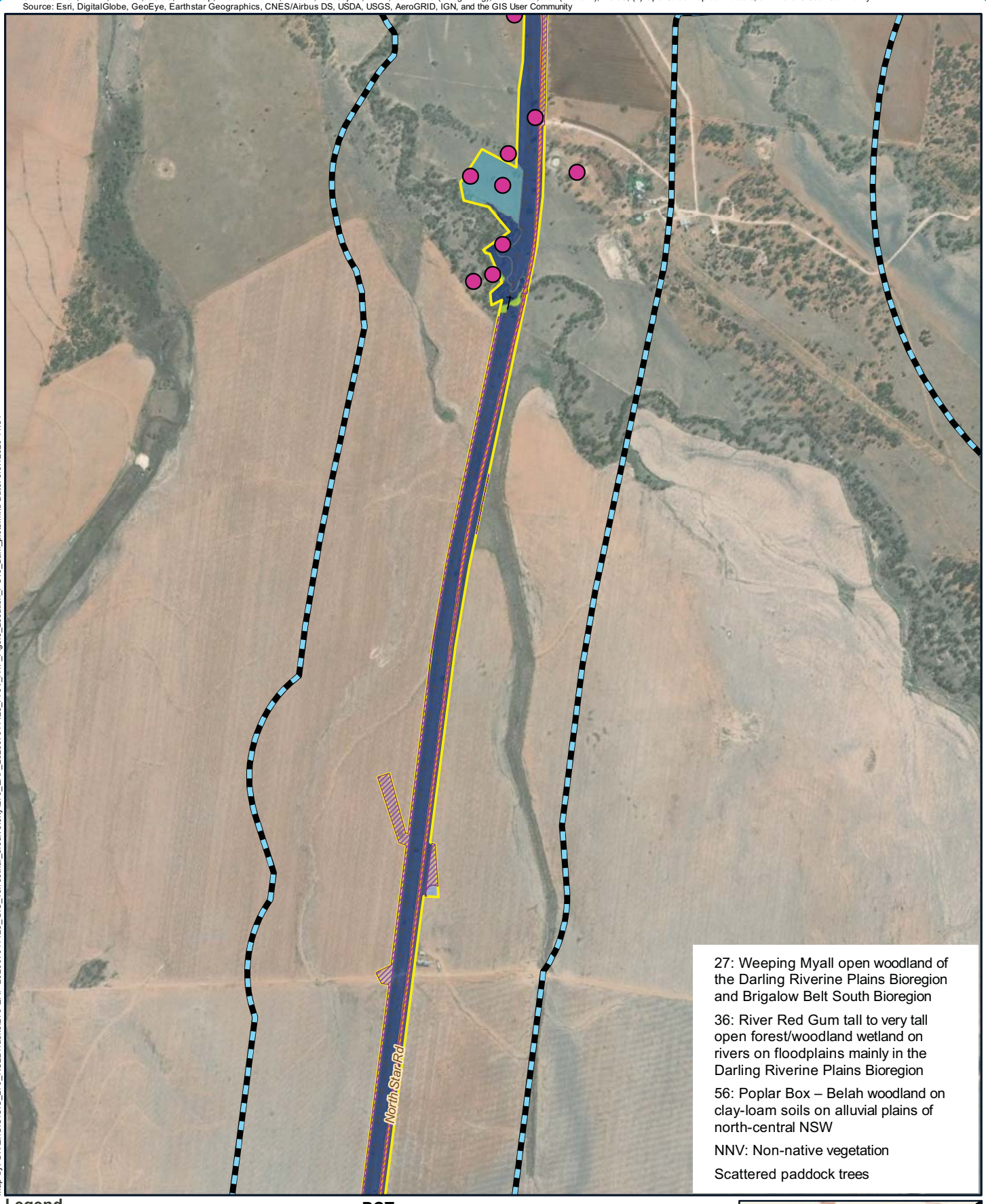
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5g:
Location of PCTs and BAM plots



27: Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion

36: River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

NNV: Non-native vegetation

Scattered paddock trees

Legend

- BAM plots
- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 27
- 36
- 56
- Scattered paddock trees

A4 scale: 1:20,000

0 0.25 0.5km

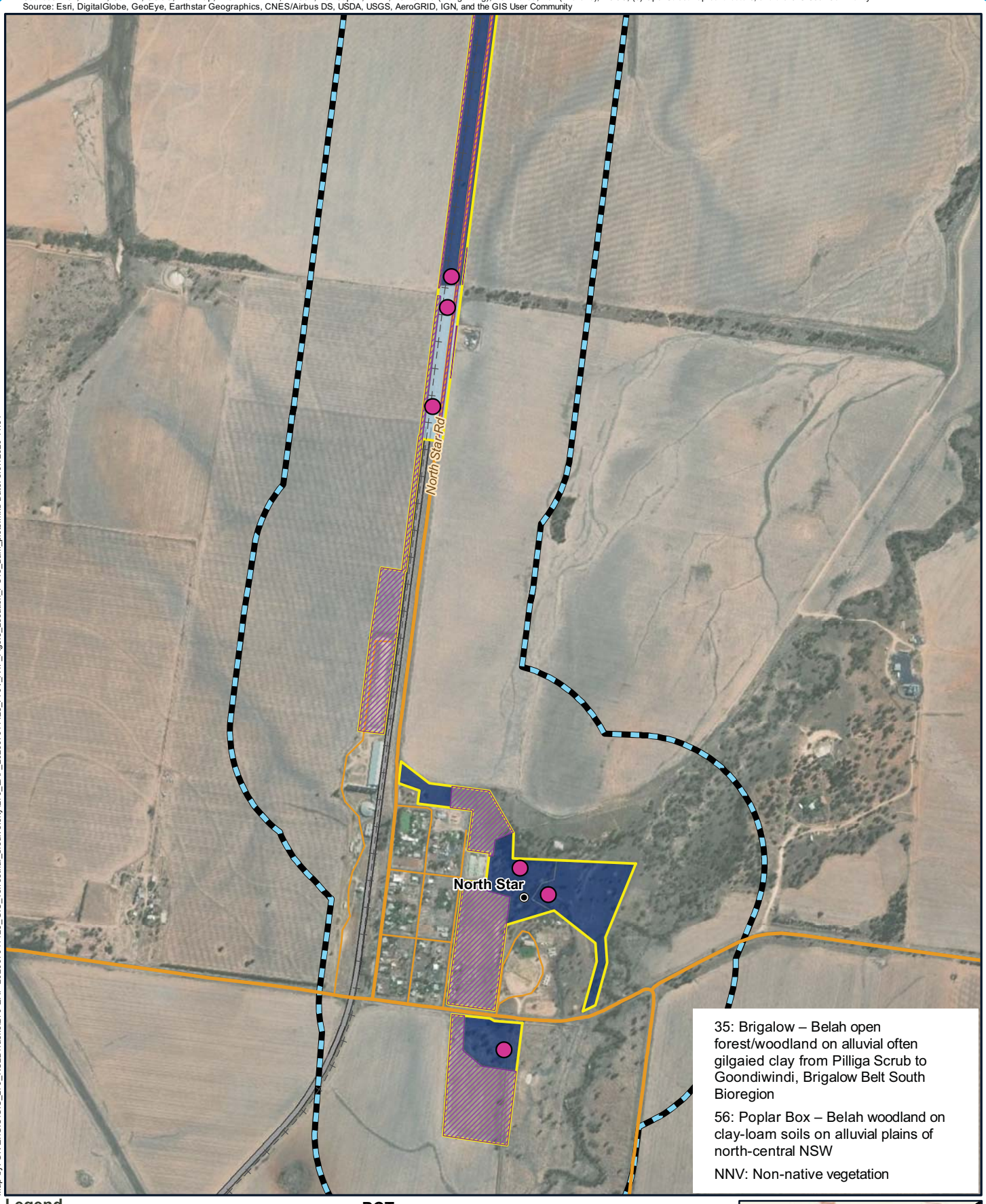
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5h: Location of PCTs and BAM plots



35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

56: Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW

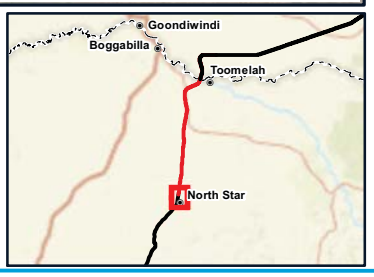
NNV: Non-native vegetation

Legend

- Localities
- BAM plots
- Existing rail (non-operational)
- Major roads
- Minor roads
- Adjoining alignments
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 35
- 56



A4 scale: 1:20,000

0 0.25 0.5km

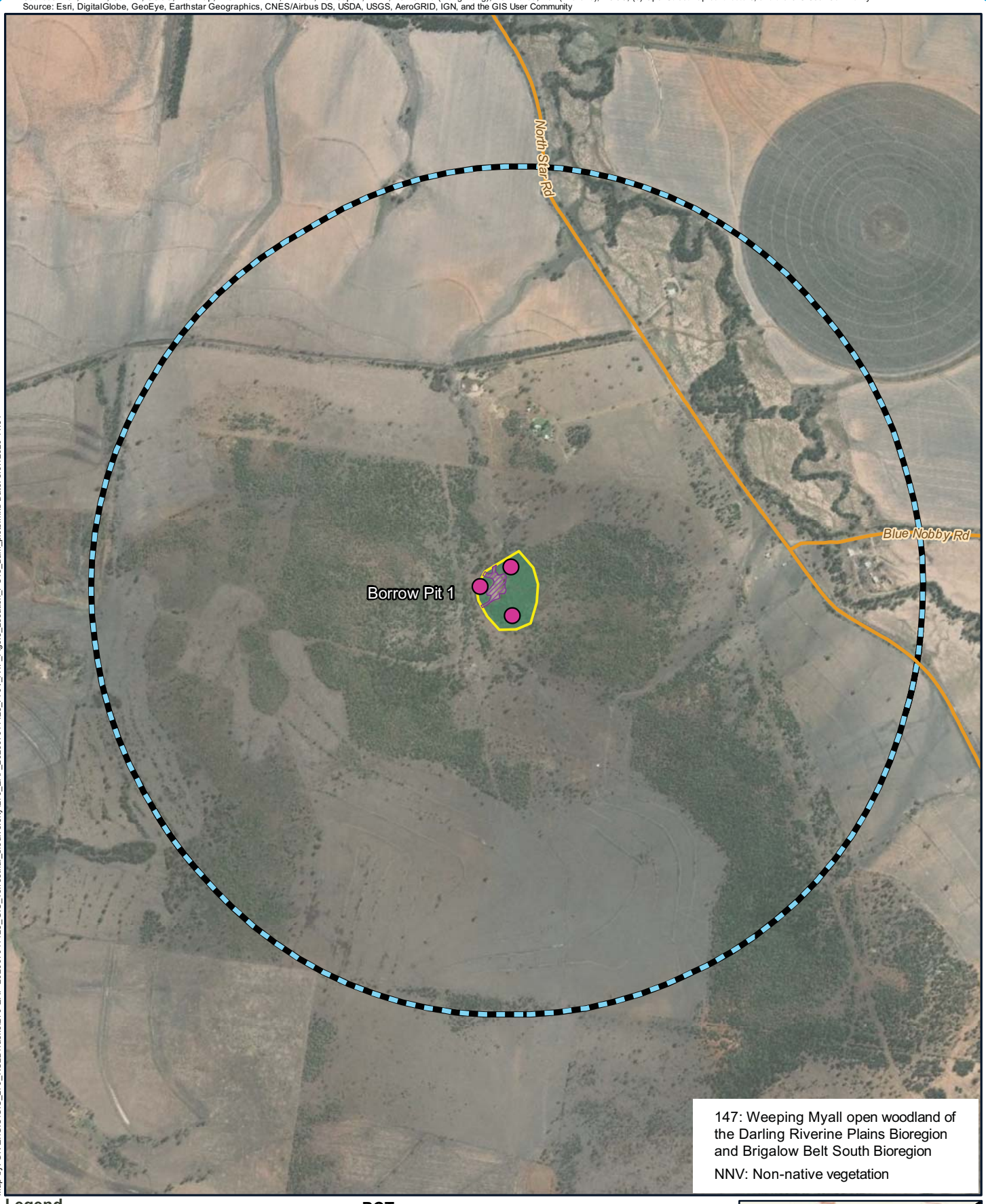
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5i: Location of PCTs and BAM plots

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54



147: Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion

NNV: Non-native vegetation

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54

Legend

- BAM plots
- Major roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 147

A4 scale: 1:20,000

0 0.25 0.5km

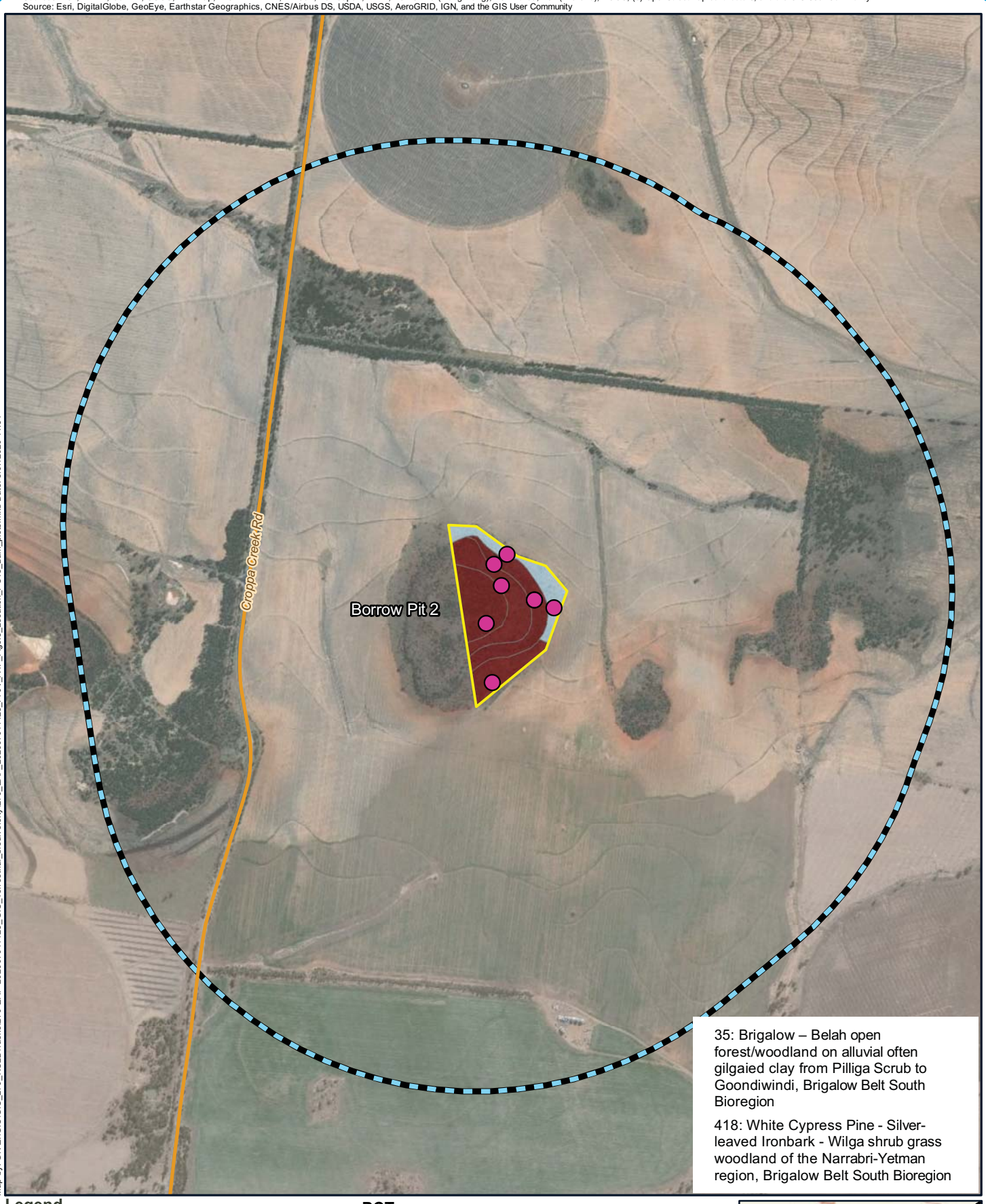
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5j: Location of PCTs and BAM plots



35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

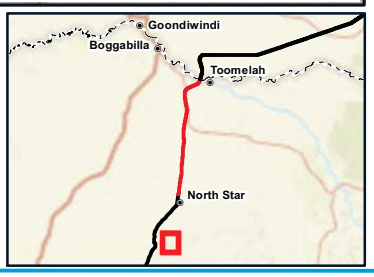
418: White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion

Legend

- BAM plots
- Major roads
- Subject land
- Study area

PCTs

- 35
- 418



A4 scale: 1:20,000

0 0.25 0.5km

Future Freight
Integrating Community, Environment and Engineering

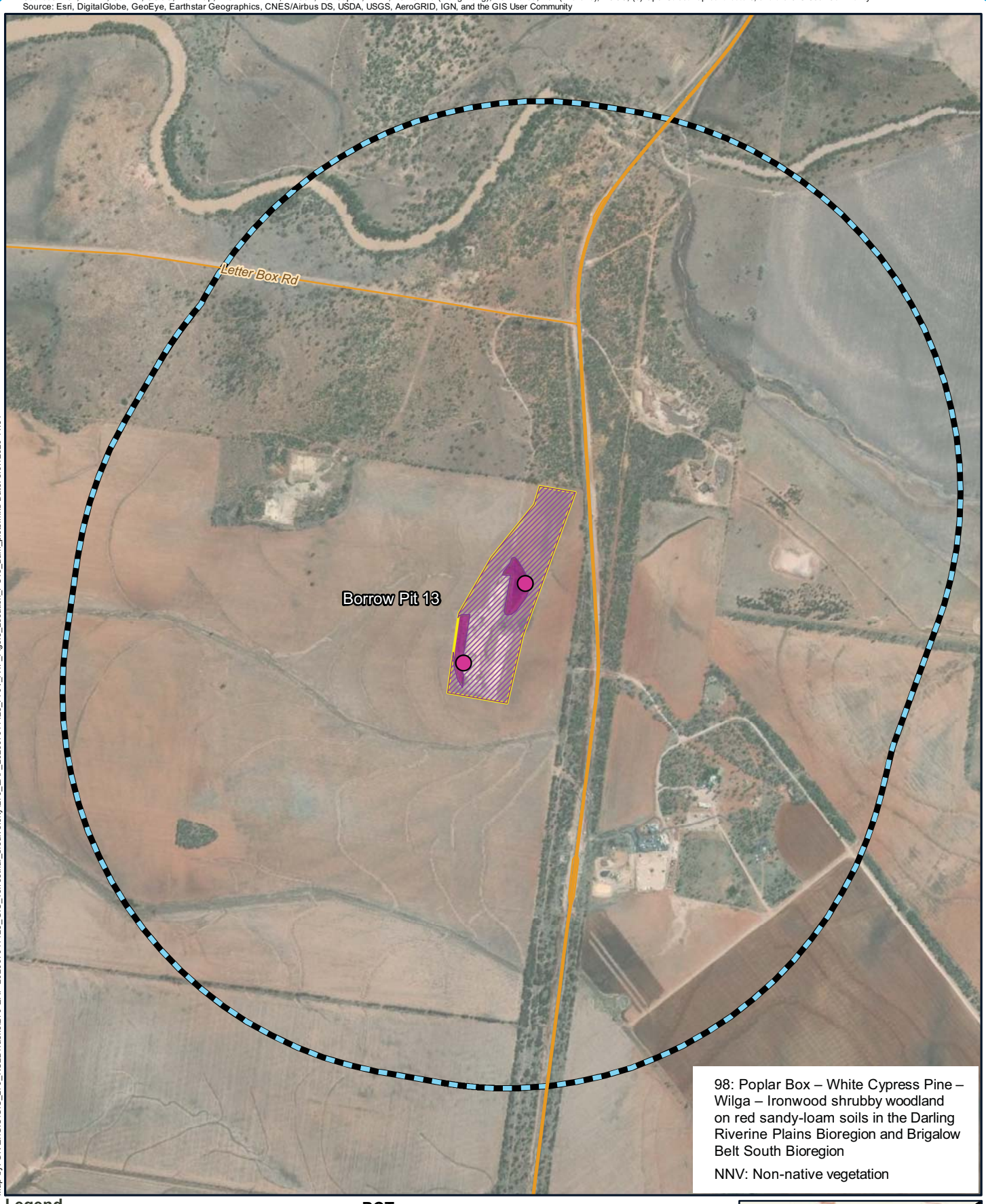
Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5k: Location of PCTs and BAM plots

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54



Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54

Legend

- BAM plots
- Major roads
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 98

A4 scale: 1:20,000

0 0.25 0.5km

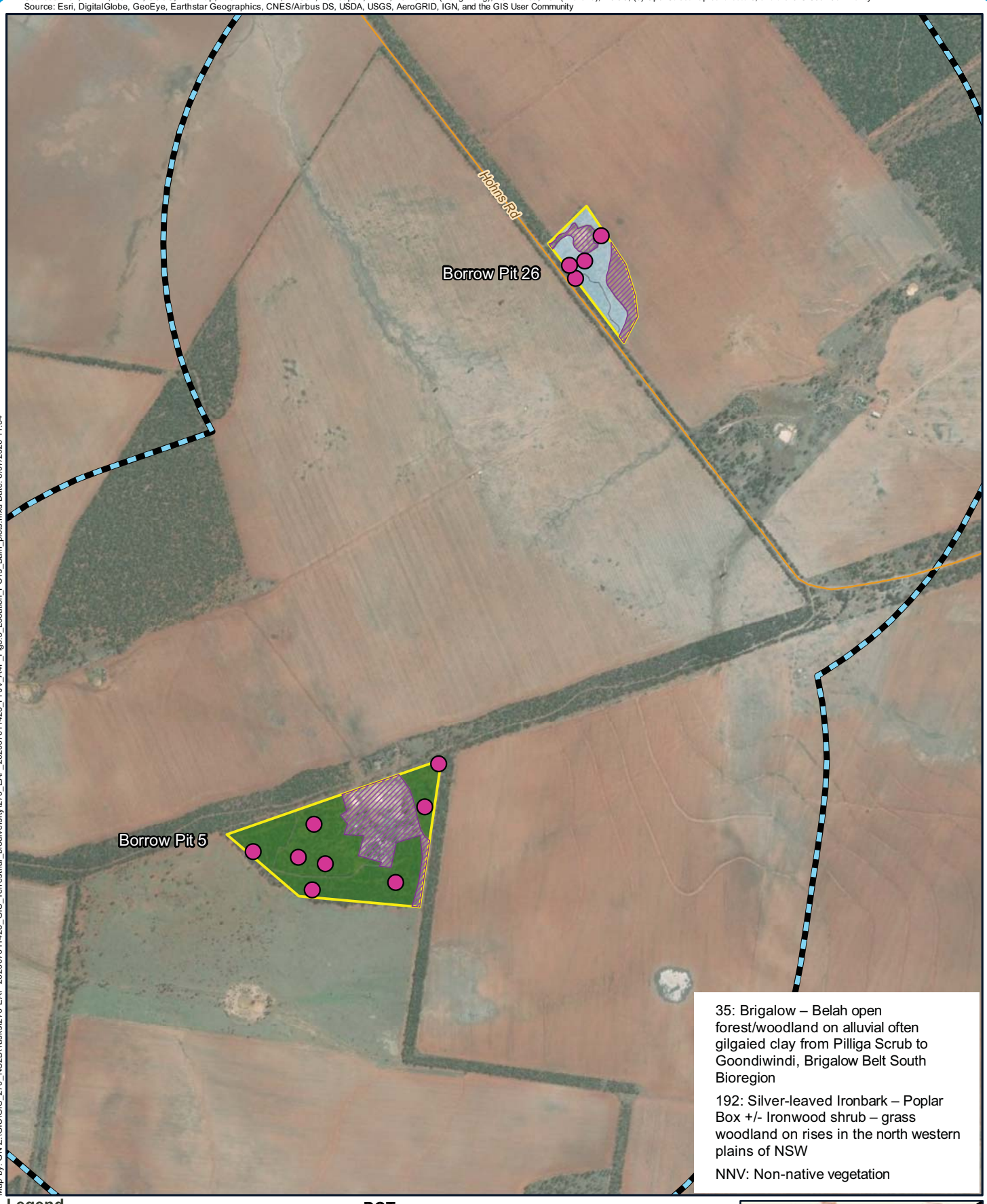
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5l: Location of PCTs and BAM plots



35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

192: Silver-leaved Ironbark – Poplar Box +/- Ironwood shrub – grass woodland on rises in the north western plains of NSW

NNV: Non-native vegetation

Legend

- BAM plots
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 35
- 192

A4 scale: 1:20,000

0 0.25 0.5 km

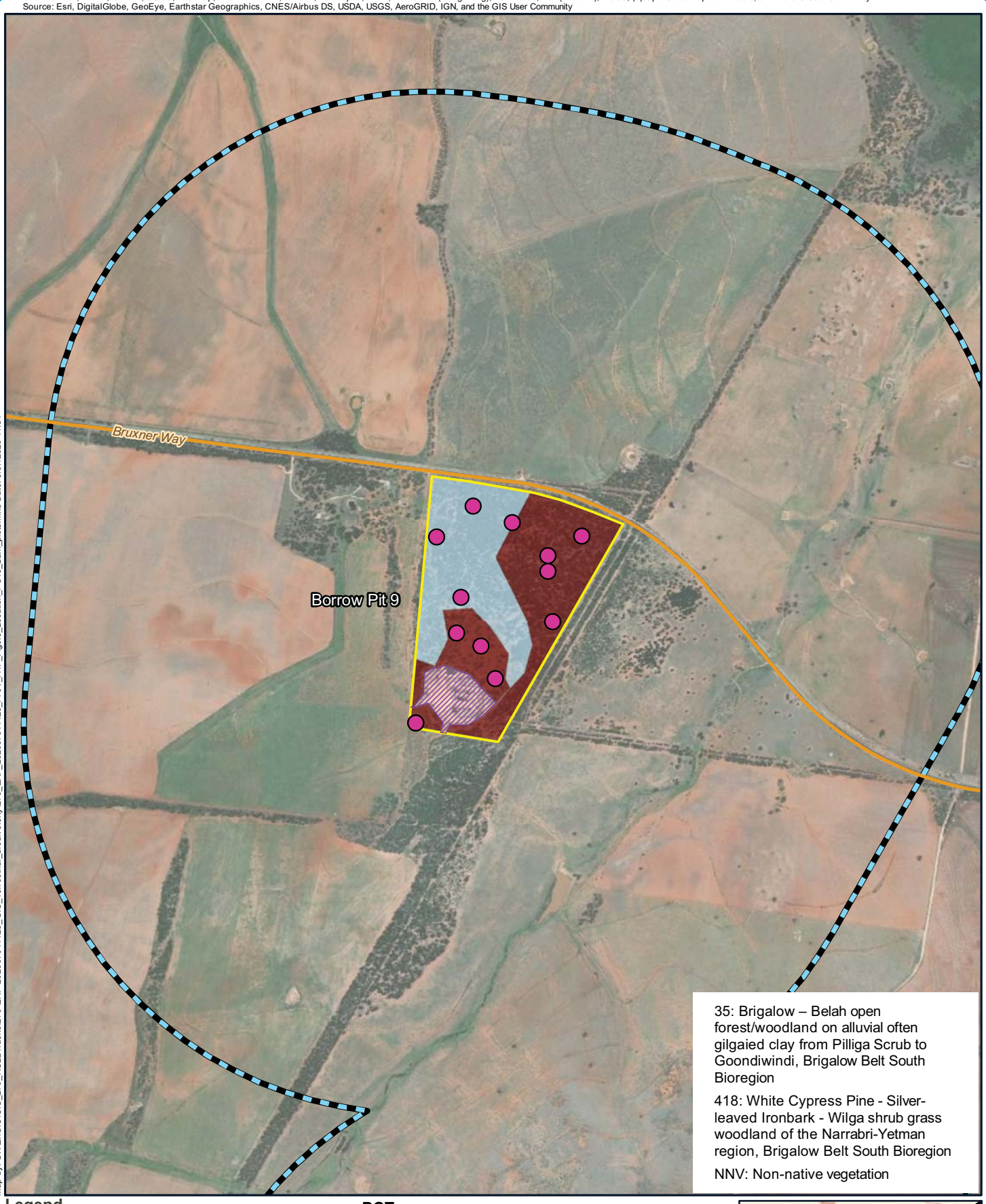
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5m: Location of PCTs and BAM plots



35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

418: White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion

NNV: Non-native vegetation

Legend

- BAM plots
- Major roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 35
- 418

A4 scale: 1:20,000

0 0.25 0.5km

Future Freight
Integrating Community, Environment and Engineering

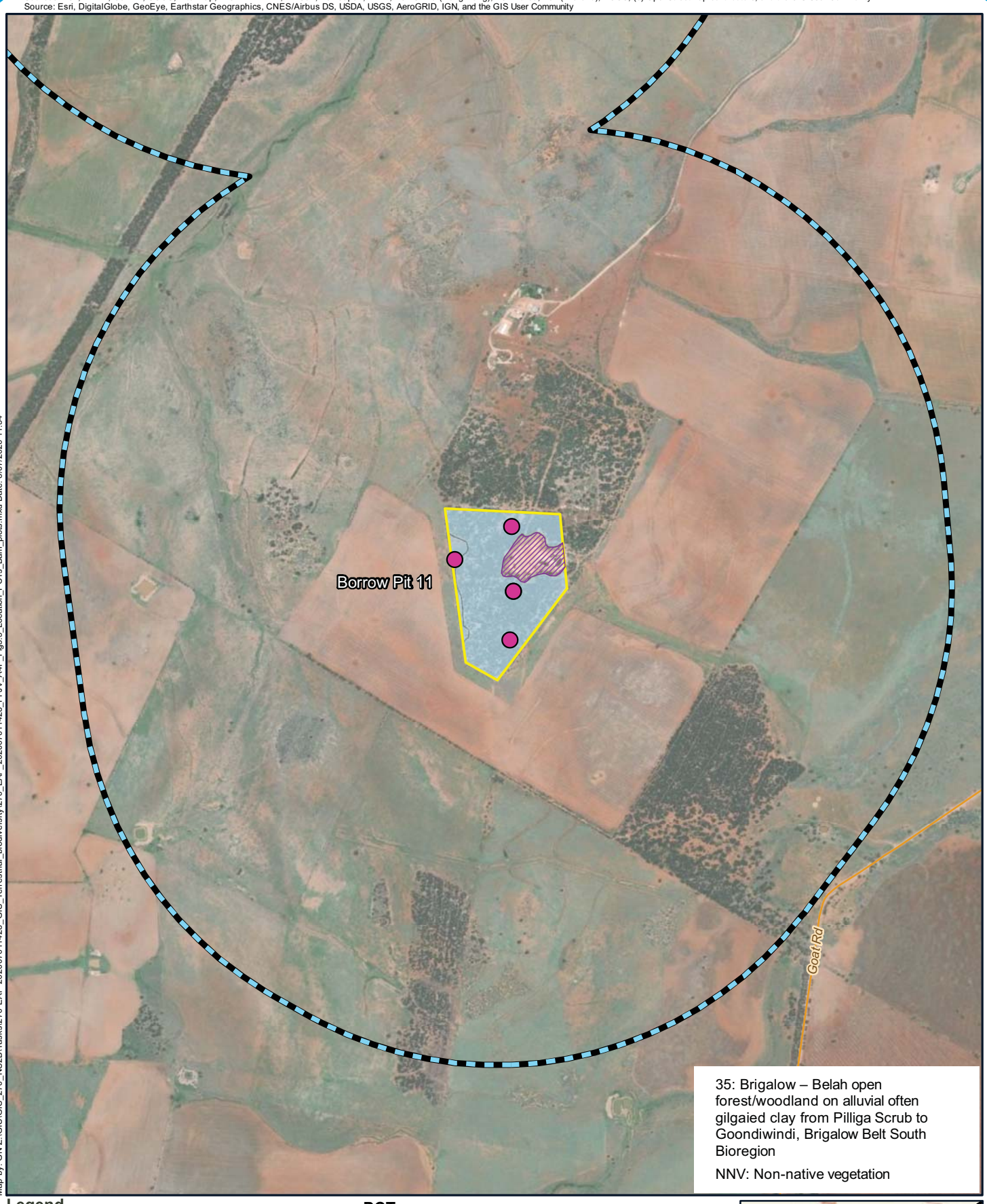
Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5n: Location of PCTs and BAM plots

Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54



Map by: GN Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig3.5_Location_PCTs_Bam_plots.mxd Date: 8/07/2020 11:54

Legend

- BAM plots
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 35

A4 scale: 1:20,000

0 0.25 0.5km

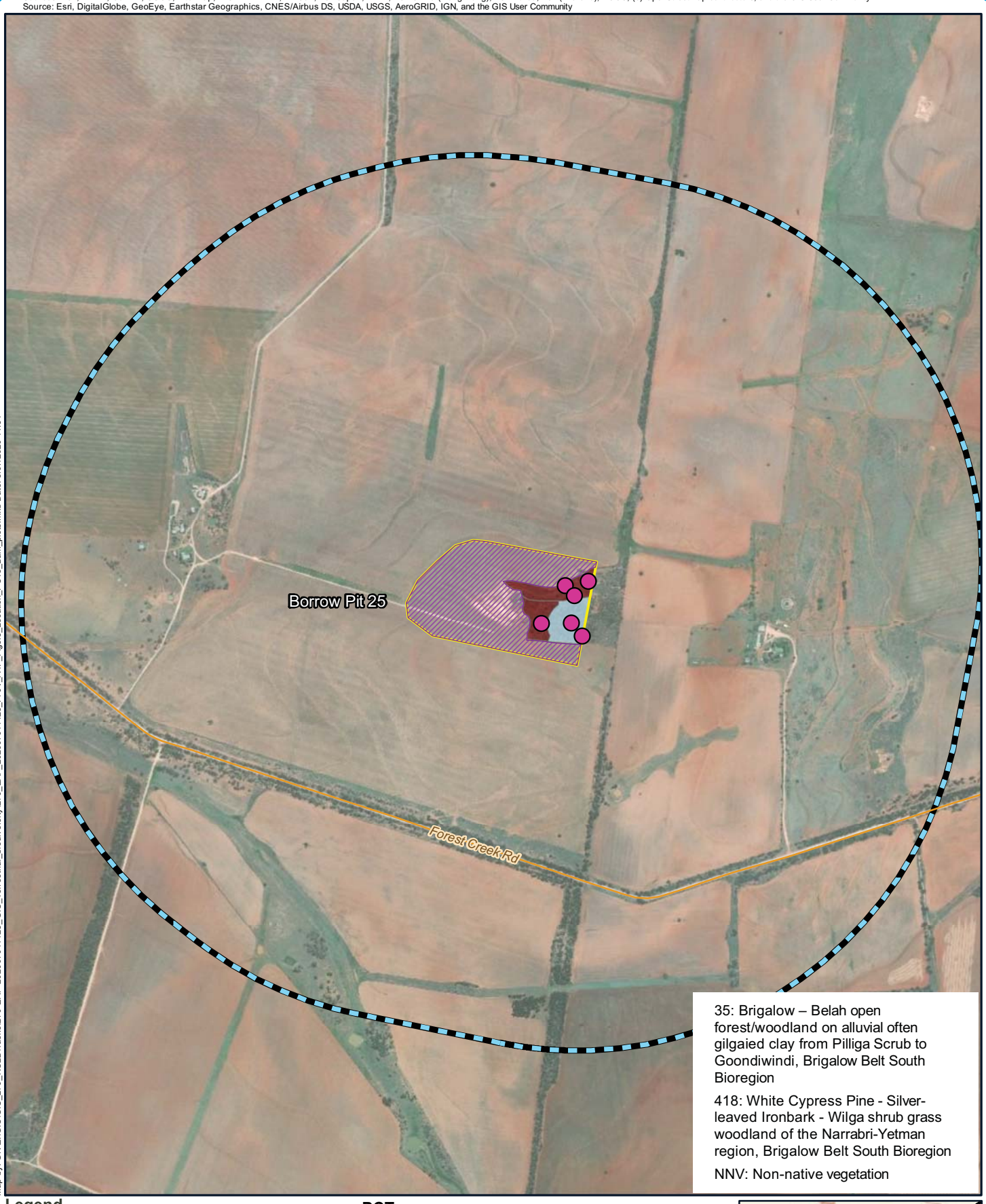
Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5o: Location of PCTs and BAM plots



35: Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion

418: White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion

NNV: Non-native vegetation

Legend

- BAM plots
- Minor roads
- Subject land
- Study area

PCTs

- Non-native vegetation (NNV)
- 35
- 418

A4 scale: 1:20,000

0 0.25 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.5p:
Location of PCTs and BAM plots

3.4.6 Threatened flora species

Prior to Part 2 of the BAM assessment commencing (refer Figure 3.1), a preliminary assessment using the Biodiversity Assessment Method Calculator (BAM C) and broad PCT mapping was undertaken which provided a list of species-credit flora species that may require survey considerations. Species identified as Ecosystem-credit species are predicted by landscape attributes and are not required to undergo specific targeted surveys.

The *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft (*DEC 2004) and *Commonwealth Threatened Species Survey and Assessment Guidelines* (various, DoEE 2010) were considered when undertaking the threatened species surveys in the subject land. This methodology was acceptable at the time of the assessment. The assessor notes that an updated draft methodology has since been released.

Targeted surveys for the species-credit flora species included targeted on-ground searches in suitable habitat throughout the subject land. Searches for these species were undertaken as meandering transects (refer Section 3.5) as described Section 5.2.7 of the TBSA Guidelines. This involved walking in suitable habitat within the subject land, including the borrow pit sites searching for targeted species. Due to the drought conditions experienced by vegetation communities in the subject land during the survey period, all threatened species credit species are assumed to be present, with the exception of *Sida rohlenae* (Shrub sida) and *Acacia jucunda* (Yetman wattle) (refer Table 4-11).

Terrestrial flora field surveys included the following methodologies:

- Surveys to confirm and map Plant Community Types (PCTs) and TECs to confirm accuracy with the NSW *Vegetation Information System* was undertaken using a rapid vegetation assessment (Rapid Data Points). At each rapid site, the dominant canopy, midstorey and groundcover species; structural cover condition; vegetation structure; PCT; priority or environmental weed species and cover; opportunistic threatened species counts; soil texture; fire history; vegetation condition; landform element and pattern; notes; photo number; surveyor; and date was recorded.
- Vegetation integrity assessment (site condition) plots were undertaken in accordance with the BAM based desktop assessments to enable the recognition of PCTs. Within each plot information relating to composition, structure and function was recorded, in addition to meandering transects to search for threatened flora species.

TEC assessments were conducted within vegetation zones within the subject land to compare key diagnostic criteria and condition thresholds to determine the presence of the EPBC Act listed TECs. The natural grasslands TEC potentially present in the study area (Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland) was asses as per the EPBC Act thresholds. However, extended drought conditions were present at the time of the site assessments, impacting the condition of these areas substantially and making detailed assessments not feasible. As such, the grassland TEC has been assumed as present for the purposes of this report until such time as a detailed site assessment is possible.

3.4.7 Threatened fauna species

In order to assess fauna, a preliminary assessment using the BAM Calculator and broad PCT mapping was undertaken by a BAM accredited assessor. This process provided a list of species-credit fauna species that may require survey in accordance with the BAM requirements. In accordance with the BAM, species identified as ecosystem-credit species are predicted by landscape attributes and are not required to undergo targeted surveys due to their cryptic nature. Some species may be both ecosystem-credit (foraging) and species-credit (breeding sites) species.

The *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (DEC 2004) and Commonwealth Threatened Species Survey and Assessment Guidelines (various, DoEE 2010) were considered when undertaking the threatened species surveys in the subject land.

The baseline sampling of vertebrate fauna species was undertaken between 23 and 30 October 2019 using the following methods:

- Fauna habitat assessments
- Active searches
- Microchiropteran bat call detection
- Camera traps
- Visual and auditory identification surveys of birds
- Spotlighting
- Call playback
- Incidental observations.

These methods are further described below, and the survey effort is presented in Appendix F.

3.4.7.1 Fauna habitat assessments

Early stage habitat assessments were undertaken within the alignment in August 2018 to characterise the fauna habitat within the subject land and were undertaken in areas of medium to high condition. Fauna habitat assessments were conducted to aid in understating potential habitat use within the subject land and while these surveys do not for fill all of the BAM requirements for species credit species they have been used to inform targeted survey efforts which occurred in October 2019 and included all borrow pits. The targeted surveys provided an indication of likely fauna utilisation, and suitability for fauna species, including listed fauna and species-credit species. Habitat attributes recorded during the assessment include:

- Vegetation structure and dominant species, including a description of canopy, shrub and ground layer structure and composition
- Presence and abundance of tree hollows and stags
- Presence and abundance of woody debris such as habitat logs and ground timber
- Presence and abundance of rocky habitat such as surface rocks, boulders, crevices, overhangs and caves
- Proximity to water (both permanent and ephemeral)
- Other disturbances such as grazing pressure, clearing, thinning or fire
- Any other significant habitat features present.

Included in the habitat assessments were searches for signs of animal activity, including tracks, scats, scratches, bones, fur, feathers, nests, foraging holes and diggings. Scats deemed as potentially belonging to a species-credit species were collected and sent to Barbara Triggs for analysis. Scat samples were analysed by removing hairs, which were then measured and examined under an optical microscope in whole mount, using 100x magnifications, in order to observe the hair profile, the structure of the medulla and the pigment distribution. The hairs were then cross-sectioned using the methods of Brunner & Coman (1974). The cross-sections were then examined under 100x magnification and the sections compared with others from the reference collection.

Targeted fauna surveys for species listed as suitable for spring survey occurred in October 2019, this included nesting raptors and several mammals. A full list of the species targeted during the spring surveys and the general location of surveys are outlined in Table 3-11. Further detail of the survey effort including number or nights/days, locations and specific PCTs is located in Appendix D and Appendix F.

Table 3-11 Spring survey species and location

Common name	Scientific name	Location	Method
Australian bustard	*Ardeotis australis*	Alignment and borrow pits as per BAMC	Daylight flushing survey
Barking owl	*Ninox connivens*	Alignment and borrow pits as per BAMC	Call playback, spotlighting, stag watching.
Black-breasted buzzard	*Hamirostra melanosternon*	Alignment and borrow pits as per BAMC	Daylight survey, nest survey
Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	*Setirostris eleryi*	Alignment and borrow pits as per BAMC	Habitat assessment, ultrasonic recorders (while not considered reliable method of assessment some calls may be of this species)
Bush stone-curlew	*Burhinus grallarius*	Alignment and borrow pits as per BAMC	Three nights of spotlighting and call playback of 30 seconds listen 4.5 minute repeated three times using the same call.
Eastern bentwing-bat	*Miniopterus schreibersii oceanensis*	Alignment and borrow pits as per BAMC	Habitat assessment, ultrasonic recorders deployed.
Eastern Cave Bat	*Vespadelus troughtoni*	Alignment and borrow pits as per BAMC	Habitat assessment, ultrasonic recorders deployed
Eastern pygmy-possum	*Cercartetus nanus*	Alignment and borrow pits as per BAMC	Spotlighting, baited camera traps
Grey-headed flying-fox	*Pteropus poliocephalus*	Alignment and borrow pits as per BAMC	Daylight survey for colonies
Koala	*Phascolarctos cinereus*	Alignment and borrow pits as per BAMC	Call playback minimum 2 nights, daylight survey, scat searches, spotlight
Little eagle	*Hieraaetus morphnoides*	Alignment and borrow pits as per BAMC	Daylight survey, nest survey
Major Mitchell's cockatoo	*Lophochroa leadbeateri*	Alignment and borrow pits as per BAMC	Daylight survey
Rufous bettong	*Aepyprymnus rufescens*	Alignment and borrow pits as per BAMC	Baited camera traps with almond oil added
Square-tailed kite	*Lophoictinia isura*	Alignment and borrow pits as per BAMC	Daylight survey, nest survey
Squirrel glider	*Petaurus norfolcensis*	Alignment and borrow pits as per BAMC	Spotlighting, baited camera traps
Superb parrot	*Polytelis swainsonii*	Alignment and borrow pits as per BAMC	Daylight survey
White-bellied sea-eagle	*Haliaeetus leucogaster*	Alignment and borrow pits as per BAMC	Daylight survey, nest survey

3.4.7.2 Active searches

Active searches were undertaken for reptiles, amphibians, small mammals and cryptic or ground-dwelling bird species and scats. This included scanning the trees and ground, searching beneath microhabitat such as rocks, fallen timber and peeling bark, digging through leaf litter and soil at tree bases and flushing birds from areas with a dense or grassy ground cover. Active searches were undertaken for a minimum of one hour within suitable microhabitat at each habitat assessment site (i.e. across the broad range of habitat types throughout the subject land).

3.4.7.3 Microchiropteran bat call detection

Microchiropteran bat echolocation calls were recorded using Song Meter ultrasonic bat call detectors, configured to record Microchiropteran species potentially occurring in the area and Anabat recorders. Detection was conducted across the subject land between dusk and dawn across the broad range of habitat types. Where possible, detection units were positioned in natural flyways, favourable for Microchiropteran bat detection. Eight units were deployed over separate locations for a combined 38 survey nights (refer Figure 3.3). Call data was forwarded to Balance! Environmental for analysis. Further information on the approaches implemented is provided in Appendix F.

3.4.7.4 Camera traps

Camera traps were deployed in strategic positions within the alignment and borrow pits to record visitation by nocturnal and diurnal animals. Strategic locations included fauna corridors and watering points such as dams and creek lines. Honey-oat mix (some with added almond oil) was used as an attractant where natural lures (e.g. water) were not present. 27 cameras were set at 13 locations for a combined 91 trap nights (refer Appendix D and Appendix F). Depending on the target animals' traps were set at either <50 cm above ground or >150 cm for arboreal animals. Further information on the approaches implemented is provided in Appendix F.

3.4.7.5 Visual and auditory identification surveys of birds

Roaming/meandering bird surveys were undertaken using both visual and auditory identification both within the alignment and borrow pits. Surveys commenced at dawn and continued for at least 20 minutes. Surveys were conducted at each habitat assessment site and during transit between sites. At least 20 minutes was spent at each survey site, with each site being sampled at least three times on separate mornings, sampling approximately 1 ha each time.

3.4.7.6 Spotlighting

In order to locate nocturnal fauna, spotlighting on foot using head torches and hand-held spotlights was undertaken over three nights at each survey location. Each survey continued for 20 minutes. In addition, spotlighting from the passenger window of a slow-moving vehicle (generally 5 to 10 km per hour) was undertaken along farm tracks, targeting larger ground and arboreal mammals and nocturnal birds.

3.4.7.7 Call playback

Call playback for nocturnal bird species and koala was undertaken three times at each targeted location following spotlight surveys (refer Appendix D and Appendix F). Call playback targeted a range of species depending on habitat type present. Calls were played for several minutes, followed by a period of listening for responses, scanning the night sky for silhouettes, and spotlighting adjacent vegetation for perched owls and ground dwelling species.

3.4.7.8 Incidental observations

All fauna observed incidentally within or in close proximity (up to 4 km) to the subject land were recorded, including those seen while travelling along roads and tracks. Fauna identified at dams and wetlands were also recorded.

3.5 Species polygon mapping for threatened species

Species polygon mapping was undertaken upon completion of the spring survey to identify and map areas having the potential to provide habitat for species-credit species listed under the provisions of the BC Act in accordance with the BAM. This included all SPS which had not undergone targeted surveys and were presumed present under the precautionary principle and the BAM requirements.

For any threatened species not listed under the provisions of the BC Act but identified within the SEARS and for all MNES species not covered under the BAM, predictive habitat modelling was undertaken as outlined in Section 7.

3.6 Permits to conduct works

The ecological field surveys reported in this document were conducted under the provisions of Aurecon's Scientific Licence (SL101374), Scientific collection permit (Fisheries) (P14/0025-1.4) and Animal Research Authority for ecological surveys within non-protected areas of New South Wales. Flora samples were collected under AECOM's scientific licence SL100659 and Aurecon's scientific licence SL101374 issued by the Office of Environment and Heritage.

3.7 Quality assurance/quality control

Quality control/assurance in relation to field results occurred through the following processes:

- BAM related work under the supervision of the BAM accredited assessors (refer Section 3.2.1.1)
- Scats that were collected in the field were sent to Barbara Triggs, scat analysis expert, for species confirmation (third party verification)
- Any threatened fauna species had to be sighted/confirmed by both members of the field team to produce a confirmed record. Where applicable/possible, proof (e.g. photograph, scat or other evidence) was collected.

The BAM accreditation of people preparing this report, and the qualifications and experience of any other people relied on in preparing the report is summarised in Table 3-12.

Table 3-12 Qualifications and experience of person involved with preparation of the report

Person	BAM accreditation	Qualifications	Experience
Sarah Glauert	BAAS17097	BSc Conservation Biology	12 years field ecology and consulting in NSW and Queensland
Ben Roberts	BAAS18042	BSc Arts, G Dip Science	14 years ecological consulting
Dr Helen Vickers	-	BSc Science (Honours), PhD	12 years ecological consulting
Andrew Craig	BAAS19022	BSc Science	20 years field ecology
Greg Ford	-	BSc App Science, G Dip Res Mgt	25 years research, field ecology
Brett Taylor	-	BSc Science, Eco and Cons Biol	12 years ecological consulting, 14 years field ecology
Kirsty Raines	-	BSc Science, M.A Env Sci and Mgt	2 years ecological consulting and field ecology in NSW
Andy Dalton	-	BSc Science	6 years field ecology
Nick Heard	-	BSc Ecology	9 years field ecology
Dr Oliver Robertson	BAAS20007	BSc Science (Honours), PhD	7 years field ecology and ecological consulting, 10 years research

3.8 Nomenclature

3.8.1 Flora

All vascular plants recorded or collected within plots were identified using keys and nomenclature in Harden (1992, 1993, 2000 and 2002). Where known, changes to nomenclature and classification have been incorporated into the results. Updated taxonomy has been derived from PlantNET (Royal Botanic Gardens Sydney 2018).

3.8.2 Fauna

The sources of nomenclature for the fauna sections of this report are as follows:

- Ingram, McDonald and Nattrass (2002) for frogs
- Wilson and Swan (2010) for reptiles
- Pizzey and Knight (2007) for birds
- Menkhorst and Knight (2011) for mammals
- Australian Bat Society (2015)
- Pusey, Kennard, Arthington (2004) for freshwater fish.

3.9 Assumptions and limitations

The following assumptions and limitations are applicable to this technical report:

- Drought and Intense Drought conditions affecting NSW, in particular within the Moree Plains and Gwydir Shires within which the subject land falls, have resulted in limited floral material being available for identification purposes and will have limited the diversity and cover of vegetation observed. Potentially, this could lead to an underestimation of the presence of native flora species and cover. In turn this may have impacted the ability to accurately determine threatened species presence and the presence of some TECs such as Poplar box grassy woodland on alluvial plains and Natural grasslands on basalt and fine-textured alluvial plains. It is the assessors understanding that DPIE have recently conducted updated BAM plot surveys in some areas to inform/update condition scores to accurately reflect drought conditions. A review of the BioNet Vegetation Classification database for several of the PCTs indicated that the results from the surveys were reasonable in terms of expected flora diversity for high, medium and low condition PCTs as mapped and that it was the percent cover which was most likely to have been impacted by the drought.
- Flora species that are difficult to identify during dry conditions, such as grasses, were assumed to be present where suitable habitat occurs. This approach is consistent with the precautionary principle.
- A number of plots located in the northern section of the subject land had four rather than five leaf litter sub- plots recorded. Where this occurred rather than use an ‘average’ of the benchmark value, the percentage cover was determined by dividing the sum of the sub-plots by four.
- All potential borrow pits have been included in this report though it is envisioned that not all borrow pits will be used. Therefore, not all credits will need to be retired. This report has followed the precautionary principle and assumed the largest potential impact will occur (i.e. worst-case scenario).

4 Description of environmental values

4.1 Desktop assessment results

4.1.1 Results of terrestrial ecology desktop assessment

The following sections detail the results of the terrestrial ecology desktop study. Search result outputs from the PMST and NSW EES Bionet Atlas databases are provided in Appendix E.

4.1.1.1 Landscape context

As outlined in Section 4.2 of the BAM, landscape features have been identified within a 500 m buffer from the boundary of the construction footprint (including the temporary and permanent disturbance footprints) along the alignment and 1,500 m surrounding the borrow pits. The subject land traverses different IBRA Bioregions and Sub-regions, Mitchell landscape areas, various stream orders and connective features. Landscape features applicable to the subject land are described in Table 4-1.

Table 4-1 Landscape features

Landscape feature	Brigalow Belt South IBRA Northern Basalts	Brigalow Belt South IBRA Northern Outwash	Darling Riverine Plains IBRA Castlereagh-Barwon
Alignment			
Subject land	117.34 ha	66.59 ha	143.28 ha
Native vegetation extent (500 m buffer)	426 ha	135 ha	497 ha
Percent native vegetation cover (500 m buffer)	33%	20%	47%
Mitchell landscapes	▪ Croppa Clay Plains ▪ Macintyre Alluvial Plains	▪ Croppa Creek Channels and Floodplains ▪ Croppa Clay Plains ▪ Macintyre Alluvial Plains	▪ Barwon Channels and Floodplains ▪ Macintyre Alluvial Plains ▪ Croppa Clay Plains ▪ Macintyre Alluvial Plains
IBRA Bioregion	Brigalow Belt South	Brigalow Belt South	Darling Riverine Plains
IBRA Sub-region	Northern Basalts	Northern Outwash	Castlereagh-Barwon
Rivers, streams, estuaries (Strahler order)	▪ Forest Creek ▪ (3rd order stream)	▪ Mobbindry Creek ▪ (3rd order stream) ▪ Back Creek ▪ (3rd order stream)	▪ Whalan Creek ▪ (2nd order stream) ▪ Macintyre River ▪ (6th order stream)
Wetlands	None	None	▪ Water reservoir associated with a cotton crop ▪ Floodplain wetland associated with Macintyre River
Connecting features	▪ Forest Creek	▪ Mobbindry Creek ▪ Back Creek	▪ Whalan Creek ▪ Macintyre River
Areas of geological significance and soil hazard features	Great Artesian Basin	Great Artesian Basin	Great Artesian Basin
Areas of outstanding biodiversity value	None	None	None

Landscape feature	Brigalow Belt South IBRA Northern Basalts	Brigalow Belt South IBRA Northern Outwash	Darling Riverine Plains IBRA Castlereagh-Barwon
Combined borrow pits			
Subject land	125.67 ha	69.37 ha	None
Native vegetation extent (1,500 m buffer)	620.60 ha	1320.43 ha	None
Percent native vegetation cover (500 m buffer)	34%	19%	31%
Mitchell landscapes	▪ Croppa Clay Plains ▪ Macintyre Alluvial Plains ▪ Yallaroi Basalts	▪ Croppa Clay Plains ▪ Macintyre Alluvial Plains	▪ Macintyre Alluvial Plains ▪ Barwon Channels and Floodplains- ▪ Croppa Clay Plains ▪ Macintyre Alluvial Plains
IBRA Bioregion	Brigalow Belt South	Brigalow Belt South	Darling Riverine Plains-
IBRA Sub-region	Northern Basalts	Northern Outwash	-Castlereagh-Barwon
Rivers, streams, estuaries (Strahler order)	▪ Forest Creek ▪ 3rd order stream	▪ Back Creek ▪ 3rd order stream (Borrow pit 7)	▪ -Macintyre River ▪ Whalan Creek ▪ 2nd order stream ▪ 6th order stream
Wetlands	None	None	▪ Water reservoir associated with a cotton crop ▪ Floodplain wetland associated with Macintyre River
Connecting features	▪ Forrest Creek	▪ Mobbinbry Creek ▪ Back Creek	▪ Whalan Creek ▪ Macintyre River
Areas of geological significance and soil hazard features	Great Artesian Basin	Great Artesian Basin	Great Artesian Basin-
Areas of outstanding biodiversity value	None	None	-

4.1.1.2 Areas of geological significance and soil hazard features

Alignment

The proposed alignment is characterised by a general decline in gradient from south to north. The highest elevation occurs at North Star (approximately 260 m AHD). The elevation gradually descends from the highlands into the low ridges of the NSW/QLD border, with the point of lowest elevation occurring as the corridor passes over Whalan Creek at 223 m AHD.

Soil profiles were examined along the proposed alignment. The road crossing of Back Creek, on the western side of the road, is associated with minor sheet, rill and gully erosion with stable scald erosion. Streambank erosion was evident on site, however no salting was found. The railway crossing on the western side of North Star Road (located south of Scotts Road) is also associated with minor sheet erosion with stable scald erosion, however no salting was evident.

Soil erosion data from the NSW Central West region, which encompasses the proposed alignment, revealed 25 per cent of soil monitoring units reporting sheet erosion as an issue, followed by 4 per cent gully erosion and 4 per cent for wind erosion. However, given that data from Metcalfe & Bui (2016) was broad-scale and has been categorised as 'limited' in confidence, indicates that actual erosion risk in proximity to the proposed alignment may vary from the study results.

None of the boreholes drilled as part of the geotechnical investigation for this proposal encountered rock between the depths of 20 and 40 m. The main geological unit under the proposal is the Kumbarilla Beds, which is a sedimentary sequence of terrestrial origin (sandstone, siltstone and mudstone). It is not known to be acid producing.

None of the younger sediments (Quaternary alluvium and Quaternary sand/soil) have the potential to be acid forming. The geology of the alignment indicates a strong dominant presence of alluvium deposits which are associated with sediments deposited through the transportation of channelled stream water. The main form of alluvium deposit in the Moree Plains and Gwydir region is likely to consist of prairie soils, black earths and grey clays which have developed on finer-grained sediment. Alluvium deposits in the region will potentially result in deposits of sand, silt or silty clay on low ridges along floodplains (DSITIA 2012). Studies of soil distribution and physical properties indicate that parent material strongly influences soil development in an area.

Borrow pits

Eleven borrow pits with the potential to provide general and/or structural fill have been identified with a maximum amount of extracted material during construction estimated to be 1,500,000 m^3. Borrow pit location IDs (refer Figure 1.1, corresponding soil types and potential qualitative contamination, soil erosion and salinity risk is detailed in Table 4-2. The location of borrow pits is based on the likely availability of suitable material. Several of the proposed borrow pits are located directly adjacent to existing borrow pits and also within close proximity to the alignment. The two borrow pits to the south of North Star (Borrow pit 1 and Borrow pit 2) are located on rocky outcrops which have not been developed for farming activities due to the amount of surface rock and the quality of the underlying soils. This is typical of the region, where most existing borrow pits are located on rocky outcrops and stony rises that are unsuitable for agriculture. Potential borrow pit sites were selected to minimise impacts to existing agricultural land-use and distance to the rail alignment. The presence of existing borrow sites was also considered. The final selection of borrow sites will consider biodiversity impacts.

Table 4-2 Soil classification and potential qualitative risk of borrow pits

Borrow pit ID	Soil type mapping	Surrounding land uses	Soil erosion risk	Salinity risk
4	Chromosols	Existing borrow pit, cropping pasture	Medium – soil type known to be susceptible to structural decline	Low - Found in well drained sites, moderate water holding capacity
5	Vertosols	Existing borrow pit, scattered vegetation, cropping pastures	Low – soil type is rich in clay and has high plasticity. Difficult to cultivate. Known shrink-swell phenomena (cracks when dry and expands when wet). Typically low sodicity.	Low – High water holding capacity. Typically low salinity.
7	Chromosols	Existing borrow pit, scattered vegetation, cropping pastures, house	Medium – soil type known to be susceptible to structural decline	Low - Found in well drained sites, moderate water holding capacity
8	Ferrosols, Dermosols and Chromosols	Existing borrow pit, cropping pasture	Low – soil type is rich in clay and has high plasticity. Difficult to cultivate. Known shrink-swell phenomena (cracks when dry and expands when wet). Typically low sodicity.	Low – High water holding capacity. Typically low salinity, can have localised salinity hazard.

Borrow pit ID	Soil type mapping	Surrounding land uses	Soil erosion risk	Salinity risk
9	Chromosols	Existing borrow pit, dense vegetation, cropping pastures	Medium – soil type known to be susceptible to structural decline	Low - Found in well drained sites, moderate water holding capacity
11	Chromosols	Existing borrow pit, dense vegetation, suspected residential rubbish disposal, housing	Medium – soil type known to be susceptible to structural decline	Low - Found in well drained sites, moderate water holding capacity
13	Vertosols	Existing borrow pit, cropping pastures, scattered vegetation	Low – soil type is rich in clay and has high plasticity. Difficult to cultivate. Known shrink-swell phenomena (cracks when dry and expands when wet). Typically low sodicity.	Low – High water holding capacity. Typically low salinity.
25	Chromosols	Existing borrow pit, cropping pastures, vegetation, house	Medium – soil type known to be susceptible to structural decline	Low - Found in well drained sites, moderate water holding capacity
26	Chromosols	Existing borrow pit, vegetation, cropping pastures	Medium – soil type known to be susceptible to structural decline	Low - Found in well drained sites, moderate water holding capacity
2	Vertosols & Dermosols	Cropping pastures, scattered vegetation	Medium – localised sheet erosion hazard	Low - Found in well drained sites, moderate water holding capacity
1	Vertosols & Dermosols	Existing borrow pit, native vegetation and grazing	Medium – localised sheet erosion hazard	Low - Found in well drained sites, moderate water holding capacity

4.1.1.3 Threatened ecological communities

Following a review of the BioNet Vegetation Classicising database and the existing PCT mapping eight PCTs were identified as having six potential analogous TECs listed under the BC Act (refer Table 4-3). Detailed assessment of these PCTs against the TECs is located in Appendix A.

Table 4-3 Plant Community Types and analogous TECs (BC Act) identified from the State Vegetation Type Map

PCTs	Analogous TEC (BC Act)
PCT 27 Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion **PCT 55** Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions
PCT 35 Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion **PCT 56** Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW **PCT 244** Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)	Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions
PCT 36 River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Artesian Springs Ecological Community in the Great Artesian Basin
PCT 147 Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion **PCT 55** Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Semi-evergreen vine thickets of the Brigalow Belt South and Nandewar Bioregions

PCTs	Analogous TEC (BC Act)
PCT 56 Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW **PCT 628** Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions
PCT 55 Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregion

4.1.1.4 Other matters of state environmental significance

Protected areas

No protected areas (including land and water) managed by DPIE and/or DPI Fisheries under the National Parks and Wildlife Act 1974 and the Marine Estate Management Act 2014 have been identified within the study area. No biobank sites, private conservation lands and other lands identified as offsets have been identified within the study area.

Critical habitat

A single area of critical habitat under Division 3 of the FM Act (1994) has been registered. This is Grey-nurse Shark Critical Habitat which is a marine environment and not relevant to the proposal.

4.1.2 Results of aquatic ecology desktop assessment

The subject land falls within the Border Rivers Catchment which comprise the catchments of the Dumaresq, Severn and Macintyre Rivers. The proposed rail corridor and borrow pits fall within the Macintyre River sub-catchment and transect several creeks. A detailed assessment can be found in the Aquatic Biodiversity Technical Report Appendix S of the EIS.

4.1.2.1 Threatened aquatic species and communities

No fish records occur within the rail corridor identified in a search of the BioNet database (refer Section 4.1.2). The only threatened aquatic species identified by the PMST was the Murray cod (*Macullochella peelii*) which is listed as vulnerable (EPBC Act). The Macintyre River provides suitable habitat for Murray cod. All other waterways surveyed are unlikely to support Murray cod due to a lack of key fish habitat, including but not limited to semi-permanence of aquatic refuges. No aquatic communities were identified in the PMST report. Further detail is provided in EIS Appendix S: Aquatic Biodiversity Technical Report.

4.1.2.2 Ramsar listed wetlands

There are no Wetlands of International Importance (Ramsar wetlands) within, or adjacent to (i.e. within 10 km) of the proposal. The following Ramsar wetlands are located 1,000 to 1,300 km from the proposal:

- Banrock Station wetland complex
- Riverland
- The Coorong and Lakes Alexandrina and Albert Wetland.

A wetland complex consisting of Morella watercourse, Pungbougal Lagoon and Boobera Lagoon are part of a remnant channel of the Macintyre River south of Goondiwindi. This wetland complex is listed as a site of national importance in the Directory of Important Wetlands in Australia (an inventory of nationally important wetlands maintained by Environment Australia). It is not located within the proposal site, with the watercourse system at a minimum of 8 km downstream from the proposal site, and hydraulically connected only during flood events.

4.1.2.3 Waterfront Land

Under the NSW *Water Management Act 2000* 'waterfront land' is defined as the bed of a river and the land within 40 m of the river bank. Within the proposal area, all watercourses and associated tributaries and adjacent lands are classed as 'waterfront land' (including the Macintyre River and adjacent lands). Under the Act this may be classed as a 'controlled activity' requiring development approval. The Guidelines for controlled activities on waterfront land (DPI 2012) provide a framework for development activities within the riparian corridor. However, the proposal has been classed as 'state significant infrastructure' and is exempt from requiring a controlled activity approval. As such, 'waterfront land' associated with the Proposal is not referred to further in this report.

Terrestrial groundwater dependent ecosystems

Moderate to high potential terrestrial GDEs are mapped within the 2 km radius groundwater search area for GDEs; these are summarised in Table 4-4. Mapping of potential GDEs is presented in EIS Chapter 14: Groundwater.

Table 4-4 Summary of terrestrial groundwater dependent ecosystems

PCT	GDE Category	Aquatic GDE description
PCT36	High	High potential terrestrial GDEs within the floodplains of Mobbindry Creek, Back Creek, Whalan Creek and, Macintyre River. This GDE is characterised by Red River Gums and open tall forest associated with flood plains. The alignment intersects this feature with a short section of cut and fill proposed.
PCT53	High	High potential terrestrial GDEs within the area mapped as PCT53 which is an ephemeral wetland.
PCT247	High	High potential terrestrial GDE within the areas mapped as lignum swamp

Subterranean groundwater dependent ecosystems

No known or potential subterranean GDEs have been mapped within the Bureau of Meteorology GDE Atlas within the GDE groundwater search area.

4.2 Existing environment

This section provides a description of the existing ecological values of the subject land based on the results of the field assessments. The results presented in this section detail the plant community types, existing flora and fauna species (including weeds and pests), habitats, and TECs observed within the study area.

4.2.1 Flora and fauna

A total of 339 flora species were observed within the subject land. Of those 283 (83 per cent) were native and 56 (17 per cent) were non-native. A full list of the flora species recorded within the subject land is located in Appendix E. Of the non-native species, 34 (61 per cent) are recorded as Naturalised on PlantNET, 15 (27 per cent) are listed as High Threat Exotics (HTE) and four (7 per cent) do not appear on the PlantNET records for NSW. One HTE was recorded outside of the subject land but has the potential to invade within a short timeframe. No species-credit or ecosystem-credit flora species were observed within the subject land. A total of 207 fauna species were observed within the subject land, including nine (4 per cent) non-native species. Observed species consisted of 145 birds, 37 mammals, 20 reptiles, and five amphibians. A full list of fauna species recorded within the study area is located in Appendix D.

4.2.2 Native vegetation within the development site

Surveys of the subject land identified 14 PCTs across 3 broad condition states, equating to 27 distinct vegetation types which are listed in Table 4-5. The percent cleared value has been taken form the BioNet Vegetation Classification database.

Table 4-5 Plant community types, broad condition classes and area of impact

PCT ID	Plant community types	Condition classes	Area of impact Alignment (Ha)	Area of impact Borrow pits (Ha)
PCT 27	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	Medium Low	0.03 4.25	N/A
PCT 35	Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	High	14.15	17.53 (BP7) 21.84 (BP9) 18.49 (BP11) 2.38 (BP25) 1.25 (BP26)
		Medium	N/A	3.27 (BP26)
		Low	9.6	3.2(BP2) 7.72 (BP7) 0.9 (BP11) 0.91 (BP26)
PCT 36	River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	High	1.16	N/A
		Medium	6.09	N/A
PCT 52	Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion	Medium	41.95	N/A
PCT 53	Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains	Medium	5.8	N/A
PCT 55	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	High	0.52	N/A
PCT 56	Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW	High	45.08	21.27 (BP7)
		Medium	29.14	N/A
		Low	100.14	0.77 (BP7) 21.14 (BP8)
PCT 98	Poplar Box – White Cypress Pine – Wilga – Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	High	1.7	1.5 (BP13)
		Low	N/A	1 (BP13)
PCT 147	Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion	High	N/A	1.46 (BP1)
		Medium	N/A	3.13 (BP1)
PCT 192	Silver-leaved Ironbark – Poplar Box +/- Ironwood shrub – grass woodland on rises in the north western plains of NSW	High	N/A	10.4 (BP5)
		Medium	5.28	7.63 (BP5)
		Low	2.96	2.45 (BP5)
PCT 244	Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)	High	10.14	N/A
		Medium	7.74	N/A
		Low	9.49	N/A

PCT ID	Plant community types	Condition classes	Area of impact Alignment (Ha)	Area of impact Borrow pits (Ha)
PCT 247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	Medium	4.35	N/A
		Low	6.89	N/A
PCT 418	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	High	N/A	21.19 (BP9)
		Medium	N/A	6.07 (BP9) 1.46 (BP25)
		Low	N/A	1.04 (BP9) 2.08 (BP25)
PCT 628	Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	Medium	11.72	N/A
		Low	20.16	N/A

These PCTs were aligned with communities described as part of the NSW VIS Classification Database (OEH 2016c). The PCTs were then categorised into 31 vegetation zones within the Alignment and 23 vegetation zones within the Borrow pits, based on condition and location within the IBRA subregions.

The composition of the PCTs including location within IBRA sub-regions and vegetation quality (High, Medium, Low) are outlined in Sections 4.2.2.1 to 4.2.2.15 and a flora species list for all plots surveyed is included in Appendix E.

4.2.2.1 PCT 27 Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion – Medium

PCT Name	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	
Condition	Medium - Low	
PCT number	27	
IBRA region	Brigalow Belt South	
IBRA sub-region	Northern Outwash	
Formation	Semi-arid Woodlands (Grassy sub-formation)	
Class	Riverine Plain Woodlands	
Percent Cleared	86	
General site description used to identify PCT	Small areas of Weeping Myall woodland occur within the subject land it has been modified by past grazing. The woodland contains a mid to low intact canopy of Weeping Myall ,*Acacia pendula,* with a grazed grassy understory containing occurrences of forbs including *Einadia nutans subsp. Nutans*, *Atriplex leptocarpa* and grasses *Enteropogon acicularis, Aristida leptopoda and Aristida jerichoensis.* The area is not currently covered by state PVT mapping but meets the EPBC condition descriptions and has been mapped at PCT27 Medium condition due to the obvious level of recent disturbance. The area is surrounded by grassland which contains both native and exotic species. The surrounding area has been mapped as Low PCT27 as this is the most likely historical PCT based on the location in the landscape, soil type and surrounding vegetation.	

PCT Name	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion
Benchmark floristic description	Mid-high and low woodland to open woodland to about 10 m high dominated by Drooping Myall often with Belah (*Casuarina cristata*) and Wild Orange (*Capparis mitchellii*). Poplar Box (*Eucalyptus populnea* subsp. *bimbil*), Western Rosewood (*Alectryon oleifolius*), Whitewood (*Atalaya hemiglauca*) or Black Box (*Eucalyptus largiflorens*) may also occur. Shrubs are sparse and include Wilga (*Geijera parviflora*), *Rhagodia spinescens*, *Capparis lasiantha*, *Acacia oswaldii, Acacia salicina, Myoporum montanum* and *Pimelea neo-anglica*. Small shrubs include species of copperburrs including *Sclerolaena brachyptera*, *Sclerolaena muricata* var. *muricata* and *Sclerolaena stelligera*. Other small shrubs include *Maireana aphylla*, *Atriplex stipitata*, *Leiocarpa panaetioides* and *Enchylaena tomentosa*. The ground cover may be dense after rain but normally is mid-dense to sparse. It contains many species of grasses and forbs. Forbs include *Einadia nutans* subsp. *nutans*, *Leiocarpa tomentosa*, *Marsilea hirsuta*, *Solanum esuriale*, *Daucus glochidiatus*, *Goodenia fascicularis*, *Oxalis perennans*, *Eryngium paludosum* and *Craspedia variabilis*. The most common grass species are *Monachather paradoxus*, *Chloris truncata*, *Enteropogon acicularis*, *Astrebla lappacea*, *Astrebla pectinata*, *Walwhalleya proluta*, *Dichanthium sericeum* subsp. *sericeum*, *Sporobolus caroli*, *Austrodanthonia setacea* and *Aristida leptopoda*. Occurs on grey to brown cracking clay, black earth or clay loam soils that are sometimes gilgaied, on flats or undulating rises on broad alluvial plains or outer floodplains that rarely flood. Mainly in the Darling Riverine Plains and Brigalow Belt South Bioregions with some outliers beyond these regions. It is estimated that > 75 per cent has been cleared due to it occurrence on arable alluvial soils. Some remnants are in good condition where they are not continuously or heavily grazed such as on roadsides or in travelling stock reserves. May have contained more of a chenopod understorey prior to European settlement in some places.
BC Act status	This PCT is consistent with the Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions - endangered. Detailed analysis is located in Appendix B
EPBC Act status	This PCT is consistent with Weeping Myall Woodland TEC - endangered. Detailed analysis against the listing is located in Appendix C

4.2.2.2 PCT 35 Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion – High – Low

PCT Name	Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	
Condition	High – Medium - Low	
PCT number	35	
IBRA Region	Brigalow Belt South	
IBRA Sub-region	Northern Basalts Northern Outwash	
Formation	Semi-arid Woodlands (Grassy sub-formation)	
Class	Brigalow Clay Plain Woodlands	
Percent Cleared	90	

PCT Name	**Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion**
General site description used to identify PCT	This community is dominated by Brigalow *Acacia harpophylla* and is often co-dominated by Poplar Box and Belah *Casuarina cristata*. In the central part of the subject land Brigalow dominated vegetation is associated with slightly elevated red clays; however, this is not considered a constraining feature of the community. Many remnants of Brigalow occur across the subject land, much of the community is regularly grazed and varies in condition and age. Where there is little or no regeneration of Brigalow the community has been mapped as Low condition. Where there is scattered Brigalow either mature trees or regeneration the community has been mapped as Medium condition and where there are mature trees with reasonably intact understory vegetation the community has been mapped as High condition. Many of the areas identified are currently mapped as Brigalow communities on the State Vegetation Map, however this mapping does overestimate the distribution of the PCT in some areas. There is no PCT35 mapped on the SVT map at borrow pit 2 however site inspection showed a small ring of low quality PCT35 containing a few remnant trees and soil type associated with Brigalow at the base of the hill, this has been included in our mapping and reporting.
Benchmark floristic description	Open forest or woodland up to 25 m high dominated by Brigalow (Acacia harpophylla) often with pockets of Belah (*Casuarina cristata*) on less gilgaied clays. Poplar Box (*Eucalyptus populnea* subsp. *bimbil*) and Pilliga Box (*Eucalyptus pilligaensis*) occur on better drained sandier soils. A sparse shrub layer is usually present including *Geijera parviflora*, *Eremophila desertii, Apophyllum anomalum, Enchylaena tomentosa, Pittosporum angustifolium, Capparis mitchellii, Eremophila mitchellii, Citrus glauca, Rhagodia spinescens, Maireana decalvans* and *Sclerolaena* spp. The ground cover is often very bare or covered with leaf litter with a very sparse to sparse cover of grasses such as *Sporobolus caroli*, *Austrodanthonia setacea*, *Austrostipa ramosissima, Sporobolus creber, Enteropogon ramosus, Diplachne parviflora, Setaria paspalidioides, Panicum queenslandicum* var. *queenslandicum, Paspalidium caespitosum* and *Chloris truncata*. Forb species include *Einadia nutans* subsp. *eremaea*, *Einadia hastata*, *Tetragonia moorei*, *Zygophyllum apiculatum*, *Brachyscome multifida* var. *multifida, Alternanthera* sp. A, *Vittadinia sulcata*, *Vittadinia pterochaeta*, *Plantago varia*, *Abutilon oxycarpum* and *Wahlenbergia communis*. Sedges include *Cyperus gracilis*, *Carex inversa* and *Eleocharis pusilla*. Nardoo fern (*Marsilea drummondii*) is often common. Weeds include *Opuntia aurantiaca*, *Opuntia stricta* var. *stricta* and *Rapistrum rugosum*. Occurs on heavy, gilgaied, grey or brown cracking clay or clayey loam soils over mainly sedimentary strata on flats or gentle rises on alluvial plains or undulating peneplains mainly in the Northern Outwash sub-region in the Brigalow Belt South Bioregion, in the dry subtropical and temperate (hot summer) climatic zones with a rainfall from 500 to 700 mm per annum. Mainly distributed south and west of Narrabri and north-east of Moree with small patches in the Pilliga forests. Outliers also occur in the Darling Riverine Plains Bioregion, on the Liverpool Plains and Mt Misery in the upper Hunter Valley. The endangered peppercress *Lepidium aschersonii* occurs areas near Narrabri along with populations of Black Striped Wallaby (*Macropus dorsalis*), which is endangered in NSW. An endangered community with less than 10 per cent or the pre-clearing extent remaining.
BC Act status	This PCT is consistent with the Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions- endangered. Detailed analysis is located in Appendix B
EPBC Act status	This PCT is consistent with the Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC - endangered. Detailed analysis against the listing is located in Appendix C

4.2.2.3 PCT 36 River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion – High – Medium – Low

PCT Name	River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	
Condition	High – Medium	
PCT number	36	
IBRA region	Brigalow Belt South Darling Riverine Plains	
IBRA sub-region	Northern Outwash Castlereagh-Barwon	
Formation	Forested Wetlands	
Class	Inland Riverine Forests	
Percent cleared	53	
General site description used to identify PCT	PCT 36 is characterised by the presence of River Red Gum *Eucalyptus camaldulensis* which are present across various size classes. This community is located along the margins of major creeks, rivers and ox-bow lakes throughout the subject land. This community has been subject to historical grazing and subsequently contains a sparse array of shrubs including Wilga *Geijera parviflora* and Warrior Bush *Apophyllum anomalum* along with a dense ground layer of *Atriplex* spp., *Sclerolaena* spp*., Aristida* spp., *and Enteropogon* spp. The vegetation on the banks of the Macintyre River is in good condition with some level of weed infestation however, the vegetation in other parts has been heavily disturbed through grazing and historical clearing activities. Areas which only contain remnant mature River Red Gums with limited regeneration and a highly disturbed understory have been mapped as Medium condition, areas which contain River Red Gums with signs of regeneration and good quality understory structure have been mapped as High condition. The project mapping correlates with State Vegetation Type mapping with one exception where the SVT map shows PCT39 and we have mapped it as PCT36, this is based on a lack of Coolabah and River Coobah (associated with PCT 39) within the area and only River Red Gum being present.	
Benchmark floristic description	Very tall or tall open forest or woodland up to 30 m high lining major watercourses dominated by River Red Gum (*Eucalyptus camaldulensis* subsp. *camaldulensis*) sometimes with Black Box (*Eucalyptus largiflorens*) or Coolabah (*Eucalyptus coolabah*) with southern areas containing Yellow Box (*Eucalyptus melliodora*). Shrubs may be absent or if present are sparse including Cooba (*Acacia salicina*), River Cooba (*Acacia stenophylla*) and Lignum (*Duma florulenta*). The ground cover may be dense after rain or flooding and is dominated by native grass species including *Austrostipa ramosissima, Austrostipa verticillata, Austrodanthonia caespitosa*, Warrego Summer Grass (*Paspalidium jubiflorum*), Umbrella Cane Grass (*Leptochloa digitata*), Native Millet (*Panicum decompositum*) and Couch (*Cynodon dactylon*). Sedge species include *Cyperus gymnocaulos*, *Eleocharis pallens* and *Eleocharis plana*. Rushes such as *Juncus radula* may be present. The fern Nardoo (*Marsilea drummondii*) is common in poorly drained sites. A range of forbs include *Pratia concolor*, *Centipeda cunninghamii, Rumex brownii*, *Haloragis glauca, Boerhavia dominii, Swainsona galegifolia, Alternanthera denticulata* and *Goodenia fascicularis*. Occurs on Quaternary alluvial grey cracking clay, loamy clays and sometimes sandy loam soils in the riparian zone of rivers (banks, levees, benches), ox-bow lakes and depressions on adjacent floodplains. A widely distributed community with large floristic variation depending on flooding regimes. Distributed on the floodplains of major rivers and creeks of central-northern western NSW mainly in the Darling Riverine Plains Bioregion extending into adjoining bioregions.	
BC Act status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act status	Not considered analogous to EPBC Act TECs – not listed under the EPBC Act	

4.2.2.4 PCT 52 Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion

PCT Name	Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion	
Condition	Medium	
PCT number	52	
IBRA region	Darling Riverine Plains	
IBRA sub-region	Castlereagh-Barwon	
Formation	Grassland	
Class	Semi-arid floodplain grassland	
Percent cleared	70	
General site description used to identify PCT	Mixed tussock grassland on alluvial grey clays on alluvial plains in northern section of the Darling Riverine Plains Bioregion and western section of the Brigalow Belt South Bioregion. This area is mapped as PCT 257 Candidate Native Grasslands and has been confirmed to be native grasslands during survey so have been relegated to PCT 52 which most closely aligns with the existing plant community. The most common species present at this location include *Astrebla spp*, *Enteropogon spp*, *Chloris truncata*, *Digitaria divaricatisim,Solanum esuriale, Sclerolaena murica, and Marsilea drummondii* Due to drought conditions the precautionary principal has been followed and all grasslands within this northern section which are not currently being 'actively farmed', as viewable on satellite imagery, have been mapped as PCT 52.	
Benchmark floristic description	Mixed tussock grassland dominated by Queensland Bluegrass (*Dichanthium sericeum*), Cup Grass (*Eriochloa crebra*), Windmill Grass (*Chloris truncata*) and after summer rains Mitchell Grass (*Astrebla elymoides*, *A squarrosa* or *A. pectinata*). Other common grass species include Native Millet (*Panicum decompositum*), *Aristida leptopoda*, *Digitaria divaricatisim*, Curly Windmill Grass (*Enteropogon acicularis*) and *Sporobolus* spp., *Monachather paradoxus* and *Austrostipa aristiglumis*. Forbs include *Solanum esuriale*, *Oxalis chnoodes*, *Hibiscus trionum*, *Alternanthera denticulata*, *Leiocarpa brevicompta*, *Pycnosorus globosus*, *Vittadinia pterochaeta*, *Plantago debilis* and *Einadia polygonoides*. A sparse shrub cover may be present including the tall shrub *Vachellia* (*Acacia*) *farnesiana* and the low shrubs Roly Poly (*Sclerolaena muricata* sens lat.), Galvanized Burr (*Sclerolaena birchii*) and *Maireana decalvans*. Sedges include *Cyperus bifax*, *Carex inversa* and *Eleocharis plana*. The aquatic fern Nardoo (*Marsilea drummondii*) is common. Occurs on grey cracking clay, brown clay, or black earth soils. Distributed on periodically flooded floodplains of major rivers including the Barwon and Gwydir Rivers extending into Queensland. Occurs mainly on alluvial grey clays on alluvial plains in the eastern section of the Darling Riverine Plains Bioregion and western section of the Brigalow Belt South Bioregion including south of Yetman. Small patches occur as far south as Warren on the Bogan and Macquarie River floodplains. Large areas would have occurred around Moree but they have mostly been cleared and cropped. This community has affinities to grasslands further west including Mitchell Grasslands on the Darling and Culgoa River floodplains (ID43). It also grades into a Windmill Grass-dominated grassland on brown clay (ID49). Further clearing would render this community as critically endangered and as of 2005 it is very poorly represented in protected areas.	
BC Act status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act status	This PCT is analogous with the Critically Endangered TEC: Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland. Detailed analysis against the listing is located in Appendix C	

4.2.2.5 PCT 53 Shallow freshwater wetland sedgeland in depressions and floodplains on inland alluvial plains and floodplains

PCT Name	Shallow freshwater wetland sedgeland in depressions and floodplains on inland alluvial plains and floodplains	
Condition	Medium	
PCT number	53	
IBRA region	Brigalow Belt South	
IBRA sub-region	Northern Basalts	
Formation	Freshwater Wetland	
Class	Inland Floodplain Swamp	
Percent cleared	67	
General site description used to identify PCT	During drought periods very limited vegetation is present however following rain the underlying vegetation community is identifiable, see image above. The species composition varies across wide distribution of this community and levels of or time since inundation. Many plant species are ephemeral but are generally *Eleocharis spp*, Nardoo (*Marsilea drummondii)*, *Paspalidium spp* and *Cyperus spp*. Some of the area covered by this PCT is mapped on the PVT mapping as non-native which if viewed during dry times or on satellite imagery is understandable, however a site visit following rain allowed accurate PCT mapping of this area.	
Benchmark floristic description	Low to mid-high sedgeland/grassland dominated by spike rushes including *Eleocharis pallens, Eleocharis acuta, Eleocharis plana* and *Cyperus* spp., along with ferns Nardoo (*Marsilea drummondii*) and *Marsilea costulifera*, the rushes Juncus subsecundus, *Juncus aridicola*, the grasses Native Millet (*Panicum decompositum*), Warrego Grass (*Paspalidium jubiflorum*), Umbrella Canegrass (*Leptochloa digitata*) and Rats Tail Grass (S*porobolus mitchellii*). Forb species include *Rumex* spp., Alternanthera spp., *Haloragis aspera, Mimulus gracilis, Pratea concolor, Boerhavia dominii* and *Ranunculus* spp. A taller sedge/shrub layer may be present composed of the tall sedge *Cyperus exaltatus*, and the shrubs Lignum (*Muehlenbeckia florulenta*), *Eremophila bignoniifolia* and River Cooba (*Acacia stenophylla*). Weed species include Lippia (*Phyla canescens*) and Bathurst Burr (*Xanthium spinosum*). Scattered trees of River Red Gum (*Eucalyptus camaldulensis*) and Belah (*Casuarina cristata*) occur in some locations. Occurs on grey and brown clays including gilgais on low lying flats or depressions on floodplains or on sandplains that regularly flood or fill from local runoff after rain. Distributed throughout the floodplains of the inland plains, particularly in the Darling Riverine Plains Bioregion with small areas in other bioregions. Grades into box woodlands on the plains and River Red Gum along the rivers. Similar to ID241 which has a dominant cover of *Acacia stenophylla*. Threatened by drainage, less frequent flooding regimes, clearing for crops and invasion of Lippia (*Phyla canescens*).	
BC Act status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act status	Not considered analogous to EPBC Act TECs – not listed under the EPBC Act	

4.2.2.6 PCT 55 Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions – High

PCT Name	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	
Condition	High	
PCT number	55	
IBRA region	Brigalow Belt South	
IBRA sub-region	Northern Basalts	
Formation	Semi-arid Woodlands (Grassy sub-formation)	
Class	North-west Floodplain Woodlands	
Percent cleared	83	
General site description used to identify PCT	This PCT is dominated by Belah *Casuarina cristata* and lacks other canopy, shrub or ground layer species. It was concluded on site that the current expanse of this community is greater than its original extent due to the influence of altered drainage patterns. It is considered likely that the existing rail line acts as a drainage barrier which results in surface water flows pooling upstream of the rail line, in the area dominated by Belah. The current extent of this community was likely originally occupied by PCT 56 Poplar Box woodland. This vegetation community is directly adjacent to the newly mapped PCT 53 and is in line with the existing STV mapping.	
Benchmark floristic description	Tall woodland of about 12 m high, dominated by Belah (*Casuarina cristata*). Other tree species include Black Box (*Eucalyptus largiflorens*) and Coolabah (*Eucalyptus coolabah*) in depressions and on higher ground Western Grey Box (*Eucalyptus microcarpa*) and Poplar Box (*Eucalyptus populnea* subsp. *bimbil*). Weeping Myall (*Acacia pendula*) may be present as an associate but not as a dominant species. Tall shrubs include Wilga (*Geijera parviflora*), Western Rosewood (*Alectryon oleifolius*), Budda (*Eremophila mitchellii*), Warrior Bush (*Apophyllum anomalum*), Wild Orange (*Capparis mitchellii*) and Supplejack (*Ventilago viminalis*). Shrubs include Western Boobialla (*Myoporum montanum*), Thorny Rhagodia (*Rhagodia spinescens*), *Maireana enchylaenoides*, Spotted Fuchsia Bush (*Eremophila maculata*) and *Eremophila deserti*. Lignum (*Duma florulenta*) may be present in frequently flooded areas. Ground cover includes the low shrubs such as Ruby Saltbush (*Enchylaena tomentosa*), many species of copperburrs including Galvanized Burr (*Sclerolaena birchii*), *Sclerolaena divaricata*, grasses such as Curly Windmill Grass (*Enteropogon acicularis*), wallaby grasses including *Monachather paradoxus* and *Austrodanthonia setacea*, *Austrostipa scabra, Austrodanthonia fulva, Austrostipa aristiglumis, Austrostipa verticillata, Aristida leptopoda, Paspalidium gracile, Sporobolus caroli* and *Panicum queenslandicum*. Forbs include *Einadia nutans*, *Oxalis chnoodes, Vittadinia cuneifolia, Boerhavia dominii, Goodenia fascicularis* and *Solanum esuriale*. Sedges such as *Eleocharis pallens*, rushes such as *Juncus radula* and Nardoo (*Marsilea drummondii*) occur in depressions. Common weed species include *Rapistrum rugosum, Carthamus lanatus* and *Medicago polymorpha*. Occurs on alluvial brown or grey clay soils that may be gilgaied on floodplains and alluvial plains and on black loam soils derived from basalt. Often lines intermittent drainage lines or on flats. Distributed in the northern and central wheatbelt of NSW mainly in the Darling Riverine Plains and Brigalow Belt South Bioregions but extending south into the NSW South-western Slopes Bioregion. Mostly cleared and an endangered community	
BC Act Status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act Status	Not considered analogous to EPBC Act TECs – not listed under the EPBC Act	

4.2.2.7 PCT 56 Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW – High

PCT Name	Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW
Condition	High – Medium – Low
PCT number	56
IBRA region	Brigalow Belt South
IBRA sub-region	Northern Basalts Northern Outwash Castlereagh-Barwon
Formation	Grassy Woodlands
Class	Floodplain Transition Woodlands
Percent cleared	78
General site description used to identify PCT	Poplar Box – Belah woodland is the most common community within the subject land which includes ~37 per cent of native vegetation. The community is dominated by Poplar Box *Eucalyptus populnea* and occasionally contains co-dominate species from adjoining communities including Belah and Brigalow. The community contains a diverse shrub layer including Geijera, *Eremophila* spp*., Pittosporum* spp*.,* Ironwood *Acacia excelsa,* Whitewood *Atalaya hemiglauca,* Warrior Bush and *Capparis* spp*.* The ground layer consists of a variety of small saltbush's, herbs and grass species. The majority of this community has been subject to past disturbance, generally from grazing and in some cases contains high threat exotic weeds including Harissa cactus, *Harissa* spp*.* and Tiger pear *Opuntia* spp.. The vegetation occurs on the soil type Mungle (mgh) which covers large areas of the project. For the most part this PCT aligns with the existing SVT mapping, changes may have occurred based of fine scale site assessment of community structure or review of soil mapping.
Benchmark floristic description	Tall to mid-high woodland dominated by Poplar Box (*Eucalyptus populnea* subsp. *bimbil*) and Belah (*Casuarina cristata*) commonly with the small tree Western Rosewood (*Alectryon oleifolius*). Tall shrubs are sparse and include Wilga (*Geijera parviflora*), Warrior Bush (*Apophyllum anomalum*), *Capparis* spp., *Citrus glauca* and Thorny Rhagodia (*Rhagodia spinescens*). Low shrubs include Galvanized Burr (*Sclerolaena birchii*), Black Roly Poly (*Sclerolaena muricata*), other copperburrs, *Maireana coronata, Maireana decalvans* and *Enchylaena tomentosa*. The ground cover is sparse during dry times but mid-dense after rain and includes grasses such as *Chloris truncata*, *Enteropogon acicularis* and *Austrostipa scabra* subsp. *scabra*. Forb species include *Einadia nutans* subsp. *nutans, Oxalis chnoodes*, *Bulbine alata, Erodium crinitum, Wahlenbergia fluminalis* and *Brachyscome heterodonta*. Generally occurring on pink to brown loamy sand or light clay in the transition zone between the floodplain and the peneplain in the central and northern plains of the NSW wheatbelt in the temperate (no dry season – hot summer) and dry subtropical climate zones with annual precipitation between 300 and 550 mm.
BC Act status	Not considered analogous to BC Act TECs – not listed under the EPBC Act
EPBC Act status	This PCT is considered analogous with the vegetation community *Poplar Box Grassy Woodland on Alluvial Plains* which is listed as Endangered. Detailed analysis against the listing is located in Appendix C

4.2.2.8 PCT 98 Poplar Box – White Cypress Pine – Wilga – Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion – High

PCT Name	Poplar Box – White Cypress Pine – Wilga – Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	
Condition	High - Low	
PCT number	98	
IBRA region	Darling Riverine Plains	
IBRA sub-region	Northern Basalts Northern Outwash	
Formation	Semi-arid Woodlands (Shrubby sub-formation)	
Class	Western Peneplain Woodlands	
Percent cleared	40	
General site description used to identify PCT	A single occurrence of this community is located within the alignment and another is found at Borrow Pit 13. This community is similar in composition to PCT 56 except with the addition of White Cypress Pine *Callitris glaucophylla*. The SVT mapping currently shows both sites as PCT35 which is not consistent with the existing vegetation community as there was no brigalow present or directly adjacent to the area. Therefore, the project has mapped this area as PCT 98. PCT 98 was chosen rather than PCT 56 due to the presence of White Cypress Pine as co-dominant in both locations and the underlying soil type of the red sandy loam, which is clearly visible onsite on aerial imagery, especially at Borrow pit 13.	
Benchmark floristic description	Mid-high woodland dominated by Poplar Box (*Eucalyptus populnea* subsp. *bimbil*) with White Cypress Pine (*Callitris glaucophylla*). Whitewood (*Atalaya hemiglauca*), Quinine Tree (*Alstonia constricta*), Ironwood (*Acacia excelsa*), Western Rosewood (*Alectryon oleifolius* subsp. *canescens*) and Supplejack (*Ventilago viminalis*) may be present as small trees. A diverse, mid-dense to sparse stratum of small trees and tall shrubs includes *Geijera parviflora*, *Eremophila mitchellii, Apophyllum anomalum, Eremophila sturtii, Dodonaea viscosa* subsp. *angustissima, Chenopodium curvispicatum*, *Myoporum montanum, Acacia aneura* and *Hakea leucoptera* subsp. *leucoptera*. Low shrub species include *Rhagodia spinescens*, *Chenopodium desertorum* subsp. *microphyllum, Enchylaena tomentosa, Pimelea pauciflora, Sclerolaena tricuspis, Sclerolaena deserticola* and *Sclerolaena birchii*. The ground cover is generally sparse and is dominated by grasses such as Box Grass (*Paspalidium constrictum*), wiregrass (*Aristida* spp.), *Austrostipa scabra* subsp. *scabra*, Curly Windmill Grass (*Enteropogon acicularis*) and *Eragrostis* spp. Forb species include *Einadia nutans* subsp. *eremaea*, *Sida cunninghamii*, *Rhodanthe moschata, Wahlenbergia stricta* subsp. *alterna, Bulbine semibarbata, Boerhavia dominii, Xerochrysum bracteata, Pimelea trichostachya* and *Nicotiana simulans*. Occurs on red and red-brown sandy loam and light clay loam soils or gravelly ridges on low rises and flats on stagnant alluvial plains and stony rises in the temperate (no dry season hot summer) and semi-arid climate (hot) zones mainly in the north-western sections of the Darling Riverine Plain and BBS Bioregions and eastern section of the Mulga Lands Bioregion.	
BC Act Status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act Status	Not considered analogous to EPBC Act TECs – not listed under the EPBC Act	

4.2.2.9 PCT 147 Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion – High - Medium

PCT Name	Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion	
Condition	High - Medium	
PCT number	147	
IBRA region	Darling Riverine Plains	
IBRA sub-region	Northern Basalts	
Formation	Rainforests	
Class	Western Vine Thickets	
Percent cleared	83	
General site description used to identify PCT	The site consists of mid-high to low closed known as "semi-evergreen vine thicket" dominated by rich diversity of low trees and shrubs to about 6 m high. Species on site included *Ehretia membranifolia,Geijera parvifolia, Notelaea microcarpa, Capparis spp, Jasminum lineare, Carisa ovata* and *Pittosporum spinescens*. Very few trees emergent trees were present. It occurs on dark brown to black loam soils on a basalt hill .The area is currently mapped on SVT mapping as PCT378 which contains Belah and Wilga +/- White Box with PCT 147 mapped adjacent. While one Belah was present within the plots the site assessment determined, based of floristic composition, PCT 147 was a closer match the existing vegetation. This was confirmed by a review of the soil mapping which noted that the soil type present, Black Hill (bhw), typically supports PCT147, while PCT378 usually occurs on clay loam soils on slopes or flats. This PCT is listed as an endangered ecological community under both the NSW BC Act and the Commonwealth EPBC Act.	
Benchmark floristic description	Mid-high to low closed or open forest known as "semi-evergreen vine thicket" dominated by rich diversity of low trees and shrubs to about 6 m high. Low trees include Mock olive (*Notelaea microcarpa var. microcarpa*), Wilga (*Geijera parviflora*), Peach Bush (*Ehretia membranifolia*) along with *Elaeodendron australe var. integrifolia, Ventilago viminalis, Psydrax oleiofolia, Alectryon subdentatus* and *Alstonia constricta*. Some tree species are facultatively deciduous. Emergent trees to 15 m high are often present including White Box (*Eucalyptus albens*), Silver-leaved Ironbark *(Eucalyptus melanophloia*), White Cypress Pine *(Callitris glaucophylla*) and Belah (*Casuarina cristata*). The shrubs layer may be mid-dense or dense and includes *Carissa ovata, Beyeria viscosa, Spartothamnella juncea, Solanum parvifolium, Rhagodia parabolica, Olearia elliptica, Senna coronilloides, Indigofera adesmiifolia, Indigofera brevidens, Breynia cernua, Solanum semiarmatum, Cassinia laevis, Myoporum montanum, Capparis lasiantha, Pimelea neo-anglica* and *Phyllanthus subcrenulatus*. Vines are common and include Wonga Vine (*Pandorea pandorana*), *Parsonsia eucalyptophylla, Clematis microphylla var. microphylla, Cayratia clematidea* and *Jasminum lineare*. Mistletoes include *Lysiana exocarpi, Lysiana subfalcata* and *Amyema miraculosum*. The ground cover is mid-dense in open areas or sparse under dense tree or shrub canopies. Common grass species include *Austrostipa verticillata, Leptochloa asthenes, Poa sieberiana var. hirtilli, Elymus scaber Panicum queenslandicum var. queenslandicum, Chloris ventriculosa, Austrodanthonia bipartita, Paspalidium gracile* and *Cymbopogon refractus*. The sub-shrub *Desmodium brachypodum* is often abundant. Forbs include *Boerhavia dominii* and *Dichondra sp*. Sedges such as *Carex inversa* may be present along with the rock fern *Cheilanthes sieberi subsp. sieberi*.	
BC Act Status	This PCT is consistent with Semi-evergreen vine thicket in the Brigalow Belt South and Nandewar Bioregions TEC - endangered. Detailed analysis is located in Appendix B	
EPBC Act Status	This PCT is consistent with Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions TEC - endangered. Detailed analysis against the listing is located in Appendix C	

4.2.2.10 PCT 192 Silver-leaved Ironbark – Poplar Box +/- Ironwood shrub – grass woodland on rises in the north western plains of NSW – Medium – Low

PCT Name	Silver-leaved ironbark – Poplar box +/- Ironwood shrub – grass woodland on rises in the north western plains of NSW	
Condition	High - Medium – Low	
PCT number	192	
IBRA region	Darling Riverine Plains	
IBRA sub-region	Northern Outwash Castlereagh-Barwon	
Formation	Semi-arid Woodlands (Shrubby sub-formation)	
Class	Subtropical Semi-arid Woodlands	
Percent cleared	33	
General site description used to identify PCT	This PCT is generally located at the northern end of the subject land and within Borrow Pit 5. The community is characterised by the co-dominance of Poplar Box and Silver-leaved Ironbark *Eucalyptus melanophloia*. White Cypress Pine was not observed within this community; however, it may have been historically removed from these areas due to its preference as a building and fencing material. Some areas containing this community have been heavily grazed and generally consisted of canopy trees and a ground layer consisting of chenopod shrubs and grass species. The vegetation in the northern section of the subject land is currently mapped as PCT 56 and PCT 71 neither of which are consistent with the dominant tree layer of Poplar Box and Silver-leaved Ironbark. Borrow Pit 5 is currently mapped as PCT 35 which is not consistent with the findings of the site assessment which do not report the presence of any Brigalow but do show Poplar Box and Silver-leaved Ironbark at both sites.	
Benchmark floristic description	Mid-high to tall open woodland or woodland dominated by Poplar Box (*Eucalyptus populnea* subsp. *bimbil*) and Silver-leaved Ironbark (*Eucalyptus melanophloia*). White Cypress Pine (*Callitris glaucophylla*) or Ironwood (*Acacia excelsa*) may be present. The understorey contains a sparse stratum of small trees and shrubs such as Wilga (*Geijera parviflora*), Wild Orange (*Capparis mitchellii*), Budda (*Eremophila mitchellii*), Western Rosewood (*Alectryon oleifolius* subsp. *canescens*), Leopardwood (*Flindersia maculosa*) and Thorny Saltbush (*Rhagodia spinescens*). Mulga (*Acacia aneura*) may be present. Small shrubs include species of Copperburr (*Sclerolaena* spp.). The ground cover may be sparse or mid-dense depending on rainfall and includes Curly Windmill Grass (*Enteropogon acicularis*), Amphipogon caricinus var. caricinus, *Monachather paradoxus*, Box Grass (*Paspalidium constrictum*), Kangaroo Grass (*Themeda australis*), spear grass (*Austrostipa scabra* subsp. *scabra*) and a number of wire grass species (*Aristida* spp.). Occurs on red or grey, sandy or stony loams or light clays on low rises or low hills above the floodplains. In NSW it is distributed near the Queensland/NSW border across the northern wheatbelt and eastern section of the northern part of the Western Division including the dry subtropical, and part of the temperate (hot summer) and semi-arid (hot) climate zones. It extends into Queensland. It has mainly been cleared for grazing in the Central Division. Merges with Silver-leaved Ironbark – White Cypress Pine on alluvium (ID227), Coolabah, Belah, Brigalow and other Poplar Box communities.	
BC Act Status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act Status	Not considered analogous to EPBC Act TECs – not listed under the EPBC Act	

4.2.2.11 PCT 244 Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt) – High – Medium – Low

PCT Name	Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)	
Condition	High – Medium – Low	
PCT number	244	
IBRA region	Brigalow Belt South Darling Riverine Plains	
IBRA sub-region	Northern Basalts Castlereagh-Barwon	
Formation	Grassy Woodlands	
Class	Floodplain Transition Woodlands	
Percent cleared	73	
General site description used to identify PCT	This community contains similar structural characteristics and species composition to PCT 56 Poplar Box woodland. It occurs on clay-loam soils on flats on alluvial plain and stagnant alluvial plain landscapes. It widespread community with significant variation it often grades into PCT 56. The area within the Norther Basalts and Castlereagh-Barwon IBRA sub-regions have been mapped as a grade from PCT56 higher on the landscape into PCT244 in the slightly lower area, with darker soils which most closely aligns with the PCT description.	
Benchmark floristic description	Mid-high to tall woodland or open woodland, averaging 13 m high, dominated by Poplar Box (*Eucalyptus populnea* subsp. *bimbil*). The small trees Belah (*Casuarina cristata*) or Western Rosewood (*Alectryon oleifolius* subsp. *canescens*) may be present but not co-dominant. The shrub layer is absent or sparse with some thickets in places. Tall shrub species include Wilga (*Geijera parviflora*), Warrior Bush (*Apophyllum anomalum*) and Budda (*Eremophila mitchellii*). Low shrubs include *Maireana microphylla*, *Maireana decalvans* and Thorny Saltbush (*Rhagodia spinescens*). The ground cover is mid-dense to sparse and contains low shrubs such as *Sclerolaena birchii* and *Sclerolaena muricata* and a range of grass species including *Austrodanthonia setacea*, *Enteropogon acicularis*, *Austrostipa scabra* subsp. *scabra*, *Elymus scaber* var. *scaber, Eragrostis parvifolia, Chloris truncata, Austrodanthonia fulva* and *Sporobolus caroli*. Forb species include *Calotis cuneifolia, Sida corrugata, Vittadinia dissecta* var. hirta, *Dichondra repens*, *Rostellularia adscendens* subsp*. adscendens*, *Oxalis perennans* and *Rumex brownii*. Sedges such as *Eleocharis plana* and *Carex inversa*, rushes (*Juncus* spp.) and Nardoo (*Marsilea drummondii*) grow in slight depressions. Weed species may be common including *Medicago* spp., *Trifolium* spp., *Hypochaeris radicata* and *Rapistrum rugosum*.	
BC Act status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act status	This PCT is considered a partial fit with the Poplar Box Grassy Woodland on Alluvial Plains which is listed as endangered. Detailed analysis against the listing is located in Appendix C	

4.2.2.12 PCT 247 Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion – High – Medium

PCT Name	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	
Condition	Medium - Low	
PCT number	247	
IBRA region	Darling Riverine Plains	
IBRA sub-region	Castlereagh-Barwon	
Formation	Freshwater Wetlands	
Class	Inland Floodplain Shrublands	
Percent cleared	63	
General site description used to identify PCT	This community is located in the northern part of the subject land, within the Darling Riverine Plains bioregion. Lignum *Duma florulenta* shrubland wetlands are located in broad, low-lying landscapes that are subject to seasonal wetting or flooding. The community is dominated by Lignum. The ground covers species were either dormant or had died off at the time of assessment due to the prolonged dry conditions. Observable ground cover species consisted of *Eleocharis pusilla, Carex inversa*, *Cyperus* spp., *Juncus* spp. and Nardoo, *Marsilea drummondii*. The PVT mapping for the area indicates historical PCT241 which contains River Coobah swamp wetlands and PCT 211, slender Saltbush – samphire – copper burr low open shrubland wetland, as there was no evidence of clearing of River Coobah or saltbush-samphire communities within the surrounding areas and there were areas of dense lignum present so it was determined that PCT 247 was the most likely fit for the vegetation community at this site.	
Benchmark floristic description	Tall shrubland or open shrubland usually to 2 m high dominated by Lignum (*Duma florulenta*). Other shrub species that may be present include *Eremophila bignoniiflora, Eremophila maculata, Rhagodia spinescens* and *Chenopodium nitrariaceum*. Scattered trees may be present with less than 10 per cent canopy cover including River Red Gum (*Eucalyptus camaldulensis*), Black Box (*Eucalyptus largiflorens*) and Coolabah (*Eucalyptus coolabah*). The ground cover may be dense after rains or inundation but very sparse during drought. The scrambler *Einadia nutans* subsp. *nutans* may be present along with copperburr shrubs such as *Sclerolaena muricata* and *Sclerolaena divaricata*. Grass species include Warrego Summer Grass (*Paspalidium jubiflorum*), Native Millet (*Panicum decompositum*), Windmill Grass (*Chloris truncata*), Curly Windmill Grass (*Enteropogon acicularis*) and Rats Tail Grass (*Sporobolus mitchellii*). Forbs include *Persicaria hydropiper*, *Alternanthera denticulata, Eclipta platyglossa*, *Haloragis glauca*, *Pratia concolor, Sida fibulifera*, *Boerhavia dominii* and *Solanum esuriale*. Sedges may be common and include *Eleocharis plana, Eleocharis pusilla, Carex inversa* and *Cyperus* spp. The rush *Juncus aridicola* is often present. Nardoo fern (*Marsilea drummondii*) is abundant. Occurs on deep, self-mulching alluvial grey clays (and rarely black earth) that are often gilgaied, in depressions on floodplains or as narrow bands near watercourses that are subject to regular inundation. Distributed within the temperate (hot summer), dry sub-tropical and eastern semi-arid (hot) climate zones which corresponds with the Darling Riverine Plain Bioregion extending eastwards to the Liverpool Plains where small stands occur on the edge of Lake Goran. Grades into Lignum (ID17) in south western NSW and Lignum in far north western NSW (ID25). Compared to those other Lignum communities, this community is more restricted and threatened. Most of its original extent has been cleared and reduced flooding threatens many stands over the long-term.	
BC Act status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act status	Not considered analogous to EPBC Act TECs – not listed under the EPBC Act	

4.2.2.13 PCT 418 White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion – High – Medium - Low

PCT Name	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	
Condition	High – Medium- Low	
PCT number	418	
IBRA region	Darling Riverine Plains	
IBRA sub-region	Northern Basalts Northern Outwash	
Formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)	
Class	North-west Slopes Dry Sclerophyll Woodlands	
Percent cleared	25	
General site description used to identify PCT	The areas mapped as PCT 418 all contained tall woodland to open forest dominated by White Cypress Pine (*Callitris glaucophylla*) usually with Silver-leaved Ironbark *(Eucalyptus melanophloia*) interspersed. Tall shrubs were generally sparse and included Wilga (*Geijera parviflora*) and *Alstonia constricta.* This community was found in the west of the study area only within borrow pits. The community occurs on deep cream to red sandy loam soils on lower hillslopes in low hills. Borrow Pit 9 is currently mapped as PCT 35 which is present over approximately half of the site, the other half however contains good quality PCT 418 with both White Cypress and Silver-leaved Ironbark as the dominant tree species. Borrow Pit 25 is also currently mapped as PCT 35 however a reasonable proportion (50 per cent) of the site is White Cypress regrowth with Silver-leaved Ironbark interspersed. Borrow Pit 2 is mapped as PCT 418 which is correct, however there is a small patch of low quality PCT 35 at the base of the hill which has been included in our PCT 35 mapping and is discussed above.	
Benchmark floristic description	Tall to mid-high woodland to open forest dominated by White Cypress Pine (*Callitris glaucophylla*) usually with Silver-leaved Ironbark (*Eucalyptus melanophloia*). Other tree species include *Eucalyptus chloroclada, Eucalyptus albens, Eucalyptus blakelyi, Eucalyptus populnea subsp. bimbil* and *Angophora leiocarpa*. Young regrowth White Cypress Pines, *Acacia cheelii* or *Acacia leiocalyx* may comprise a small tree layer. Tall shrubs are very sparse and include Wilga (*Geijera parviflora), Alstonia constricta, Pimelea neo-anglica, Acacia decora, Notelaea microcarpa var. microcarpa, Cassinia laevis* and *Acacia deanei subsp. paucijuga*. Low shrubs include *Solanum ferocissimum, Breynia cernua, Solanum parvifolium, Abutilon oxycarpum subsp. subsagittatum* and *Carissa ovata*. Vines include *Parsonsia eucalyptophylla* and *Clematis microphylla*. The ground cover is sparse and includes the grasses *Aristida vagans, Austrostipa verticillata, Austrostipa scabra subsp. scabra, Digitaria brownii, Cymbopogon refractus, Eragrostis leptostachya and Austrodanthonia racemosa. Forbs include Einadia nutans subsp. linifolia, Vittadinia dissecta var. hirta, Chenopodium melanocarpum, Calandrinia eremaea, Oxalis perennans, Rostellularia adscendens, Calotis lappulacea, Daucus glochidiatus, Vittadinia sulcata* and *Goodenia paniculata*. Possibly partly a derived community through past forestry silvicultural treatment that favoured cypress pine.	
BC Act status	Not considered analogous to BC Act TECs – not listed under the BC Act	
EPBC Act status	Not considered analogous to EPBC Act TECs – not listed under the EPBC Act	

4.2.2.14 PCT 628 Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion – Medium – Low

PCT Name	Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	
Condition	Medium– Low	
PCT number	628	
IBRA region	Darling Riverine Plains	
IBRA sub-region	Castlereagh-Barwon	
Formation	Grassy Woodlands	
Class	Floodplain Transition Woodlands	
Percent cleared	90	
General site description used to identify PCT	This PCT is generally located on slightly elevated crests adjoining low-lying areas that formally supported Lignum wetlands which have been modified for cropping land uses. It was determined that the benchmark description for this community is slightly inaccurate for what was recorded on site as it was found that the community is co-dominated by Carbeen *Corymbia tessellaris*, Poplar Box and *Eucalyptus tereticornis* (rather than *Eucalyptus coolabah* or *Eucalyptus camaldulensis*) as described in the PCT benchmark. This community has been modified by grazing and generally supports a canopy layer with trees of varying ages and a ground layer consisting of chenopod shrubs and grass species. No other PCT descriptions found fit the community as closely as this one so it was decided to use PCT 628.	
Benchmark floristic description	Mid-high to tall open woodland or woodland dominated by Carbeen (*Corymbia tessellaris*) often with Coolabah (*Eucalyptus coolabah* subsp. *coolabah*), River Red Gum (*Eucalyptus camaldulensis* subsp. *camaldulensis*), Poplar Box (*Eucalyptus populnea* subsp. *bimbil*) or Weeping Myall (*Acacia pendula*). Shrubs are absent or very sparse and include *Geijera parviflora, Acacia salicina, Sclerolaena muricata* var. *muricata* and *Enchylaena tomentosa*. The ground cover may be dense after flooding or rain but is usually mid-dense to sparse. Species include *Enteropogon acicularis*, *Panicum decompositum*, *Eriochloa crebra*, *Einadia nutans* subsp. *nutans* and *Chloris truncata*. Occurs on brown or grey clay loam to loam soils on slightly elevated parts of floodplains in the Moree – Wee Waa and Walgett regions mainly in the Darling Riverine Plains Bioregion. Highly restricted, occurring in small patches and mostly cleared. Grades into Coolabah grassy woodland (ID40) on heavy clay soils and into Poplar Box grassy woodland (ID244) on sandy loam soils. Differs in species composition from Carbeen woodland on sand rises (prior streams) near the Queensland border or Carbeen – cypress pine woodland on sandstone in forests near Narrabri.	
BC Act status	This PCT is consistent with the Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions – endangered. Detailed analysis is located in Appendix B	
EPBC Act status	Not considered analogous to EPBC Act TECs- not listed under the EPBC Act	

4.2.2.15 Number of Biodiversity Assessment Methodology plots required for assessment

Based on the assignment of vegetation zones the area of impact within each zone was then assessed to determine the minimum number of BAM plots required for assessment, this is outlined in Table 4-6 for the alignment and Table 4-7 for each Borrow pit.

Table 4-6 Plant Community Type area and number of BAM plots required within the alignment

PCT and IBRA subregion	Zone (condition class)	Area (ha)	Number of transects required	Number of transects completed
Castlereagh Barwon				
36	High	0.72	1	2
36	Medium	5.61	3	3
52	Medium	41.95	3	4
56	Medium	14.56	3	4
56	Low	14.31	3	3
192	Medium	5.28	2	3
192	Low	2.96	2	3
244	Medium	3.57	2	2
244	Low	9.49	2	3
247	Medium	4.35	2	3
247	Low	6.89	3	3
628	Medium	11.72	3	4
628	Low	21.06	4	4
Northern Outwash				
27	Medium	0.03	1	1
27	Low	4.25	2	1*
35	High	4.17	1	3
35	Low	4.69	1	1
36	High	0.44	1	2
36	Medium	0.48	1	3
56	High	2.65	2	3
56	Medium	2.27	2	2
56	Low	47.4	5	5
Northern Basalts				
35	High	9.98	2	2
35	Low	4.91	2	2
53	Medium	5.8	3	3
55	High	0.52	1	2
56	High	27.87	4	5
56	Medium	12.31	3	4
56	Low	38.43	4	5
244	High	10.14	3	4
244	Medium	4.17	2	3

Table note:

* Due to movement of the proposed laydown areas the area of impact on PCT27 increased post initial survey effort. When ecologist returned to the site the impact of the drought was considerably more prevalent thus is was decided that the most accurate way to represent the condition of this area was to replicate the existing plot data for that vegetation zone rather than record a more degraded environment.

Table 4-7 Plant Community Type area and number of BAM plots required within each Borrow pit

Borrow pit and PCT	Zone (condition class)	Area (ha)	Number of transects required	Number of transects completed
Borrow pit 1				
147	High	1.46	1	1
147	Medium	3.13	2	2
Borrow pit 2				
35	Low	3.2	2	2
418	High	8.19	3	3
418	Medium	7.03	3	3
Borrow pit 5				
192	High	10.04	3	3
192	Medium	7.63	3	3
192	Low	2.45	2	2
Borrow pit 7				
35 (Northern outwash)	High	10.99	3	3
35 (Northern outwash)	Low	7.72	2	2
35 (Northern basalt)	High	6.54	3	3
56 (Northern outwash)	High	21.27	4	4
56 (Northern Outwash)	Low	0.77	1	1
Borrow pit 8				
56	Low	21.14	4	4
Borrow pit 9				
35	High	21.84	4	4
418	High	21.19	4	4
418	Medium	6.07	3	3
418	Low	1.04	1	1
Borrow pit 11				
35	High	18.49	3	3
35	Low	0.9	1	1
Borrow pit 13				
98	High	1.5	1	1
98	Low	1	1	1
Borrow pit 25				
35	High	2.38	2	2
418	Medium	1.46	1	1
418	Low	2.08	2	2
Borrow pit 26				
35	High	1.25	1	1
35	Medium	3.27	2	2
35	Low	0.91	1	1

4.2.2.16 Non-native vegetation

Non-native vegetation covers 23.65 per cent of the subject land (700.86 ha) including areas surrounding the borrow pits. Non-native vegetation is associated with areas that has been modified for agricultural cropping, including dryland broad acre cropping and irrigated cropping. Dryland cropping is generally located in areas that once supported PCT 56 Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW, whilst the cotton cropping is generally located in low-lying areas that formally supported PCT 247 Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion.

Areas that are mapped as non-native vegetation rarely contain scattered paddock trees where cropping has occurred. Non-native pastures sown with *Cenchrus ciliaris* (Buffel grass) are also typically devoid of trees. Where appropriate, scattered paddock trees have been recorded and assessed in accordance with Appendix 1 of the BAM – Streamlined assessment module – clearing paddock trees (OEH 2017).

Two paddock trees have been identified within the subject land (refer Appendix A Map C.6). The paddock trees are of the species *Eucalyptus populnea* (Poplar box) and *Eucalyptus camaldulensis* (River red gum) and both are assumed to contain hollows. These trees may provide habitat refuges for threatened fauna such as Squirrel glider (*Petaurus norfolcensis*) and Glossy black cockatoo (*Calyptorhynchus lathami*) and may also be used as 'stepping stones' during dispersal across areas of non-native vegetation.

4.2.3 Ecosystem – credit species

4.2.3.1 Predicted

Fifty ecosystem-credit species are predicted to occur under BAM across all assessment areas within the subject land. The ecosystem-credit species predicted to occur in the subject land are listed in Table 4-8 and species observed during field investigations are presented in Appendix F. Within the BAM C some assessment was made on the likelihood of those species occurring based upon whether or not critical habitat features were present within the PCT zone. Where species required trees and the PCT quality was such that no or very few (<1 tree per 0.5ha) trees were present, then the species was determined not to occur within that area (i.e. Koala or Painted Honeyeater). However, if the species uses trees but may forage in open areas they were assumed present within areas of the PCT in which they were predicted even where trees did not occur (i.e. Varied sittella). A list of the species impacted and the habitat assumptions associated with low-quality PTCs is located in Table 4-9.

Table 4-8 Ecosystem-credit species predicted to occur under BAM C within the subject land

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	PCTs within the subject land in which the species is predicted to occur		
					Brigalow Belt South IBRA Northern Basalts PCT number	Brigalow Belt South IBRA Northern Outwash PCT number	Darling Riverine Plains IBRA Castlereagh-Barwon PCT number
Australasian bittern	*Botaurus poiciloptilus*	E	E1, P	High	53	-	36,39,247
Australian painted snipe	*Rostratula australis*	E, Ma	E1, P	High	53	-	36,52,247
Barking Owl	*Ninox connivens*	-	V,P	Moderate	35,53,55,56,98,244	35,36,56	36,39,56,192,244,247,628
Black-breasted buzzard	*Hamirostra melanosternon*	-	V, P, 3	Moderate	55,56,98	-	36,39,56,247
Black-chinned Honeyeater	*Melithreptus gularis gularis*	-	V,P	Moderate	244	36	36,192,244,628
Black-necked stork	*Ephippiorhynchus asiaticus*	-	E1, P	High	53	36	36,39,247
Black-striped wallaby	*Macropus dorsalis*	-	E1, P	High	35,147,418	35,418	-
Black-tailed godwit	*Limosa limosa*	C, J, K	V, P	Moderate	53	-	39
Blue-billed duck	*Oxyura australis*	-	V, P	Moderate	53	-	247
Brolga	*Grus rubicunda*	-	V, P	Moderate	27,53,98	-	36,39,52,247
Brown treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	-	V, P	Moderate	244	-	
Corben's long-eared Bat	*Nyctophilus corbeni*	V	V	Moderate	35,55,56,98,147,244	35,36,56	36,39,56,192,244,247
Diamond firetail	*Stagonopleura guttata*	-	V, P	Moderate	27,35,55,56,98,147,244,418	35,36,56,418	36,39,56,192,244,247,628
Dusky woodswallow	*Artamus cyanopterus cyanopterus*	-	V, P	Moderate	-	-	36,39,52,56,192,244,247,628
Eastern bentwing-bat	*Miniopterus orianae oceanensis*	-	V, P	Moderate	55,56,147,244	-	-
Eastern Grass owl	*Tyto longimembris*	-	V,P	Moderate	-	-	52
Five-clawed worm-skink	*Anomalopus mackayi*	V	E1, P	High	27,35,55,56,244	35,36,56	36,52,56,24,4247,628
Flame robin	*Petroica phoenicea*	-	V, P	Moderate	-	-	36
Flock Bronzewing	*Phaps histronica*		E, P	High	-	-	52
Freckled duck	*Stictonetta naevosa*	-	V, P	Moderate	53	-	36,247

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	PCTs within the subject land in which the species is predicted to occur		
					Brigalow Belt South IBRA Northern Basalts PCT number	Brigalow Belt South IBRA Northern Outwash PCT number	Darling Riverine Plains IBRA Castlereagh-Barwon PCT number
Glossy black-cockatoo	*Calyptorhynchus lathami*	-	E2, V, P,2	Moderate	55,56,244	36,56	36,56,192,244,247,628
Grey falcon	*Falco hypoleucos*	-	E1, P,2	High	-	35,36,56	36,39,52,56,192,244, 247,628
Grey-crowned babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	-	V, P	Moderate	27,35,55,56,98,244	35,36,56	36,39,56,192,244,628
Grey-headed flying-fox	*Pteropus poliocephalus*	V	V, P	Moderate	35,55,56,147,244	35,36,56	-
Hooded robin (south-eastern form)	*Melanodryas cucullata cucullata*	-	V, P	Moderate	27,35,55,56,98,147,244, 418	5,36,56,418	36,39,56,192,244,628
Koala	*Phascolarctos cinereus*	V	E2, V,P	Moderate	35,55,56,98,244	35,36,56	39,52,56,192,244,247
Kultarr	*Antechinomys laniger*	-	E1, P	High	-	-	52,56,192,244,247
Little eagle	*Hieraaetus morphnoides*	-	V,P	Moderate	27,35,53,55,56,98,147,2 44	35,36,56	36,36,52,56,247,628
Little lorikeet	*Glossopsitta pusilla*	-	V,P	Moderate	418	-	-
Little pied bat	*Chalinolobus picatus*	-	V,P	Moderate	27,35,56,56,98,147,244, 418	35,36,56	36,39,56,192,244,247,4 18,628
Magpie goose	*Anseranas semipalmata*	-	V,P	Moderate	-	36	36,39,52,247
Major Mitchell's cockatoo	*Lophochroa leadbeateri*	-	V,P,2	Moderate	-	-	36,39,56,192,244,628
Masked owl	*Tyto novaehollandiae*	-	V,P,3	Moderate	27,35,55,56,98,147,244	-	36,39,52,56,192,244,24 7
Painted honeyeater	*Grantiella picta*	V	V,P	Moderate	27,35,55,56,98,147,244	35,36,56	36,56,192,244,628
Pied honeyeater	*Certhionyx variegatus*	-	V,P	Moderate	-	-	36,39,56,192,244,247
Red-tailed black-cockatoo (inland subspecies)	*Calyptorhynchus banksii samueli*	-	V,P,2	Moderate	-	-	36,39,52,56,192,244,24 7,628
Scarlet robin	*Petroica boodang*	-	V, P	Moderate	-	-	36,56,192,244
Speckled warbler	*Chthonicola sagittata*	-	V,P	Moderate	27,35,55,56,98,147,244	35,56	56,192,244,628
Spotted harrier	*Circus assimilis*	-	V,P	Moderate	27,35,55,56,98,244	35,36,56	36,39,56,244,247,628
Spotted-tailed quoll	*Dasyurus maculatus*	E	V,P	High	147	-	36,628

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	PCTs within the subject land in which the species is predicted to occur		
					Brigalow Belt South IBRA Northern Basalts PCT number	Brigalow Belt South IBRA Northern Outwash PCT number	Darling Riverine Plains IBRA Castlereagh-Barwon PCT number
Square-tailed kite	*Lophoictinia isura*	-	V,P,3	Moderate	27,35,55,56,98,244	35,36,56	36,39,56,192,244,247,628
Stripe-faced dunnart	*Sminthopsis macroura*	-	V,P	Moderate	27,35,55,56,244	35,36,56	36,39,52,56,192,244,247,628
Superb parrot	*Polytelis swainsonii*	V	V,P,3	Moderate	-	-	36,39,52,56,244
Swift parrot	*Lathamus discolor*	CE	E1,P,3	Very High	418	-	-
Turquoise parrot	*Neophema pulchella*	-	V,P,3	Moderate	244	36	36,244,628
Varied sittella	*Daphoenositta chrysoptera*	-	V,P	Moderate	27,35,55,56,98,147,244	35,36,56	36,39,56,192,244,628
White-bellied sea-eagle	*Haliaeetus leucogaster*	C, Ma	V,P	Moderate	-	35,36,56	36,39,56,244,247,628
White-fronted chat	*Epthianura albifrons*	-	E2,V,P	Moderate	-	-	52,247
Woma	*Aspidites ramsayi*	-	V,P	Moderate	-	-	36,39,56,192,247
Yellow-bellied sheathtail-bat	*Saccolaimus flaviventris*	-	V,P	Moderate	27,35,55,56,98,147,244,418	35,36,56	36,39,52,192,244,247,628

Table 4-9 Ecosystem Credit Species exclusions based on habitat assumptions

Common name	Species name	PCTs which have been excluded as habitat	Reasons for exclusion	Details
Black-chinned Honeyeater	*Melithreptus gularis gularis*	Low-quality 36 Low-quality 192 Low-quality 244 Low-quality 628	Habitat constraints	The species feed in trees on both insects and nectar in trees. The low-quality PTCs contain only highly scattered individual or no trees therefore do no provide habitat for the species
Brown tree-creeper (eastern subspecies)	*Climacteris picumnus victoriae*	Low-quality 244 Low-quality 418	Habitat constraints	The species occur in timbered areas with a preference for the presence of fallen timber. Where neither of these components are present i.e. low-quality PTCs the area is not considered to provide habitat features for the species.
Koala (Foraging)	*Phascolarctos cinereus*	Low-quality 35 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 192 Low-quality 244 Low-quality 247	Habitat constraints	The species require trees for food and shelter the low-quality PTCs contain only highly scattered individual or no trees therefore do no provide suitable habitat for the species
Glossy black-cockatoo (Foraging)	*Calyptorhynchus lathami*	Low-quality 56 Low-quality 192 Low-quality 244 Low-quality 247 All of Borrow pit 8	Habitat constraints	The species feed almost exclusively on *Casuarina* and *Allocasuarina* species neither of which are found within the low-quality PCTs or within Borrow pit 8
Grey-headed flying-fox (Foraging)	*Pteropus poliocephalus*	Low-quality 35 Low-quality 55 Low-quality 56 Low-quality 147 Low-quality 244 Low-quality 418	Habitat constraints	The species feed and roosts in trees, the low-quality PTCs contain only highly scattered individual or no trees therefore do no provide suitable habitat for the species
Little lorikeet	*Glossopsitta pusilla*	Low-quality 418	Habitat constraints	The species feed on nectar and pollen. There are no trees within this low-quality PCT so the area is not considered habitat for the species
Painted honeyeater	*Grantiella picta*	Low-quality 27 Low-quality 35 Low-quality 56 Low-quality 92 Low-quality 244 Low-quality 247 Low-quality 628	Habitat constraints	The species is a specialist feeder on the fruit of mistletoes which require trees to grow on. The low-quality PTCs contain only highly scattered individual or no trees therefore there is little or no habitat for mistletoes and henceforth no suitable habitat for the Painted honeyeater in Low quality PCTs.
Pied honeyeater	*Certhionyx variegatus*	Low-quality 36 Low-quality 56 Low-quality 192 Low-quality 244 Low-quality 247	Habitat constraints	The species require shrubs and mistletoes which are either not present at all or are present in very low densities within the low-quality PCTs

Common name	Species name	PCTs which have been excluded as habitat	Reasons for exclusion	Details
Swift parrot	*Lathamus discolor*	Low-quality 418	Habitat constraints	The species feed on flowering eucalypts and lerps which required trees. Low-quality PCT 418 does not contain trees therefore is not considered habitat for the species.
Varied sittella	*Daphoenositta chrysoptera*	Low-quality 27 Low-quality 35 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 147 Low-quality 244 Low-quality 628	Habitat constraints	The species feeds on insects gleaned from the bark of trees and does not live in open habitat, as there are no or very limited trees within the low-quality PCTs there is no quality habitat for the species.

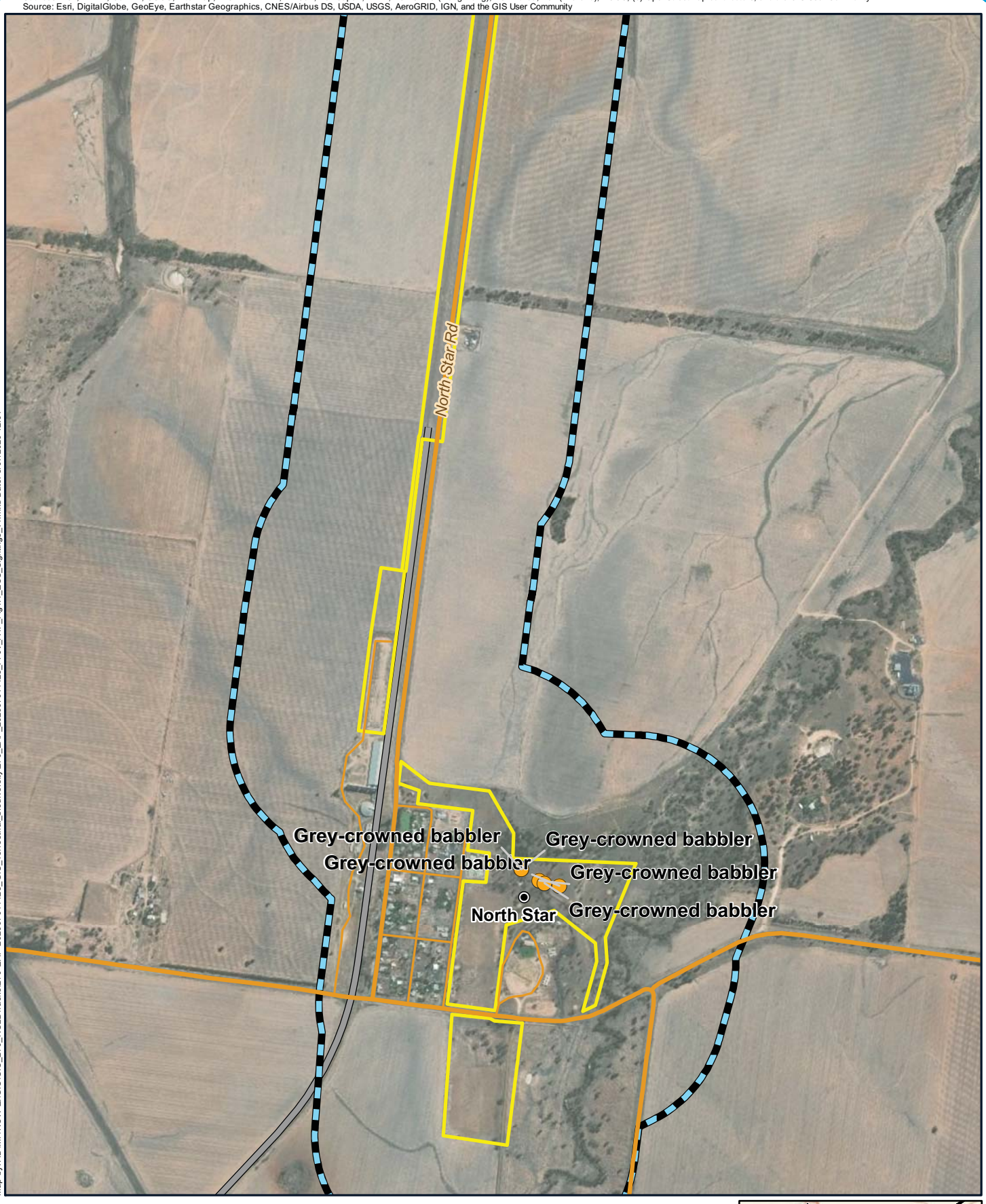
4.2.3.2 Observed

Although targeted surveys for ecosystem-credit species are not required in accordance with the BAM, some of these species were incidentally identified during the surveys undertaken within the subject land (refer Appendix D). Eleven ecosystem-credit species were observed within the subject land and adjacent areas including:

- Australian bittern (*Botaurus poiciloptilus*)
- White-bellied sea-eagle (*Haliaeetus leucogaster*)
- Grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)
- Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)
- Little pied bat (*Chalinolobus picatus*)
- Yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*)
- Northern free-tailed bat (*Mormopterus lumsdenae*)
- Corben's Long-eared Bat (*Nyctophilus corbeni*)[1] (possible ID from call analysis).
- Grey-headed flying-fox (*Pteropus poliocephalus*)
- Spotted harrier (*Circus assimilis*)
- Scarlet robin (*Petroica boodang)*

The location of ecosystem-credit species identified in the field is shown in Figure 4.1.

[1] The ultrasonic bat call detectors identified one or more *Nyctophilus* species within the subject land (the *Nyctophilus* genus cannot be identified to species level from their calls). Three species potentially occur in the subject land: – *Nyctophilus geoffroyi, Nyctophilus gouldi* and the Vulnerable *Nyctophilus corbeni* which is an ecosystem credit species.



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Adjoining alignments
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

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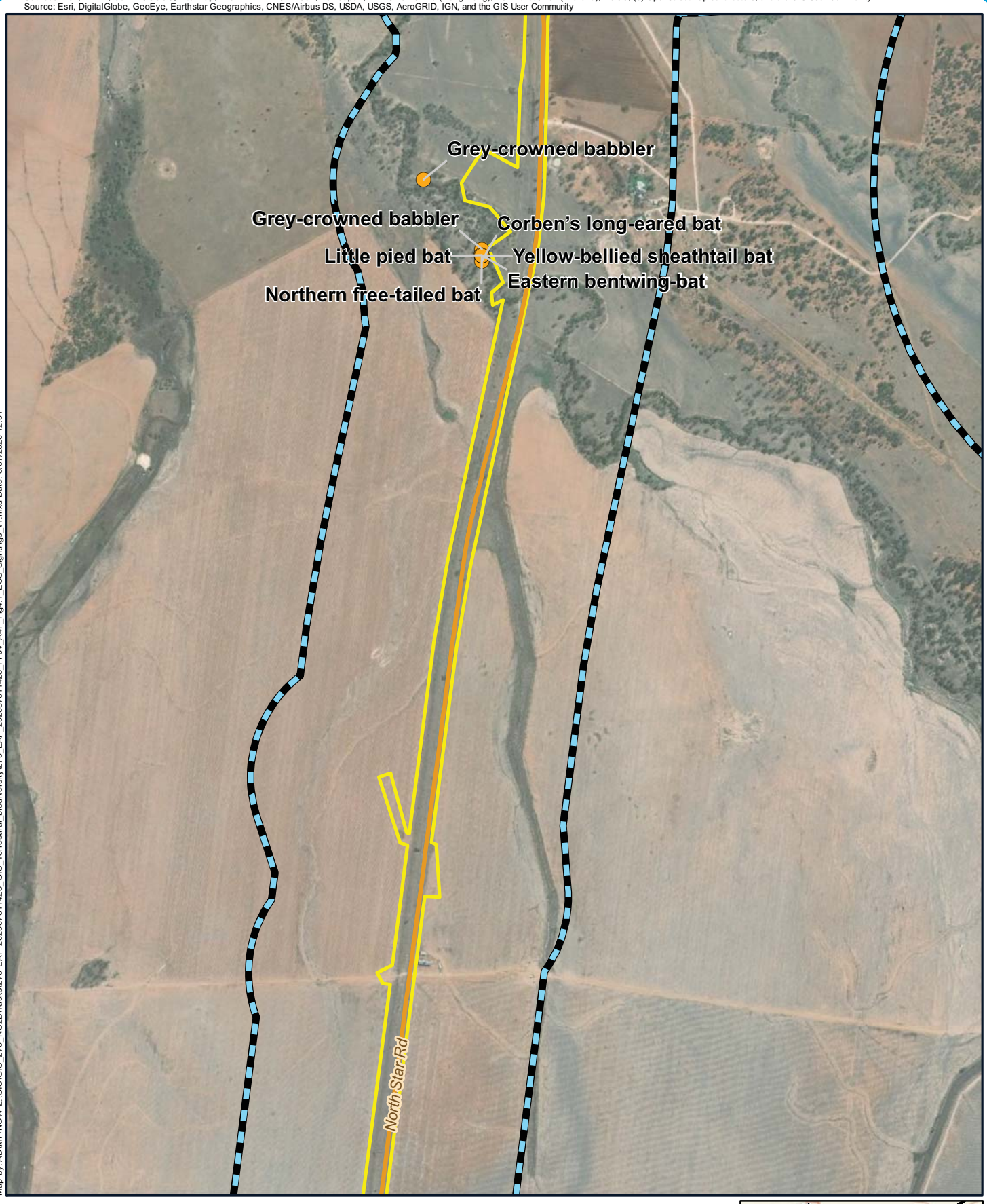
North Star to NSW/QLD border

Figure 4.1a: Location of ecosystem-credit species within the study area



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

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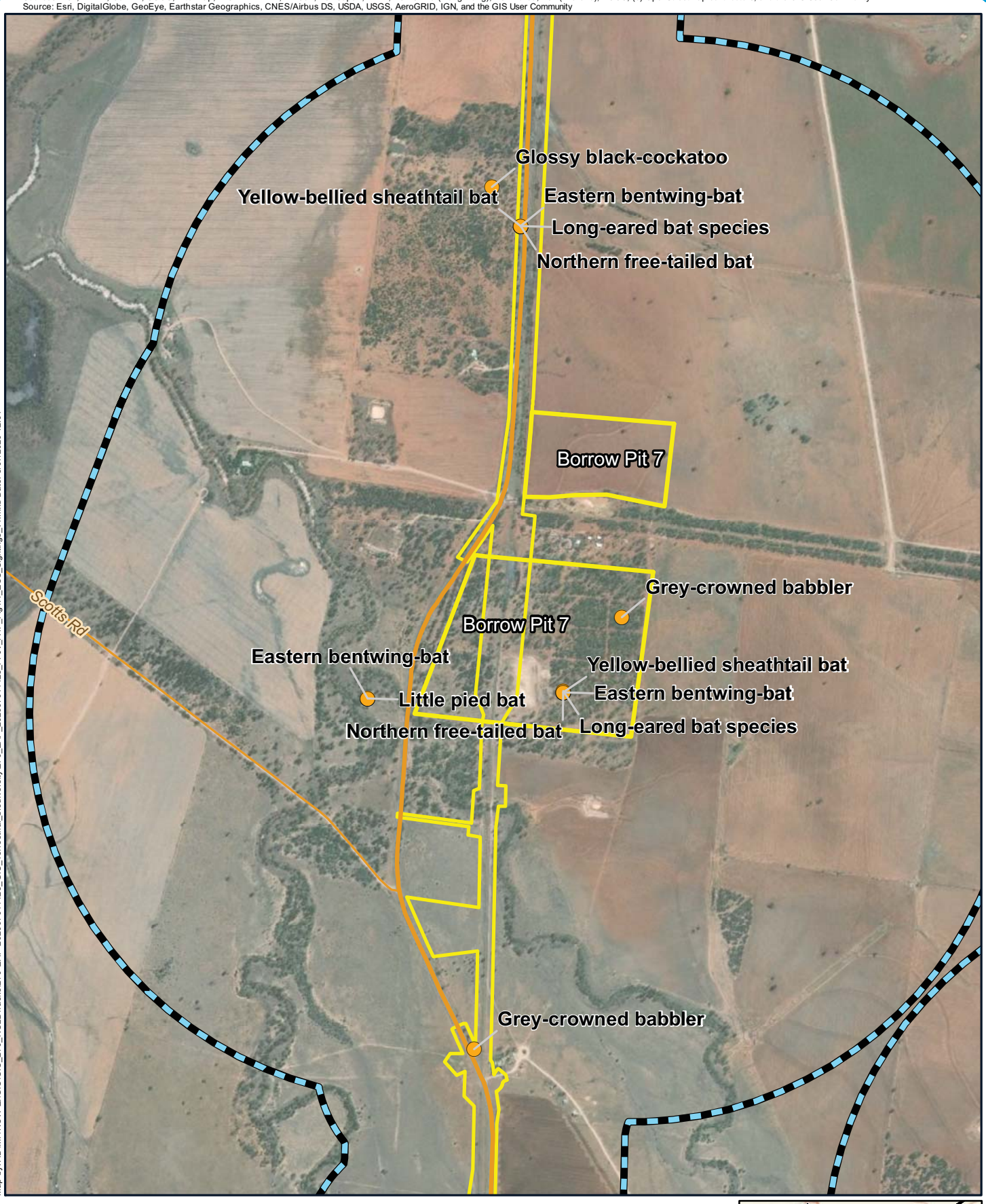
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1b: Location of ecosystem-credit species within the study area



Map by: ADMF/NCW Z:\GIS\GIS_270_NS2BTasks\270-EAP-202007011428_GIS_Terrestrial_biodiversity\270_EAP_202007011428_FFJV_A4P_Fig4.1_ECS_Sightings_v1.mxd Date: 8/07/2020 12:01

Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

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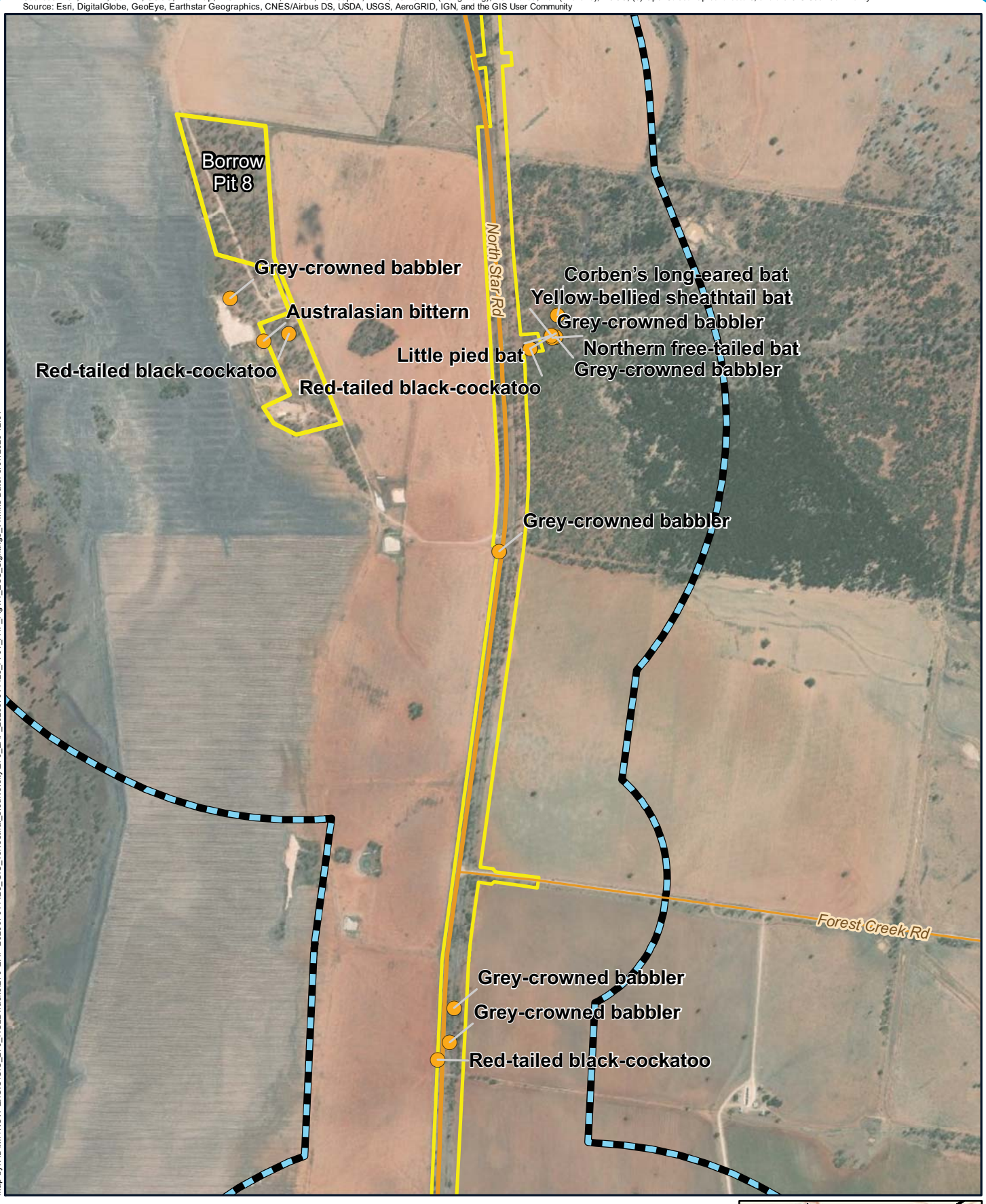
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1c: Location of ecosystem-credit species within the study area



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

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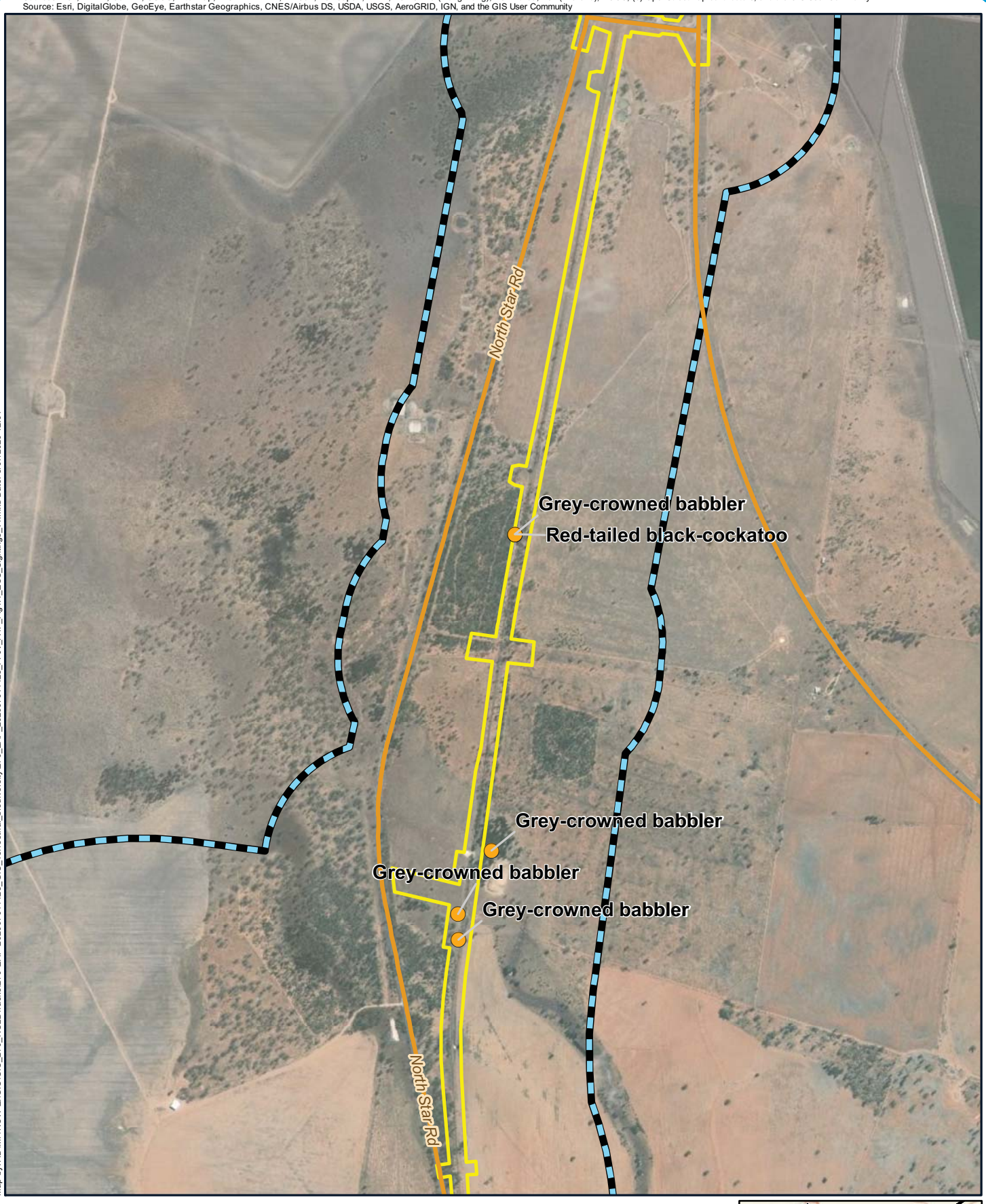
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1d: Location of ecosystem-credit species within the study area



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Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

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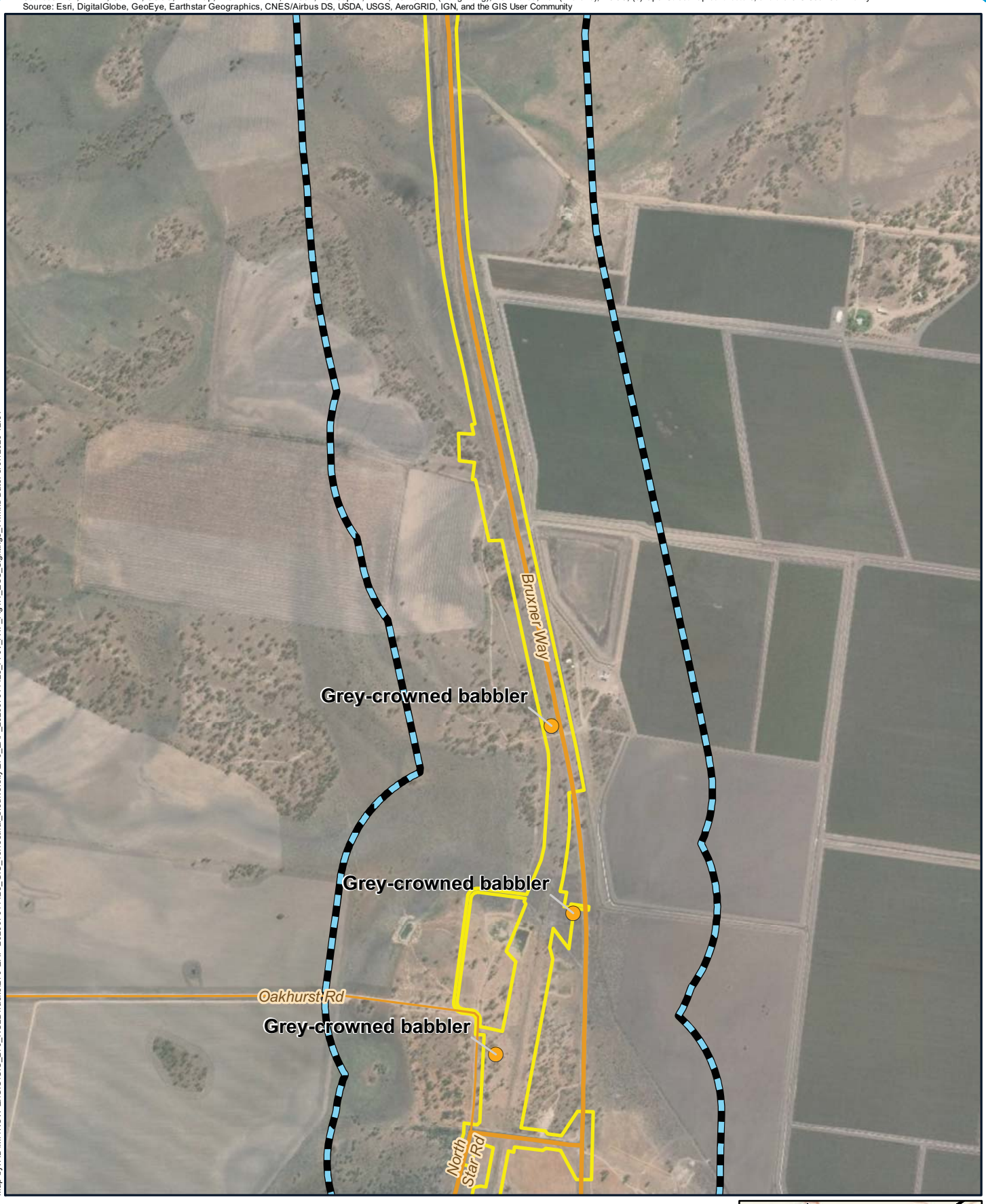
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1e: Location of ecosystem-credit species within the study area



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

Future Freight
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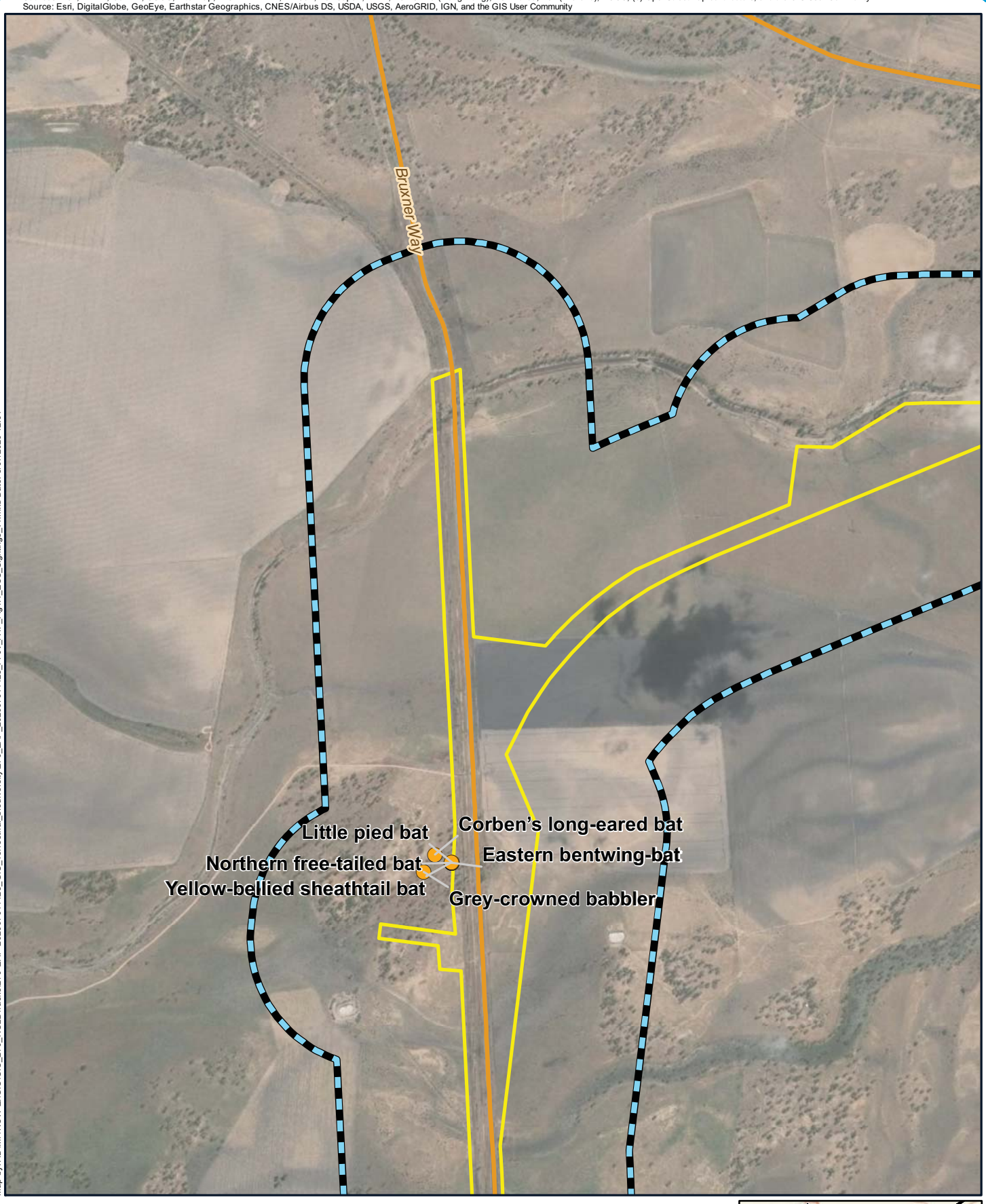
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1f: Location of ecosystem-credit species within the study area



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

Future Freight
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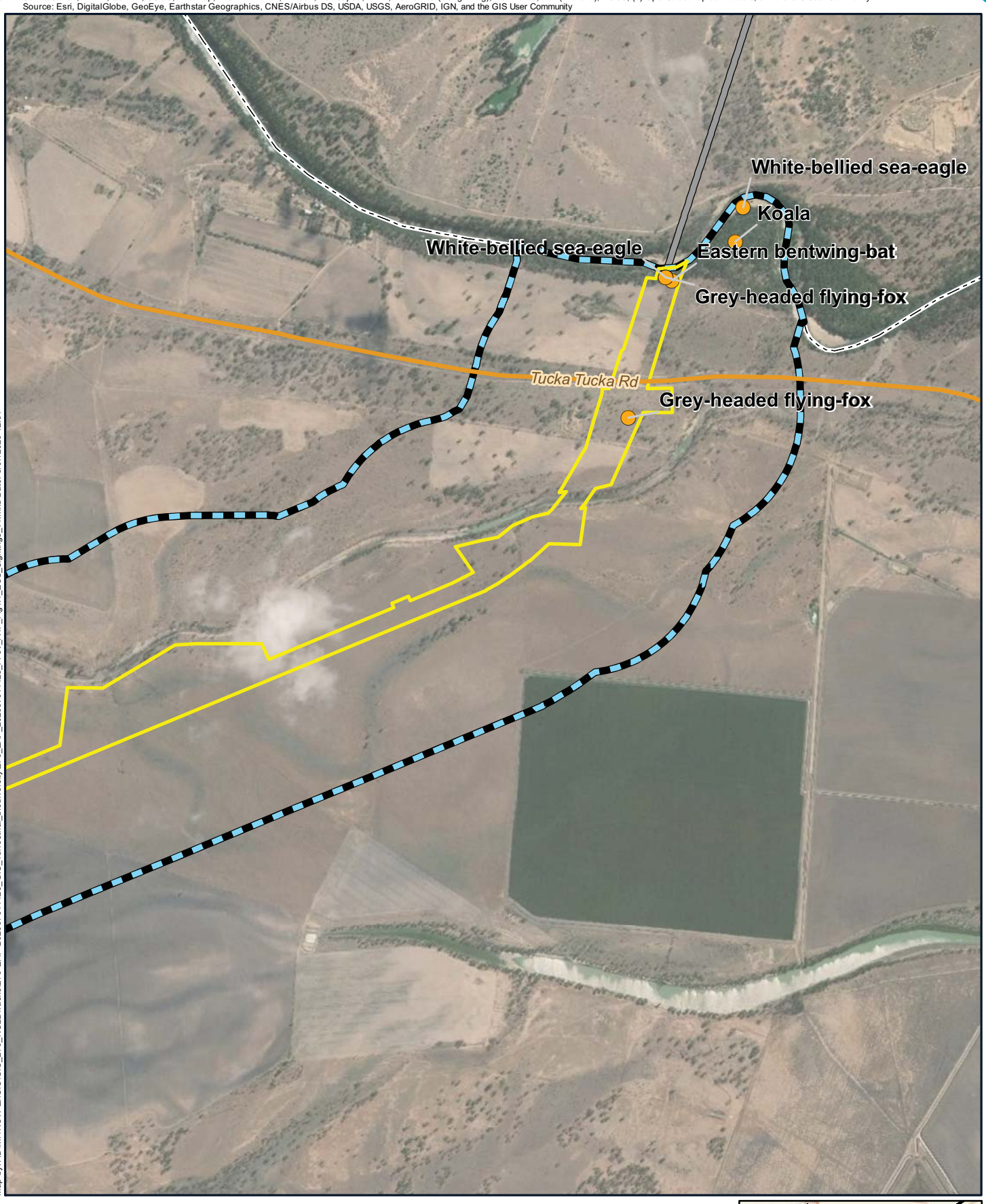
North Star to NSW/QLD border

Figure 4.1g: Location of ecosystem-credit species within the study area



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Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Adjoining alignments
- NSW/QLD border
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

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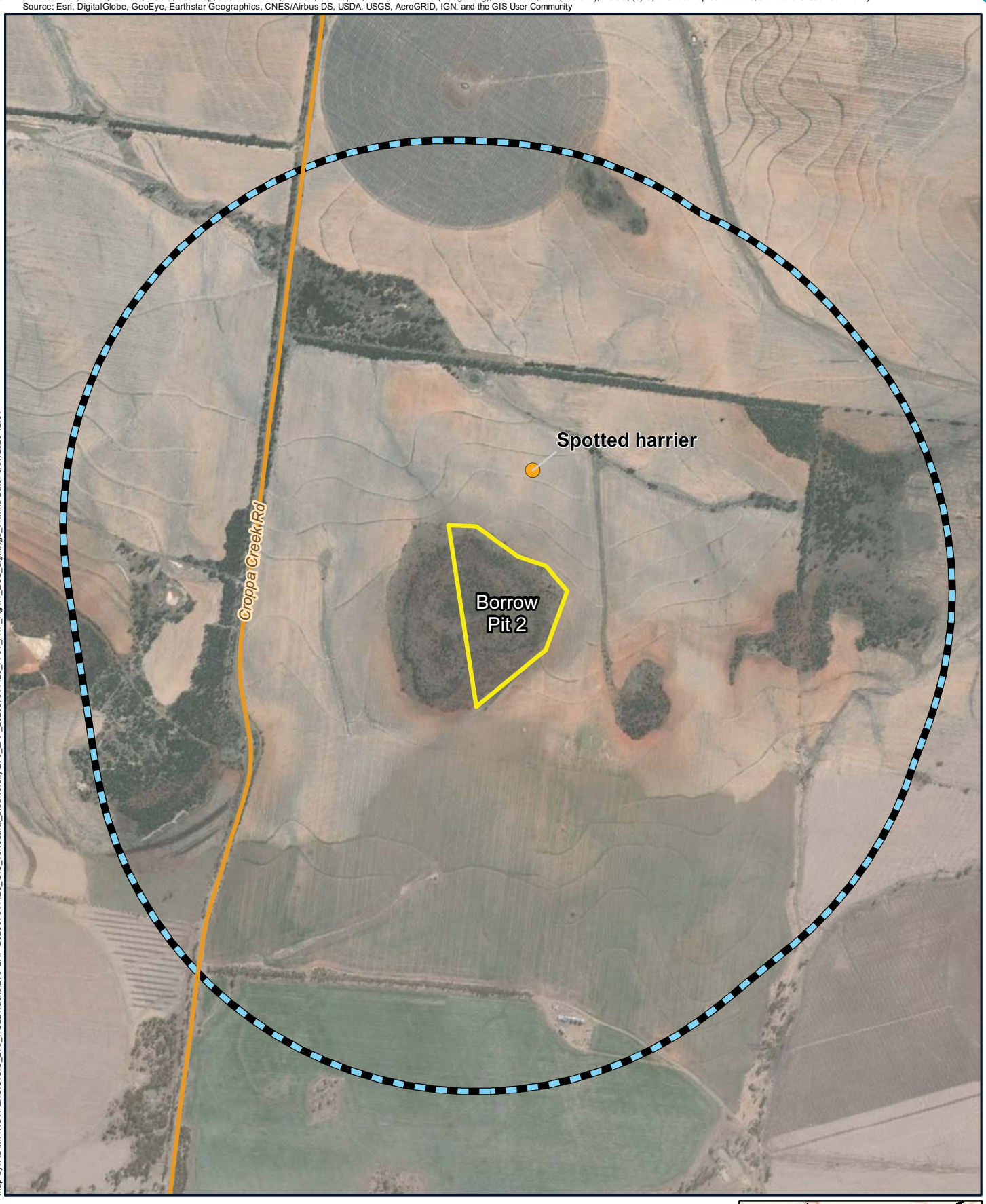
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1h: Location of ecosystem-credit species within the study area

Figure 4.1i: Location of ecosystem-credit species within the study area



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

Future Freight
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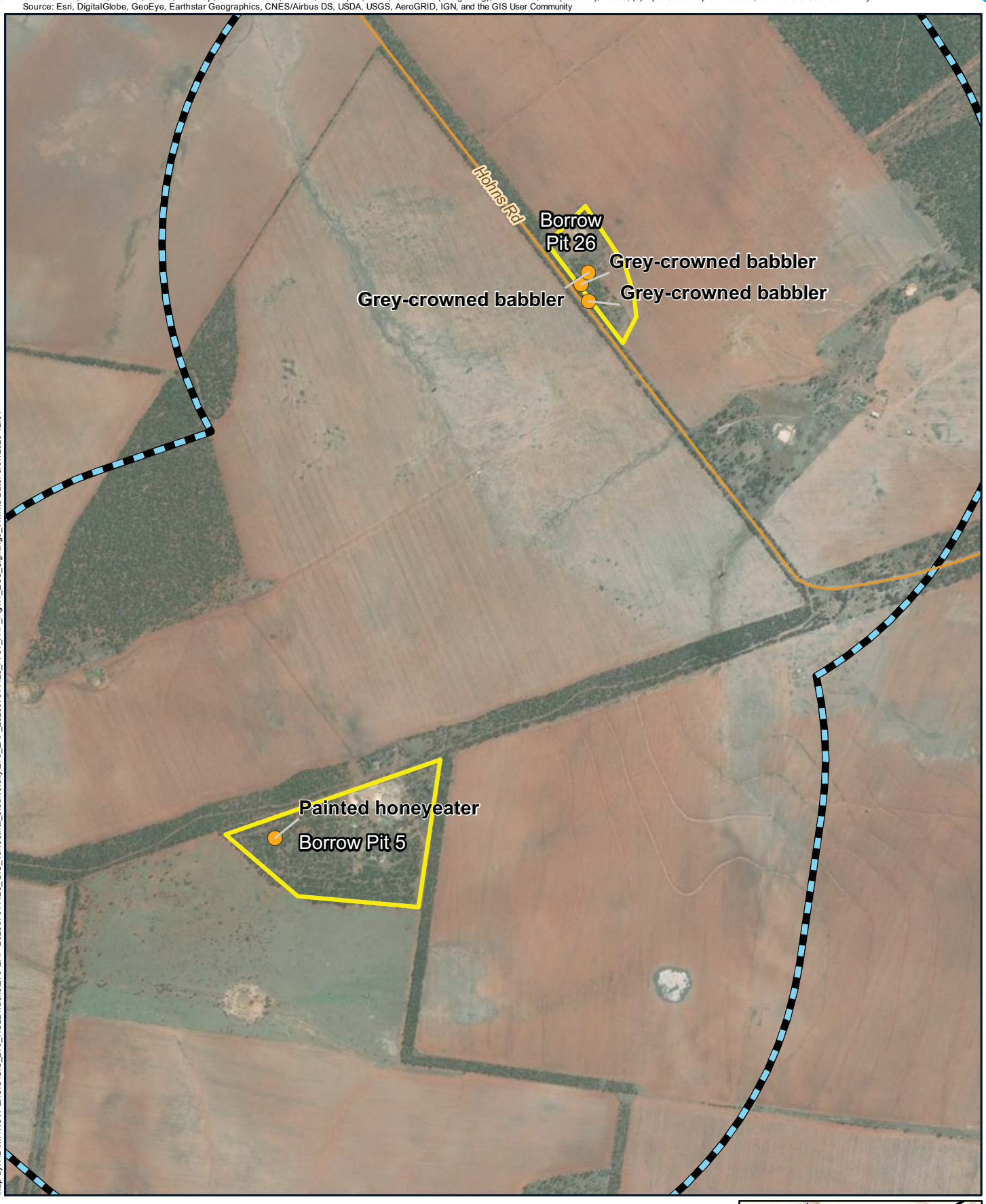
Date: 08/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1j: Location of ecosystem-credit species within the study area



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Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

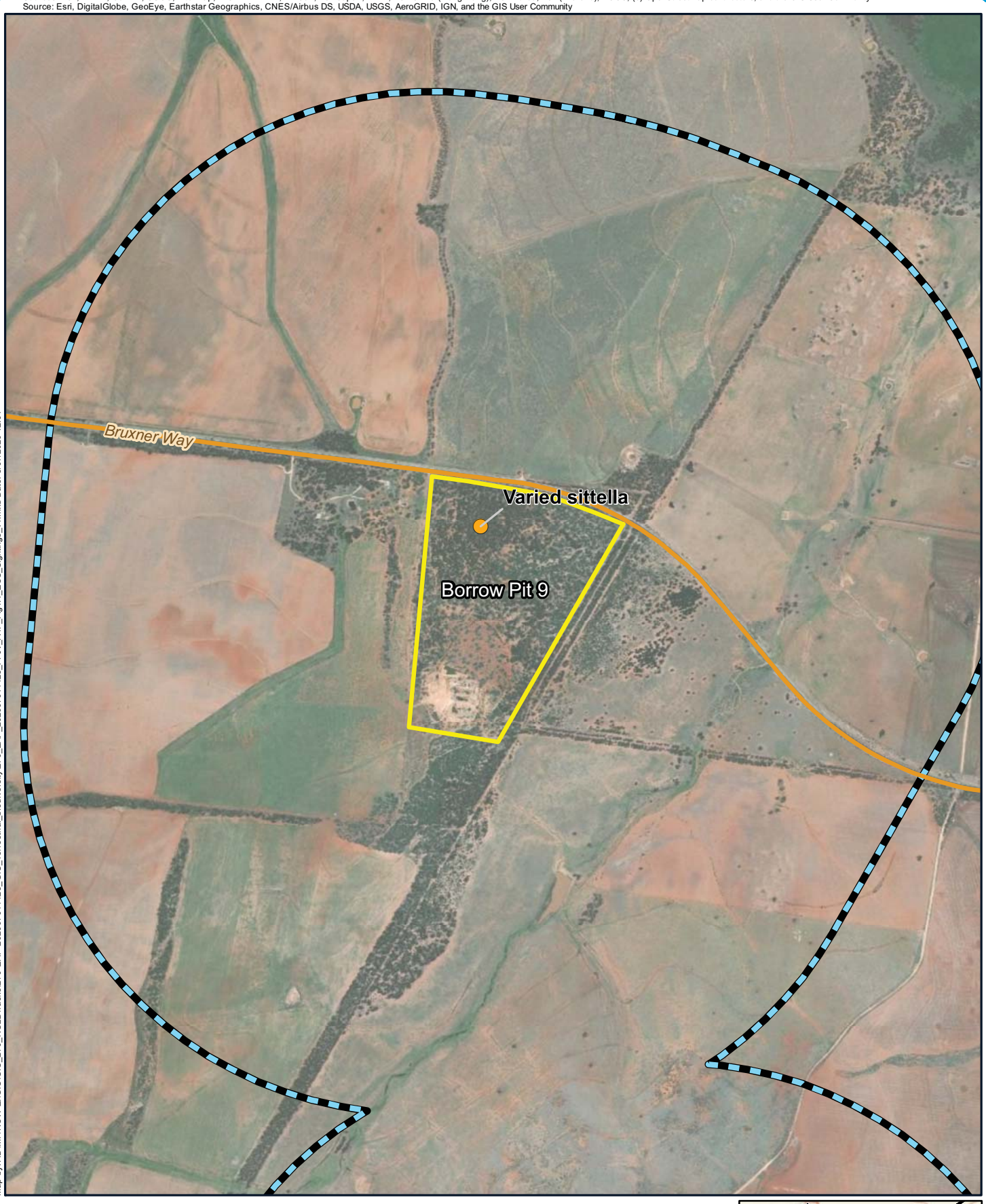
0 100 200 300 400 500 m

Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1k: Location of ecosystem-credit species within the study area



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

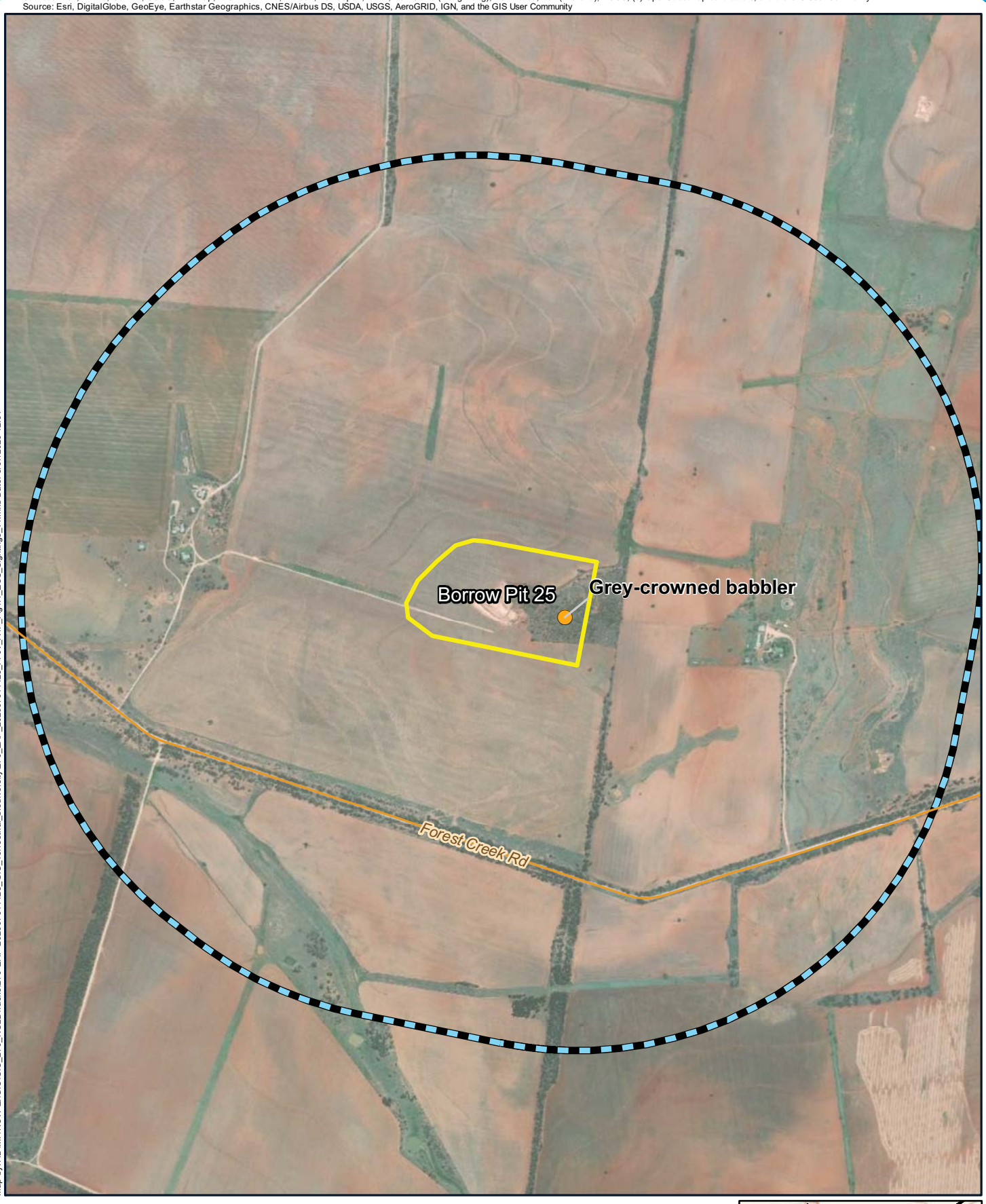
0 100 200 300 400 500 m

Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1l: Location of ecosystem-credit species within the study area



Map by: ADMF/NCW Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701428_GIS_Terrestrial_biodiversity\270_EAP_20200701428_FFJV_A4P_Fig4.1_ECS_Sightings_v1.mxd Date: 8/07/2020 12:01

Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Study area
- Subject land

A4 scale: 1:20,000

0 100 200 300 400 500 m

Future Freight
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Date: 08/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.1m: Location of ecosystem-credit species within the study area

4.2.4 Species – credit species

4.2.4.1 Predicted

Fifty-three species-credit species are predicted to occur across the subject land. Table 4-10 provides a list of species-credit species, including their sensitivity to loss, Biodiversity Risk Rating, and the PCTs in which they are predicted to occur. The BAM C includes an assessment of the likelihood of those species occurring based the presence or absence of critical habitat features within the PCT zone. Where species required trees and the PCT condition was low (no mature trees) the species was considered absent within that vegetation zone (i.e. Koala or Painted honeyeater). However, if the species requires trees but also forages in open areas, presence was assumed in associated PCTs in low condition (i.e. Varied sittella). A list of these occurrences and the habitat assumptions is shown in Table 4-11.

4.2.4.2 Candidate species

Following field work a revision of habitat feature availability across all PCT zones enabled a refined list of candidate species for targeted survey to be developed. Table 4-12 details the candidate species and where targeted surveys are required within each IBRA subregion for both the alignment and borrow pits.

4.2.4.3 Observed

Two species-credit species were identified within the study area and adjacent areas during the field assessment, including:

- Squirrel glider (*Petaurus norfolcensis*)
- Koala (*Phascolarctos cinereus)*

The location of species-credit species observed in the field is shown in Figure 4.2. No other species-credit species were detected during the field assessment completed by FFJV. One Squirrel glider was recorded outside of the study area in PCT244 High which is connected with PCT 244 High within the study area. Based on this observation the associated PCT, has been added to the species polygon mapping and BAM C workings for this species.

Table 4-10 Species-credit species predicted to occur by BAM C within the subject land

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	Biodiversity risk rating	PCTs within the subject land in which the species is predicted to occur		
						Brigalow Belt South IBRA Northern Basalts PCTs (Habitat)	Brigalow Belt South IBRA Northern Outwash PCTs (Habitat)	Darling Riverine Plains IBRA Castlereagh-Barwon PCTs (Habitat)
Flora								
Belson's panic	*Homopholis belsonii*	V	E1,P	High	1	35,55,56,98,147,244,418	35,56,418	52,56,244
Bluegrass	*Dichanthium setosum*	V	V,P	Moderate	2	35,55,56,418	35,56,418	-
Braid fern	*Platyzoma microphyllum*	-	E1,P,3	Very high	2	53	-	247
Creeping tick-trefoil	*Desmodium campylocaulon*	-	E1,P	High	2	27,35,418	35,418	52
Cyperus conicus	*Cyperus conicus*	-	E1,P	High	2	55,56	56	56
Finger panic grass	*Digitaria porrecta*	-	E1,P	High	2	27,35,55,56,244,418	35,56,418	52,56,244,628
Native milkwort	*Polygala linariifolia*	-	E,P	High	2	418	418	192
Phyllanthus maderaspatensis	*Phyllanthus maderaspatensis*	-	E1,P	High	2	-	-	36,247
Pine donkey orchid	*Diuris tricolor*	-	V,P,2	Moderate	1.5	56	-	-
Scant pomaderris	*Pomaderris queenslandica*	-	E		2	418	-	-
Shrub sida	*Sida rohlenae*	-	E1,P	High	2	-	-	628
Silky swainson-pea	*Swainsona sericea*	-	V,P	Moderate	2	27,56,98,244	418	-
Slender darling pea	*Swainsona murrayana*	V	V,P	Moderate	1.5	27,35,55,56,418,244	35,56,418	52,56,244,247,628
Spiny peppercress	*Lepidium aschersonii*	V	V,P	High	2	35,53,55,56	35,56	-
Slender tylophora	*Tylophora linearis*	E	V		2	418	418	
Winged peppercress	*Lepidium monoplocoides*	E	E1,P	High	2	-	-	52,56,244,247, 628
Yetman wattle	*Acacia jucunda*	-	E1,P	Very high	2	35,55,418	418	-

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	Biodiversity risk rating	PCTs within the subject land in which the species is predicted to occur		
						Brigalow Belt South IBRA Northern Basalts PCTs (Habitat)	Brigalow Belt South IBRA Northern Outwash PCTs (Habitat)	Darling Riverine Plains IBRA Castlereagh-Barwon PCTs (Habitat)
Fauna								
Australian bustard	*Ardeotis australis*	-	E1,P	High	2	27,35,53,55,56,244,418	35,56,418	52,56,192,244, 247,628
Barking owl (Breeding)	*Ninox connivens*	-	V,P	Moderate	2	35,53,55,56,98,244,418	35,36,56,418	36, 56,192,244, 247,418,628
Black-breasted buzzard (Breeding)	*Hamirostra melanosternon*	-	V,P,3	Moderate	1.5	55,56,98	-	36,56,247
Black-tailed godwit	*Limosa limosa*	C,J,K	V,P	Moderate	2	53,98	-	-
Border thick-tailed gecko	*Uvidicolus sphyrurus*	E	V		2	418		-
Bristle-faced free-tailed bat, Hairy-nosed freetail Bat	*Setirostris eleryi*	-	E, P	High	2	35,55,56,98,244	35,56	36,56,192,244, 628
Bush stone-curlew	*Burhinus grallarius*	-	E1,P	High	2	27,35,56,98,244	35,56	36,52,192,244, 628
Cotton pygmy-Goose	*Nettapus coromandelianus*	-	E1,P	High	2	53	-	-
Eastern bentwing-bat (Breeding)	*Miniopterus schreibersii oceanensis*	-	V,P	Moderate	3	55,56,147,244,418	-	-
Eastern cave bat	*Vespadelus troughtoni*	-	V,P	Moderate	3	56,147	-	-
Eastern pygmy-possum	*Cercartetus nanus*	-	V,P	Moderate		244	-	-
Glossy black-cockatoo (Breeding)	*Calyptorhynchus lathami*	-	E2,V,P, 2	Moderate	2	55,56,244,418	36,56,418	36,56,192,244,247,628
Grey-headed flying-fox (Breeding)	*Pteropus poliocephalus*	V	V,P	Moderate	2	35,56,147,244,418	35,56,418	-
Koala (Breeding)	*Phascolarctos cinereus*	V	E2,V,P	Moderate	2	35,55,56,98,244,418	35,36,56,418	36,56,192,244, 628
Large-eared pied bat	*Chalinolobus dwyeri*	V	V	Moderate	3	147		
Little eagle (Breeding)	*Hieraaetus morphnoides*	-	V,P	Moderate	1.5	35,53,55,56,98,147,244,418	35,36,56,418	36,52,56,192, 244,247,418,628

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	Biodiversity risk rating	PCTs within the subject land in which the species is predicted to occur		
						Brigalow Belt South IBRA Northern Basalts PCTs (Habitat)	Brigalow Belt South IBRA Northern Outwash PCTs (Habitat)	Darling Riverine Plains IBRA Castlereagh-Barwon PCTs (Habitat)
Major Mitchell's cockatoo (Breeding)	*Lophochroa leadbeateri*	-	V,P,2	Moderate	2	-	-	36,56,192,244, 628
Masked owl (Breeding)	*Tyto novaehollandiae*	-	V,P,3	Moderate	2	35,56,55,56,98,147,244 ,418	-	36,56,192,244, 247,418
Northern free-tailed bat	*Ozimops lumsdenae*	-	V,P	Moderate	2	36,244	36	36,244,628
Pale imperial hairstreak	*Jalmenus eubulus*	-	E4A,2	Very high	3	35	35	-
Pale-headed snake	*Hoplocephalus bitorquatus*	-	V,P	Moderate	2	35,53,56,244,418	36,56,418	36,52,56,192, 244, 247
Red-tailed black-cockatoo (inland subspecies) (Breeding)	*Calyptorhynchus banksii samueli*	-	V,P,2	Moderate	2	-	-	36,56,192,244, 247,628
Rufous bettong	*Aepyprymnus rufescens*	-	V,P	Moderate	2	35,55	-	-
Sloane's froglet	*Crinia sloanei*	-	V,P	Moderate	1.5	-	-	56
Square-tailed Kite (Breeding)	*Lophoictinia isura*	-	V,P,3	Moderate	1.5	35,55,56,98,244,418	35,56	36,56,192,244, 247,418,628
Squatter pigeon (southern)	*Geophaps scripta scripta*	V	E4A,P	Very high	3	53,56,98,244,418	-	36,56,192,244, 247,628
Superb parrot (Breeding)	*Polytelis swainsonii*	V	V,P,3	Moderate	2	-	-	36,52,56,244
Squirrel glider	*Petaurus norfolcensis*	-	V	Moderate	2	418	-	36
Swift parrot (Breeding)	*Lathamus discolor*	CE	E	High	3	418		
White-bellied sea-eagle (Breeding)	*Haliaeetus leucogaster*	C, Ma	V,P	Moderate	2	-	35,36,56,418	36,56,244,247,628
Zigzag velvet gecko	*Amalosia rhombifer*		E	High	2	418	-	-

Table 4-11 Species Credit Species exclusions based on habitat assumptions

Common name	Scientific name	PCTs and Borrow pits	Reason for exclusion	Detailed reasoning
Barking owl (Breeding)	*Ninox connivens*	Low-quality 35 Low-quality 53 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 244 Low-quality 418 Low-quality 628	Habitat constraints	The species nest in hollow trees. The low-quality PCTs do not contain any large trees therefore do not provide breeding habitat for the species
Black-breasted buzzard (Breeding)	*Hamirostra melanosternon*	Low-quality 35 Low-quality 36 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 192 Low-quality 244 Low-quality 247 Low-quality 418 Low-quality 628 All of Borrow pit 8	Habitat constraints	The species prefer timbered watercourses for breeding which do not occur within or adjacent to Borrow pit 8. The closest timbered watercourse is the Macintyre River is approximately 14 km north east of the site. Low-quality PCTs do not contain large trees with hollows and are therefore not considered breeding habitat for the species. Suitable breeding habitat does exist in other parts of the study area and no breeding pairs were recorded during targeted surveys.
Black-tailed godwit (Breeding)	*Limosa limosa*	All	Habitat constraints	The species is only known to breed in Europe and Asia.
Bristle-faced free-tailed bat, Hairy-nosed freetail Bat	*Setirostris eleryi*	All	Habitat constraints	While little is known about the species it is believed to be reliant on hollows and tree fissures for roosting sites the same as other Australian species from the same family. The vegetation quality found in Low PCTs does not provide suitable habitat for the species.

Common name	Scientific name	PCTs and Borrow pits	Reason for exclusion	Detailed reasoning
Koala (Breeding)	*Phascolarctos cinereus*	Low-quality 35 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 192 Low-quality 244 Low-quality 247 Low-quality 418 Low-quality 628	Habitat constraints	Areas mapped as low-quality contain either few small scattered or no trees which are a critical part of the habitat requirement of the species. The species is known to inhabit woodlands and forests which are not consistent with low quality PCTs
Glossy black-cockatoo (Breeding)	*Calyptorhynchus lathami*	Low-quality 36 Low-quality 55 Low-quality 56 Low-quality 192 Low-quality 244 Low-quality 418 Low-quality 628	Habitat constraints	The species require large tree hollows for breeding and these low-quality PCTs do not contain large trees with hollows therefore these areas are not considered habitat for the species
Grey-headed flying-fox (Breeding)	*Pteropus poliocephalus*	Low-quality 35 Low-quality 56 Low-quality 147 Low-quality 244 Low-quality 418	Habitat constraints	The species require dense vegetation for roosting and breeding which is not found within the low-quality PCTs.
Little eagle (Breeding)	*Hieraaetus morphnoides*	Low-quality 35 Low-quality 36 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 147 Low-quality 244 Low-quality 247 Low-quality 418 Low-quality 628	Habitat constraints	The species nest in tall living trees within open eucalypt forest, woodland or open woodland which does not fit the description of low quality PCTs due to the general lack of trees in these areas. Suitable breeding habitat does exist in other parts of the study area and no breeding pairs were recorded during targeted surveys.

Common name	Scientific name	PCTs and Borrow pits	Reason for exclusion	Detailed reasoning
Major Mitchells cockatoo (Breeding)	*Lophochroa leadbeateri*	Low-quality 36 Low-quality 56 Low-quality 192 Low-quality 244 Low-quality628	Habitat constraints	The species breed in tree hollows. Low-quality PCTs do not contain large trees with hollows and therefore do not provide breeding habitat for the species. Suitable breeding habitat does exist in other parts of the study area and no breeding pairs were recorded during targeted surveys.
Masked owl (Breeding)	*Tyto novaehollandiae*	Low-quality 35 Low-quality 36 Low-quality 56 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 147 Low-quality 244 Low-quality 418	Habitat constraints	The species breed in large nest hollows. Low-quality PTCs do not contain large trees with hollows therefore do not provide breeding habitat for the species
Pale-headed snake	*Hoplocephalus bitorquatus*	Low-quality 36 Low-quality 52 Low-quality 56 Low-quality 192 Low-quality 244 Low-quality 247 Low-quality418	Habitat constraints	The species live in tree hollows and under decorticating bark, and in dryer environments it appears to favour habitats close to riparian areas. The low-quality PCTs contain very few, or no trees and are not located within riparian areas therefore do not provide suitable habitat for the species
Pale imperial hairstreak	*Jalmenus eubulus*	Low-quality 35	Habitat constraints	The species has only ever been known to breed in old growth brigalow forest and does not appear to colonise regrowth. All areas of low-quality PCT 35 no longer contain mature trees therefore do not provide habitat for this species
Sloane's froglet	*Crinia sloanei*	All areas	Habitat constraints	The threatened species information has been updated and the species is now no longer expected to occur north of Dubbo. An email from the Threatened Species Officer in charge of the species is in Appendix B

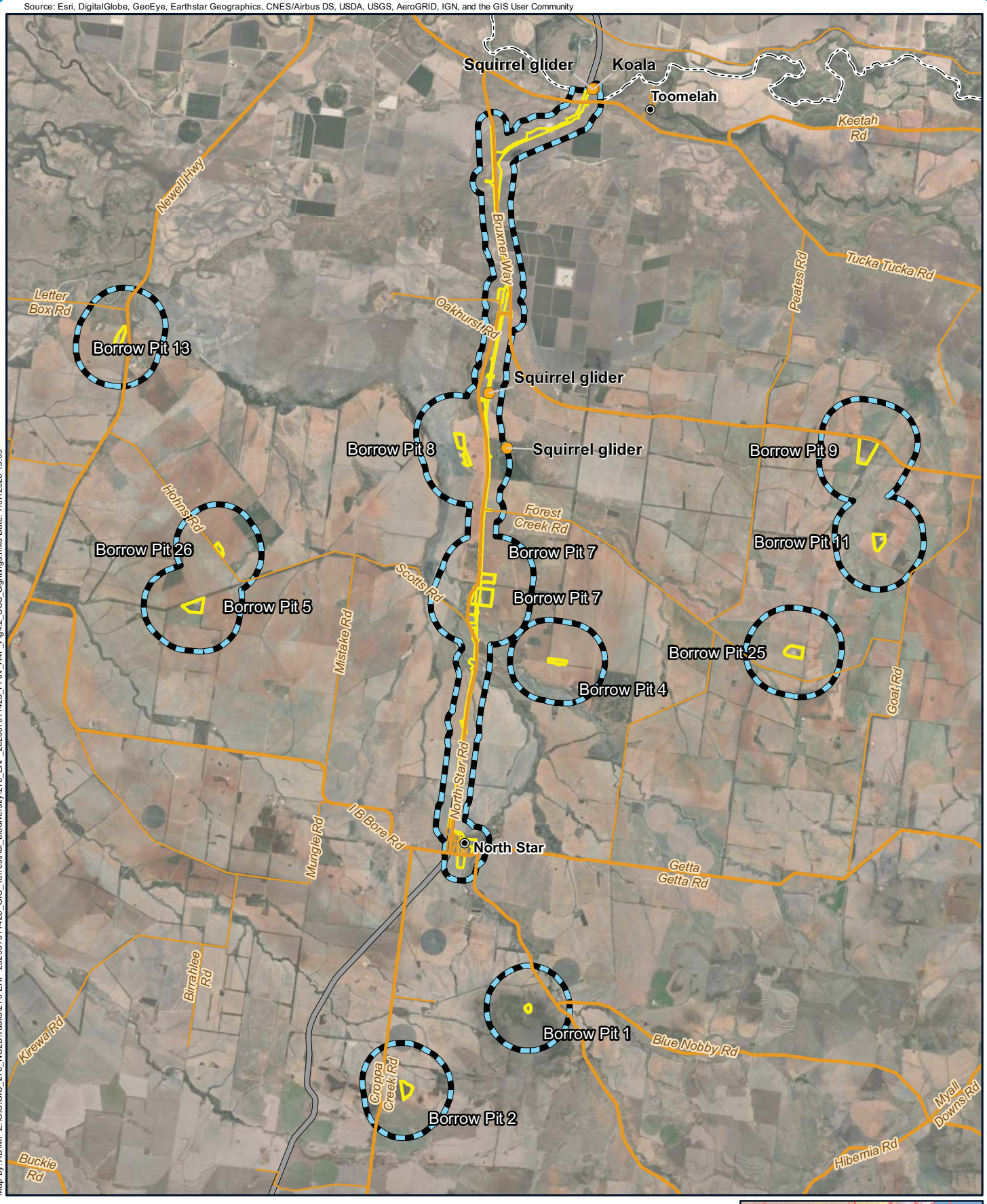
Common name	Scientific name	PCTs and Borrow pits	Reason for exclusion	Detailed reasoning
Square-tailed Kite (Breeding)	*Lophoictinia isura*	Low-quality 35 Low-quality 36 Low-quality 55 Low-quality 56 Low-quality 98 Low-quality 192 Low-quality 244 Low-quality 247 Low-quality 418 Low-quality 628	Habitat constraints	The species generally nest in trees in timbered habitats, with a preference for timbered watercourses. The low-quality PTCs do not contain timbered areas along watercourses therefore do not provide breeding habitat for the species. Suitable breeding habitat does exist in other parts of the study area and no breeding pairs were recorded during targeted surveys.
Squirrel glider	*Petaurus norfolcensis*	Low-quality 244 Low-quality 418	Habitat constraints	The species requires an abundance of trees and hollows. The low-quality PCT does not contain a suitable density of trees therefore does not provide habitat for the species
Superb Parrot (Breeding)	*Polytelis swainsonii*	Low-quality 36 Low-quality 52 Low-quality 56 Low-quality 244	Habitat constraints	In this region the species nest in hollows in trees mainly in tall riparian River Red Gum forest or woodland. The low-quality PTCs do not contain large trees with hollows therefore do not provide breeding habitat for the species, suitable breeding habitat does exist in other parts of the study area.
Swift Parrot (Breeding)	*Lathamus discolor*	All areas	Habitat constraints	The species is only known to breed in Tasmania
White-bellied sea-eagle (Breeding)	*Haliaeetus leucogaster*	Low-quality 35 Low-quality 36 Low-quality 56 Low-quality 244 Low-quality 247 Low-quality 418 Low-quality 628	Habitat constraints	The species nest in large trees. The low-quality PCTs do not contain any suitable large trees therefore do not provide breeding habitat for the species. Suitable breeding habitat does exist in other parts of the study area.

Table 4-12 Candidate species credit species for further assessment

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	Biodiversity risk rating	PCTs within the subject land in which candidate species credit species which are predicted to occur		
						Brigalow Belt South IBRA Northern Basalts PCTs (Habitat)	Brigalow Belt South IBRA Northern Outwash PCTs (Habitat)	Darling Riverine Plains IBRA Castlereagh-Barwon PCTs (Habitat)
Flora								
Belson's panic	*Homopholis belsonii*	V	E1,P	High	1	35,55,56,98,147,244,418	35,56,418	52,56,244
Bluegrass	*Dichanthium setosum*	V	V,P	Moderate	2	35,55,56,418	35,56,418	-
Braid fern	*Platyzoma microphyllum*	-	E1,P,3	Very high	2	53	-	247
Creeping tick-trefoil	*Desmodium campylocaulon*	-	E1,P	High	2	27,35,418	35,418	52
Cyperus conicus	*Cyperus conicus*	-	E1,P	High	2	55,56	56	56
Finger panic grass	*Digitaria porrecta*	-	E1,P	High	2	27,35,55,56,244,418	35,56,418	52,56,244,628
Native milkwort	*Polygala linariifolia*	-	E,P	High	2	418	418	192
Phyllanthus maderaspatensis	*Phyllanthus maderaspatensis*	-	E1,P	High	2	-	-	36,247
Pine donkey orchid	*Diuris tricolor*	-	V,P,2	Moderate	1.5	56	-	-
Scant pomaderris	*Pomaderris queenslandica*	-	E		2	418	-	-
Shrub sida	*Sida rohlenae*	-	E1,P	High	2	-	-	628
Silky swainson-pea	*Swainsona sericea*	-	V,P	Moderate	2	27,56,98,244	418	-
Slender darling pea	*Swainsona murrayana*	V	V,P	Moderate	1.5	27,35,55,56,418,244	35,56,418	52,56,244,247,628
Spiny peppercress	*Lepidium aschersonii*	V	V,P	High	2	35,53,55,56	35,56	-
Slender tylophora	*Tylophora linearis*	E	V		2	418	418	
Winged peppercress	*Lepidium monoplocoides*	E	E1,P	High	2	-	-	52,56,244,247, 628
Yetman wattle	*Acacia jucunda*	-	E1,P	Very high	2	35,55,418	418	-

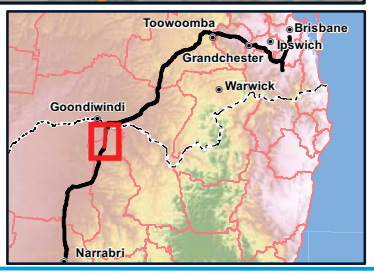
Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	Biodiversity risk rating	PCTs within the subject land in which candidate species credit species which are predicted to occur		
						Brigalow Belt South IBRA Northern Basalts PCTs (Habitat)	Brigalow Belt South IBRA Northern Outwash PCTs (Habitat)	Darling Riverine Plains IBRA Castlereagh-Barwon PCTs (Habitat)
Fauna								
Australian bustard	*Ardeotis australis*	-	E1,P	High	2	27,35,53,55,56,244,418	35,56,418	52,56,192,244, 247,628
Barking owl (Breeding)	*Ninox connivens*	-	V,P	Moderate	2	35,53,55,56,98,244,418	35,36,56,418	36, 56,192,244, 247,418,628
Black-breasted buzzard (Breeding)	*Hamirostra melanosternon*	-	V,P,3	Moderate	1.5	55,56,98	-	36,56,247
Black-tailed godwit	*Limosa limosa*	C,J,K	V,P	Moderate	2	53,98	-	-
Border thick-tailed gecko	*Uvidicolus sphyrurus*	E	V		2	418		-
Bristle-faced free-tailed bat, Hairy-nosed freetail Bat	*Setirostris eleryi*	-	E, P	High	2	35,55,56,98,244	35,56	36,56,192,244, 628
Bush stone-curlew	*Burhinus grallarius*	-	E1,P	High	2	27,35,56,98,244	35,56	36,52,192,244, 628
Cotton pygmy-Goose	*Nettapus coromandelianus*	-	E1,P	High	2	53	-	-
Eastern bentwing-bat (Breeding)	*Miniopterus schreibersii oceanensis*	-	V,P	Moderate	3	55,56,147,244,418	-	-
Eastern cave bat	*Vespadelus troughtoni*	-	V,P	Moderate	3	56,147	-	-
Eastern pygmy-possum	*Cercartetus nanus*	-	V,P	Moderate		244	-	-
Glossy black-cockatoo (Breeding)	*Calyptorhynchus lathami*	-	E2,V,P, 2	Moderate	2	55,56,244,418	36,56,418	36,56,192,244,247,628
Grey-headed flying-fox (Breeding)	*Pteropus poliocephalus*	V	V,P	Moderate	2	35,56,147,244,418	35,56,418	-
Koala (Breeding)	*Phascolarctos cinereus*	V	E2,V,P	Moderate	2	35,55,56,98,244,418	35,36,56,418	36,56,192,244, 628
Large-eared pied bat	*Chalinolobus dwyeri*	V	V	Moderate	3	147		
Little eagle (Breeding)	*Hieraaetus morphnoides*	-	V,P	Moderate	1.5	35,53,55,56,98,147,244 ,418	35,36,56,418	36,52,56,192, 244,247,418,628

Species name	Scientific name	EPBC Act	BC Act	Sensitivity to loss	Biodiversity risk rating	PCTs within the subject land in which candidate species credit species which are predicted to occur		
						Brigalow Belt South IBRA Northern Basalts PCTs (Habitat)	Brigalow Belt South IBRA Northern Outwash PCTs (Habitat)	Darling Riverine Plains IBRA Castlereagh-Barwon PCTs (Habitat)
Major Mitchell's cockatoo (Breeding)	*Lophochroa leadbeateri*	-	V,P,2	Moderate	2	-	-	36,56,192,244, 628
Masked owl (Breeding)	*Tyto novaehollandiae*	-	V,P,3	Moderate	2	35,56,55,56,98,147,244 ,418	-	36,56,192,244, 247,418
Northern free-tailed bat	*Ozimops lumsdenae*	-	V,P	Moderate	2	36,244	36	36,244,628
Pale imperial hairstreak	*Jalmenus eubulus*	-	E4A,2	Very high	3	35	35	-
Pale-headed snake	*Hoplocephalus bitorquatus*	-	V,P	Moderate	2	35,53,56,244,418	36,56,418	36,52,56,192, 244, 247
Red-tailed black-cockatoo (inland subspecies) (Breeding)	*Calyptorhynchus banksii samueli*	-	V,P,2	Moderate	2	-	-	36,56,192,244, 247,628
Rufous bettong	*Aepyprymnus rufescens*	-	V,P	Moderate	2	35,55	-	-
Sloane's froglet	*Crinia sloanei*	-	V,P	Moderate	1.5	-	-	56
Square-tailed Kite (Breeding)	*Lophoictinia isura*	-	V,P,3	Moderate	1.5	35,55,56,98,244,418	35,56	36,56,192,244, 247,418,628
Squatter pigeon (southern)	*Geophaps scripta scripta*	V	E4A,P	Very high	3	53,56,98,244,418	-	36,56,192,244, 247,628
Superb parrot (Breeding)	*Polytelis swainsonii*	V	V,P,3	Moderate	2	-	-	36,52,56,244
Squirrel glider	*Petaurus norfolcensis*	-	V	Moderate	2	418	-	36
Swift parrot (Breeding)	*Lathamus discolor*	CE	E	High	3	418		
White-bellied sea-eagle (Breeding)	*Haliaeetus leucogaster*	C, Ma	V,P	Moderate	2	-	35,36,56,418	36,56,244,247,628
Zigzag velvet gecko	*Amalosia rhombifer*		E	High	2	418	-	-



Legend

- Fauna observations
- Localities
- Major roads
- Minor roads
- Adjoining alignments
- NSW/QLD border
- Study area
- Subject land



A4 scale: 1:200,000

0 1 2 3 4 5 km

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.2: Location of species-credit species within the study area

4.2.5 Species credit species exclusions following surveys

Following the targeted surveys outlined in Section 3.4.7 and Appendices A and D the following species have been determined not to be present within the subject land.

Table 4-13 Species credit species PCT exclusions following targeted survey

Common name	Scientific name	PCTs and Borrow pits	Reason for exclusion
Shrub Sida	*Sida rohlenae*	All areas	Not found during targeted survey effort within defined survey period. Samples of sida were sent to the herbarium for identification and were returned as other sida species. Details on the survey effort is located in Section 3.4.6 and Appendix B
Yetman Wattle	*Acacia jucunda*	All areas	Not found during targeted survey effort within defined survey period and outside of known or expected range. Details on the survey effort is located in Section 3.4.6 and Appendix B.
Black-breasted buzzard (Breeding)	*Hamirostra melanosternon*	All areas	Not found during targeted survey effort within defined survey period. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Eastern bent-wing bat/ Large bent-winged bat (Breeding)	*Miniopterus schreibersii oceanensis/ Miniopterus orianae oceanensis*	Individual site assessment	Habitat constraints following targeted habitat assessment. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Koala (Breeding)	*Phascolarctos cinereus*	35 55 56 98 192 244 247 418 628	No Koalas were recorded within these PCTs during targeted surveys within the breeding season. One Koala was recorded within PCT 36. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Grey-headed flying-fox (Breeding)	*Pteropus poliocephalus*	All areas	No colonies of any flying-fox species located during targeted surveys, colonies tend to be easily recognised by both sight and smell. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Little eagle (Breeding)	*Hieraaetus morphnoides*	All areas	No breeding pairs were recorded during targeted surveys undertaken within specified time frames. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Major Mitchells cockatoo (Breeding)	*Lophochroa leadbeateri*	All areas	No breeding pairs were recorded during targeted surveys undertaken within specified time frames. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Squatter pigeon (southern)	*Geophaps scripta scripta*	All areas	Not found during any surveys, targeted or otherwise. The species is well known to a number of ecologists conducting the surveys and is not likely to have been overlooked had it been present. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Square-tailed Kite (Breeding)	*Lophoictinia isura*	All areas	No individuals or breeding pairs were recorded during targeted surveys within specified time frames. Details on the survey effort is located in Section 3.4.7 and Appendix D.
Superb Parrot (Breeding)	*Polytelis swainsonii*	All areas	No individuals or breeding pairs were recorded during targeted surveys within specified time frames. Details on the survey effort is located in Section 3.4.7 and Appendix D..
White-bellied sea-eagle (Breeding)	*Haliaeetus leucogaster*	All areas	No breeding pairs or suitable nests were recorded during targeted surveys within specified time frames. Details on the survey effort is located in Section 3.4.7 and Appendix D.

4.2.6 Species habitat polygons

Species habitat polygons have been prepared for all species-credit species recorded or assumed present within the subject land and are shown in Appendices A and F. Species polygon mapping was undertaken upon completion of the spring survey in 2019. This enabled the assessor to further refine, identify and map areas having the potential to provide habitat for species-credit species (refer Table 4-12) in accordance with the BAM. Any species which was not subject to a targeted survey effort in spring 2019 and which had suitable habitat present was considered to occur. All predicted PCT zones which provided suitable habitat features such as hollow bearing logs, cracking clay soils or mistletoe, depending upon the species, were considered suitable habitat and were included within the species polygon mapping for that species. Where suitable habitat did not occur i.e. lack of hollow bearing trees for hollow dependent breeding species then that PCT zone was excluded from the species polygon map for the species requiring that habitat feature. A detailed breakdown of the areas excluded as potential habitat for species credit species is located in Table 4-11 and Table 4-13.

Species habitat features and constraints along with estimated area of habitat are reported below (refer Table 4-16). It is important to note that these polygons have been developed based on assumed presence for the majority of species.

Species polygons were prepared using the following parameters:

- Using the unit of measurement identified for those species in the Threatened Species Profile Database
- Including the location of the species or areas likely occupied by the species
- Containing the specific habitat feature associated with the species at the subject land.

Due to the large scale and number of individual species polygons, we have presented these as combined figures in Appendix A and Appendix F. The shape files for these polygons will be submitted to DPIE. A copy of the PCT zones associated with each species is shown below in Table 4-14 for the alignment and Table 4-15 for the Borrow pits.

Table 4-14 Polygon mapping for Species Credit Species and their related PCT zones within the Alignment

Species name	Scientific name	Northern Basalts	Northern Outwash	Castlereagh-Barwon
Glossy black-cockatoo (Breeding)	*Calyptorhynchus lathami*	55H,56H,56M,244M,244H	36H,36M,56H,56M	247M,36M,36H,56M,192M,244M,628M
Cyperus conicus	*Cyperus conicus*	55H,56H,56M,56L	56H,56M,56L	56M,56L
Creeping tick-trefoil	*Desmodium campylocaulon*	35H,35L	34H,35L,27M,27L	52M,
Bluegrass	*Dichanthium setosum*	35H,35L,55H,56H,56M,56L	27M,27L,35H,35L,56H,56M,56L	
Finger panic grass	*Digitaria porrecta*	35H,35L,55M,56H,56M,56L,244H,244M	27M,27L,35H,35L,56H,56M,56L	52M,56L,56M,244L,244M,628M,628L
Pine donkey orchid	*Diuris tricolor*	56H,56M		
Belson's panic	*Homopholis belsonii*	35H,35L,55H,56H,56M,56L,98H,244H,244M,244L	35H,35L,56H,56M,56L,27L,27M	52M,56L,56M,244L,244M
Pale-headed snake	*Hoplocephalus bitorquatus*	53M,56H,56M,244H,244M,	36H,36M,56H,56M,56L,27M	247M,36M,36H,56M,192M,244M,
Pale imperial hairstreak	*Jalmenus eubulus*	35H	35H	
Winged peppercress	*Lepidium monoplocoides*			247M,52M,56L,56M,244M,628M,247L,628L
Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	*Mormopterus eleryi*	35LH,56M,56H,244M,244H,98H,35H,55H	35H,36H,36M,56H,56M	36H,36M,56M,192M,244M,628M,

Species name	Scientific name	Northern Basalts	Northern Outwash	Castlereagh-Barwon
Cotton Pygmy-Goose	*Nettapus coromandelianus*	53M		
Squirrel Glider	*Petaurus norfolcensis*	55H, 244H		36H
Koala (Breeding)	*Phascolarctos cinereus*			36H
Phyllanthus maderaspatensis	*Phyllanthus maderaspatensis*			247M,36M,36H,247L
Braid fern	*Platyzoma microphyllum*	53M		247L,247M
Native Milkwort	*Polygala linariifolia*			192L,192M
Scant Pomaderris	*Pomaderris queenslandica*			
Slender darling pea	*Swainsona murrayana*	35H,35L,55H,56H,56M,56L,244H,244M,244L	27L,27M,35H,35L,56H,56M,56L	247M,52M,56L,56M,244L,244M,247L,628L
Silky swainson-pea	*Swainsona sericea*	56H,56M,56L,244H,244M,244L,98H		
Masked owl (Breeding)	*Tyto novaehollandiae*	35H,55H,56H,56M,98H,244H,244M	35H,55H,56H,56M,98H,244H,244M	247M,36M,36H,56M,192M,

Table notes:

H = High, M=Medium, L=Low PCT zones

4.2.7 Threatened flora

No flora species listed as threatened under the BC Act or EPBC Act were observed in the study area.

Table 4-15 Polygon mapping for Species Credit Species and their related PCT zones within the Borrow pits

Species name	Scientific name	BP5	BP7	BP8	BP9	BP11	BP13	BP25	BP26	BP 1	BP 2
Zigzag Velvet Gecko	*Amalosia rhombifer*				418H,418M			418M,418L			
Glossy black-cockatoo (Breeding)	*Calyptorhynchus lathami*	192M,192H	56H	56M	418H,418M						418M
Cyperus conicus	*Cyperus conicus*		56H,56L	56M							
Creeping tick-trefoil	*Desmodium campylocaulon*		35H,35L		35H	35H,35L		35H	35H,35M,35L		35L
Bluegrass	*Dichanthium setosum*		35H,35L,56H,56L	56M	35H	35H,35L		35H,418M,418L	35H,35M,35L		35L,418H,418M
Finger panic grass	*Digitaria porrecta*		35H,35L,56H,56L	56M	35H	35H,35L		35H	35H,35M,35L		35L
Pine donkey orchid	*Diuris tricolor*			56M							
Belson's panic	*Homopholis belsonii*		35H,35L,56H,56L	56M	35H	35H,35L	98H,98L	35H	35H,35M,35L	417H,417	35L
Pale-headed snake	*Hoplocephalus bitorquatus*	192H,192M,192L	56H,56L	56M	418H,418M						418H,418M
Pale imperial hairstreak	*Jalmenus eubulus*		35H		35H	35H		35H	35H,35M		
Native Milkwort	*Polygala linariifolia*	192H,192M,192L			418H,418M			418M,418L			418H,418M
Scant Pomaderris	*Pomaderris queenslandica*				418H,418M			418M,418L			
Slender darling pea	*Swainsona murrayana*		35H,35L	56M	35H	35H,35L		35H,418M,418L	35H,35M,35L		35L
Silky swainson-pea	*Swainsona sericea*			56M	418H,418M			418M,418L	35H,35M,35L		
Tylophora linearis	*Tylophora linearis*				418H,418M			418M,418L			418H,418M
Masked owl (Breeding)	*Tyto novaehollandiae*			56M	35H,418H,418M						
Border Thick-tailed Gecko	*Uvidicolus sphyrurus*				418H,418M			418M,418L			

Table 4-16 Species-credit species recorded or assumed present within the subject land

Species name	Scientific name	Habitat feature/ constraints	Northern Basalts area	Northern Outwash area	CB area	Borrow pits	Total area (ha)
Flora							
Belson's panic	*Homopholis belsonii*	None listed	111.73	65.44	83.97	127.48	389
Bluegrass	*Dichanthium setosum*	None listed	83.46	65.44		139.56	288
Braid fern	*Platyzoma microphyllum*	East of Goondiwindi	5.8		11.24		17
Creeping tick-trefoil	*Desmodium campylocaulon*	None listed	14.89	13.14	41.95	77.35	147
-	*Cyperus conicus*	Waterbodies, wetlands and wet run on areas	79.13	52.28	28.96	43.18	204
Finger panic grass	*Digitaria porrecta*	None listed	108.87	65.44	116.8	120.45	412
Native Milkwort	*Polygala linariifolia*	None listed			8.23	66.41	74.6
-	*Phyllanthus maderaspatensis*	None listed			30.8		30.8
Pine donkey orchid	*Diuris tricolor*	None listed	22.45			21.14	43.6
Silky swainson-pea	*Swainsona sericea*	None listed	96.32	-	-	51.94	148
Slender darling pea	*Swainsona murrayana*	None listed	108.96	62.05	128	101.95	401
Winged peppercress	*Lepidium monoplocoides*	Semi-permanent/ ephemeral wet areas, land containing seasonally damp or waterlogged sites			128		128
Fauna							
Border thick-tailed gecko	*Uvidicolus sphyrurus*	None listed				30.8	30.8
Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	*Setirostris eleryi*	Land within 100m of watercourse or dams surrounded by eucalypts containing hollows	67.3	10.0	41.1		118.4
Cotton pygmy-goose	*Nettapus coromandelianus*	Deep permanent fresh waters on floodplains with floating an emergent vegetation, waterbodies	5.8	-	-	-	5.8
Glossy black-cockatoo (Breeding)	*Calyptorhynchus lathami*	Hollow bearing trees: living or dead with hollows greater than 15 cm diameter and greater than 5 m above ground	55.55	5.42	45.45	103.34	209.7
Koala (Breeding)	*Phascolarctos cinereus*	Presence of 'important habitat'			0.72		0.72
Masked owl (Breeding)	*Tyto novaehollandiae*	Hollow bearing trees living or dead with hollows greater than 20 cm diameter	67.37	-	34.63	74.79	181.4

Species name	Scientific name	Habitat feature/ constraints	Northern Basalts area	Northern Outwash area	CB area	Borrow pits	Total area (ha)
Pale imperial hairstreak	*Jalmenus eubulus*	Old growth Brigalow or *Acacia melvillei*	9.98	4.17		64.49	78.6
Pale-headed snake	*Hoplocephalus bitorquatus*	None listed	60.83	53.25	75.68	129.92	319.71
Squirrel glider	*Petaurus norfolcensis*	None listed	10.66	-	0.72	-	11.38
Zigzag velvet gecko	*Amalosia rhombifer*	None listed	-	-	-	49.1	49.1

4.2.8 Threatened ecological communities

Once field work was completed comparison of each PCT present against potential analogous TEC scientific determinations, as shown in the BioNet Vegetation Classification database, was undertaken. This included review of the advice provided by the Scientific Committee guidelines for interpreting listings for species, populations and ecological communities under the EPBC Act and BC Act, respectively. A total of five EPBC Act listed and four BC Act listed TECs are considered present within the subject land. Detailed analysis of the vegetation zones with respect to the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee determinations is provided in Appendix EB and Appendix H respectively.

Five of the 13 PCTs mapped within the subject land are considered analogous to EPBC Act and/or BC Act listed TECs which are listed in Table 4-17. The extent of TEC's within the study area was determined by the extent of analogous PCTs. The EPBC listing of Poplar box grassy woodland on alluvial plains occurred following the completion of field work. Therefore, all zones of PCT 56 and 244 have been assumed to meet one of the Benchmarks for this listing. Further detailed studies will be required within this TEC to determine its classification in relation to the TEC conservation listing advice.

Table 4-17 Plant Community Types consistent with NSW threatened ecological communities and analogous to EPBC Act TECs

Plant community type	BC Act threatened ecological communities	Analogous TEC under the EPBC Act	Presence of *Biodiversity Conservation Act 2016* threatened ecological communities	Presence of EPBC Act TEC
PCT 27 Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions	Weeping Myall Woodland	Present	Present
PCT 35 Brigalow – Belah open forest/woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	Brigalow (*Acacia harpophylla* dominant and co-dominant)	Present	Present
PCT 36 River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Artesian Springs Ecological Community in the Great Artesian Basin	The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Absent	Absent
PCT 52 Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion	N/A	Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland	NA	Present

Plant community type	BC Act threatened ecological communities	Analogous TEC under the EPBC Act	Presence of *Biodiversity Conservation Act 2016* threatened ecological communities	Presence of EPBC Act TEC
PCT 55 Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregion	Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Absent	Absent
	Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions	Weeping Myall Woodland	Absent	Absent
	Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Absent	Absent
PCT 56 Poplar Box – Belah woodland on clay-loam soils on alluvial plains of north-central NSW	Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	Brigalow (Acacia harpophylla dominant and co-dominant)	Absent	Absent
	Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions	N/A	Absent	N/A
	N/A	Poplar Box Grassy Woodland on Alluvial Plains	N/A	Present
PCT 98 Poplar Box – White Cypress Pine – Wilga – Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion *High -Low*	N/A	N/A	N/A	N/A
PCT 192 Silver-leaved Ironbark – Poplar Box +/- Ironwood shrub – grass woodland on rises in the north western plains of NSW *Medium – Low*	N/A	N/A	N/A	N/A
PCT 147 Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion	Semi-evergreen vine thickets of the Brigalow Belt South and Nandewar Bioregions	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Present	Present

Plant community type	BC Act threatened ecological communities	Analogous TEC under the EPBC Act	Presence of *Biodiversity Conservation Act 2016* threatened ecological communities	Presence of EPBC Act TEC
PCT 244 Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)	Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	Brigalow (Acacia harpophylla dominant and co-dominant)	Absent	Absent
	N/A	Poplar Box Grassy Woodland on Alluvial Plains	N/A	Present
PCT 247 Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	N/A	N/A	N/A	N/A
PCT 418 White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	N/A	N/A	N/A	N/A
PCT 628 Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions	N/A	Present	N/A

4.2.9 High Threat Exotic flora species

Within the subject land a total of 13 High Threat Exotics (HTEs) were recorded. Details associated with identified HTEs are presented in Table 4-18.

Table 4-18 Hight Threat Exotic species identified within the subject land

Common name	Scientific name	Northern Basalts	Northern Outwash	Castlereagh-Barwon
African boxthorn	*Lycium ferocissimum*	Yes	Yes	Yes
Balloon vine	*Cardiospermum grandiflorum*	-	-	Yes
Buffel grass	*Cenchrus ciliaris*	Yes	Yes	Yes
Guinea grass	*Megathyrsus maximus*	Yes	_	Yes
Lippia	*Phyla canescens*	-	-	Yes
Mimosa bush	*Vachellia farnesiana*	Yes	Yes	Yes
Harrisia cactus	*Harrisia martinii*	Yes	Yes	Yes
Mother of millions	*Bryophyllum* spp.	Yes	-	-
Noogoora burr	*Xanthium occidentale*	Yes	Yes	Yes
Rhodes grass	*Chloris gayana*	Yes	Yes	Yes
Serrated tussock	*Nassella trichotoma*	-	Yes	-
Tiger pear	*Opuntia aurantiaca*	Yes	Yes	Yes
Velvet tree pear	*Opuntia tomentosa*	Yes	Yes	Yes

Most of HTEs were recorded across all IBRA subregions within the subject land, the main exceptions were Balloon vine, Lippia and Mother of millions. Both Lippia and Mother of millions have the potential to be spread by construction works as well as other vectors, as such specific mitigation measures have been developed to contain these species. Balloon Vine was recorded only within PCT36 within Castlereagh-Barwon and tends to rely on the microclimate provided by the proximity to water and shade of larger trees, also the seeds are spread by water. Due to the high level of distribution of this species – specific maps of their locations have not been developed. Lippia was recorded in several PCTs within the subject land, including in areas of non-native vegetation. One HTE, Coolatai grass (*Hyparrhenia hirta*) was noted along several road reserves outside of the subject land this species has the potential to invade the subject land given the poor ground cover conditions created by the current drought.

4.2.10 Threatened fauna observed in the study area

Fauna species listed as threatened under the BC Act and/or EPBC Act or listed as migratory under the EPBC Act which have been observed within the study area and adjacent areas during site investigations are detailed in Table 4-19.

Table 4-19 Threatened and migratory species observed within the study area and adjacent area

Family	Species name	Common name	BC Act status	EPBC Act status
Ardeidae	*Botaurus poiciloptilus*	Australasian bittern	E,P	E
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned babbler	V,P	-
Accipitridae	*Haliaeetus leucogaster*	White-bellied sea-eagle	V,P	Ma
Cacatuidae	*Calyptorhynchus banksii samueli*	Red-tailed black-cockatoo (inland subspecies)	VP	-
Cacatuidae	*Calyptorhynchus lathami*	Glossy black-cockatoo	V	-
Meliphagidae	*Grantiella picta*	Painted honeyeater	V	V
Neosittidae	*Daphoenositta chrysoptera*	Varied sittella	V	-
Petauridae	*Petaurus norfolcensis*	Squirrel glider	V,P	-
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	V
Vespertilonidae	*Nyctophilus corbeni*[1]	Corben's long-eared bat	V,P	-
Vespertilonidae	*Miniopterus orianae oceanensis*	Eastern large-winged bat	V,P	-
Miniopteridae	*Miniopterus schreibersii oceanensis*	Eastern bentwing-bat	V	-
Molossidae	*Mormopterus lumsdenae*	Northern free-tailed bat	V	-
Vespertilonidae	*Chalinolobus picatus*	Little pied bat	V,P	-
Molossidae	*Mormopterus lumsdenae*	Northern free-tailed bat	V,P	-
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied sheathtail-bat	V,P	-
Molossidae	*Setirostris eleryi*	Bristle-faced free-tailed bat	V,P	-
Pteropodidae	*Pteropus poliocephalus*	Grey-headed flying fox	V	V
Scolopacidae	*Gallinago hardwickii*	Latham's snipe	P	M
Accipiter	*Circus assimilis*	Spotted harrier	V	-
Petroicidae	*Petroica boodang*	Scarlet robin	V	-

Table notes:

P=Protected, V=Vulnerable, E=Endangered, M=Migratory, Ma – Marine,

1 The ultrasonic bat call detectors identified one or more Nyctophilus species within the subject land (the *Nyctophilus* genus cannot be identified to species level from their calls). Three species potentially occur in the subject land: – *Nyctophilus geoffroyi*, *Nyctophilus gouldi* and the Vulnerable *Nyctophilus corbeni* which is an ecosystem credit species.

4.2.11 Pest fauna species

Ten introduced fauna species were identified within the subject land, including:

- Feral cat (*Felis catus*)
- Pig (*Sus scrofa*)
- European rabbit (*Oryctolagus cuniculus*)
- European fox (*Vulpes vulpes*)
- European hare (*Lepus europaeus*)
- Dog (*Canis lupus*)
- Camel (*Camelus dromedaries*)
- Rock dove (*Columbia livia)*
- Common myna (*Sturnus tristis*)
- Common starling (*Sturnus vulgaris*).

Feral cats (*Felis catus*) were seen in high numbers during spotlighting surveys, and numerous captures of the European fox (*Vulpes vulpes*) were recorded on five of the camera traps, including two individuals in one picture.

5 Potential impacts and impact mitigation

5.1 Introduction

The location of infrastructure associated with the alignment has been determined through the feasibility design process, this includes access tracks, laydown areas and the North Star camp. The final determination of which borrow pits will be utilised will be determined by the amount of suitable fill they are able to provide, the proximity to the works and the level of impact that will require offsetting. Given the legislative requirements of the BC Act though the BAM, multiple assessment methodologies as detailed in Section 3.2 were utilised. Ecological receptors specific to the BAM have been assessed in Section 6.1 and those ecological receptors not subject to the BC Act have been assessed in Section 7 in accordance with the SIAM.

Potential impacts and proposed mitigation measures are the same for ecological receptors assessed under the BAM and those assessed under the SIAM.

5.1.1 Proposal activities

Infrastructure activities proposed as part of the proposal have been categorised into three phases; construction, commissioning and reinstatement, and operation. A description of proposal related activities and the duration of their disturbance is provided in Table 5-1.

Table 5-1 Description of proposal related activities associated with construction, commissioning and reinstatement and operation phases

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 7-3 for definitions)
Construction	Site preparation	Vegetation clearing	Permanent
		Topsoil stripping	Medium term/ Permanent
		Construction of temporary site compounds	Medium term
		Construction of rail access roads	Permanent
		Installation of boreholes and construction water	Medium term
		Installation of offices, hardstands, etc.	Medium term
		Stockpiling	Medium term
		Dewatering of Borrow pits	Short term
	Utility diversions	Excavation	Permanent
		Trenching	Short term
		Modification, diversion and realignment of utilities and associated infrastructure	Short term/Medium term
	Drainage	Culvert installation	Permanent
	Structures	Construction of bridges over main waterways	Medium term
		Road/rail bridge construction	Medium term
	Civil works	Cutting construction	Medium term
		Embankment construction using cut to fill from rail alignment and borrow to fill from external borrow sources, where required	Medium term
		Construction of temporary haul roads	Medium term
		Drainage controls	Medium term

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 7-3 for definitions)
		Borrow pits use	Medium term
	Road works	Road realignment	Permanent
		Construction of permanent rail maintenance access roads	Permanent
	Rail logistics	Sleeper stockpiling	Medium term
		Rail stockpiling	Medium term
	Rail construction	Drilling	Temporary
		Blasting	Temporary
		Ballast installation	Short term
		Sleeper placement	Short term
		Rail placement	Short term
		Installation Train signals and communications infrastructure	Short term
		Demobilising site compounds	Short term
		Material borrow extraction	Permanent
	Signals and communications installation	Removal of temporary fencing	Temporary
Commissioning and reinstatement	Demobilisation	Establish permanent fencing	Temporary
		Restoration of disturbed areas, including revegetation where required	Short term
	Road conversion	Conversion of haul roads and construction access roads into permanent roads	Medium term
	Fencing	Fence construction and installation	Permanent
	Restoration	Minor maintenance works	Temporary
Operation	Train operations	Train movement along rail	Permanent
	Operational maintenance	Ongoing vehicle movement within rail corridor	Permanent
	Road works	Bridge and culvert inspections	Temporary
		Sleeper replacement	Temporary
		Rail welding	Temporary
		Rail grinding	Temporary
		Ballast dropping	Temporary
		Track tamping	Temporary
		Major periodic maintenance	Temporary

5.2 Nature of impacts

5.2.1.1 Habitat loss and degradation from vegetation clearing/removal

The removal of vegetation resulting in habitat loss and degradation is likely to pose the largest risk of adverse impacts for terrestrial biodiversity arising from the proposal. The impact may be direct in the form of vegetation and habitat removal, or indirect, such as a reduction in flora and fauna diversity due to shortages in available habitat resources or habitat degradation in areas adjacent to direct impacts. Small-scale clearing within largely intact patches of vegetation can cause localised depletion of some species (Kutt *et al.* 2012). Habitat loss as a result of vegetation clearing is likely to occur during the construction phase activities. TECs and habitats for threatened species are included in the likely ecological receptors potentially impacted.

Whilst it is acknowledged that the majority of the subject land within the alignment and several of the borrow pits exist in a highly modified state and potential vegetation removal associated with the proposal is considered to be relatively minor when compared to the historical broad scale vegetation clearing that has occurred in the region for agricultural purposes, this does not diminish the significance of such loss. Vegetation clearing and habitat loss that cannot be avoided, particularly in high constraint areas, is likely to result in permanent impacts to ecological receptors. Specifically, there is a risk that some of the proposed clearing of TECs may pose a direct threat to the local viability of these ecosystems and potentially heavily impact upon individual threatened species, this is discussed in detail within Section 7. The majority of impacts will occur in or directly adjacent to the existing rail corridor and in areas cleared of native vegetation or with highly modified vegetation communities.

Vegetation within some of the proposed borrow pits is relatively intact. Removal of this vegetation is likely to cause larger impacts where the whole remnant patch is removed rather than were a subset of remnant vegetation will be cleared. Vegetation clearing and habitat loss that cannot be avoided, particularly in high constraint areas, is likely to result in permanent impacts to ecological receptors. This includes a reduction of feed availability for herbivores as well as sheltering offered by trees and fallen timber. Specialist feeders such as the Pale Imperial Hairstreak are most likely to be severely impacted by the removal of their obligate food source (Brigalow). Other ecological receptors that are most likely to be impacted include TECs and habitat-specialist fauna species which are dependent on native vegetation, such as Dunmall's snake, Koala, Large-eared pied bat, Five-clawed worm-skink, and Spot-tailed quoll. The potential effects associated with this impact include direct loss of breeding habitat and loss of foraging habitat which will in turn lead to greater pressure on remining available habitat outside of the subject land. The resulting increase in pressure on resource availability is likely to increase individual animal stress levels which may result in reduced breeding success, genetic isolation and population decline over time.

5.2.1.2 Fauna species injury or mortality

Fauna injury and/or death is a direct impact that reduces local population numbers and is most likely to occur during vegetation removal associated with the proposal activities. This trauma has the potential to occur during construction activities that involve vegetation clearing, earthworks, trenching and increased labour force in the fields (through the movement of vehicles). This potential impact will be proportionate to the extent of vegetation and habitat potential for species that is removed and has the potential to impact ecological receptors, including habitat for threatened fauna species listed under the provisions of the EPBC Act and/or BC Act.

Some diurnal (active during the day) and mobile species, such as birds, may move away from areas being disturbed (i.e. vegetation removal) and may not be adversely impacted unless they are nesting. Other species that are less mobile (i.e. Zigzag velvet gecko and Koala), or those that are nocturnal and nest or roost in tree hollows during the day (i.e. such as Spot-tailed quoll and Corben's long-eared bat), may find it difficult to move away from roosts.

There is the potential for fauna injury or mortality during all phases of the proposal through vehicle collision, but particularly when high volumes of vehicle activity (i.e. trains) occur or during the operational stages of the rail. Vehicle collision is a direct impact that reduces local population numbers and is a common occurrence in Australia (Coffin 2007; Rowden *et al.* 2008). The establishment of construction tracks and borrow pits, as well as the general use of access tracks and roads across the proposal site will result in increased vehicle movements that may cause injury or death to fauna by vehicle strike. In addition, once operational, train strike may also occur. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly common species (e.g. macropods) that are tolerant of disturbance and/or those species that can utilise roads for movement pathways or as foraging habitat. Threatened species such as Squirrel gliders may be impacted where the alignment passes close to woodland vegetation. Due to the height of trains with double-stacked containers, gliders may be particularly vulnerable to train strike when gliding across the alignment.

In addition, entrapment of wildlife in utility diversions (e.g. trenches) or other excavations associated with the proposal may also cause physical trauma to fauna. For example, open trenches for underground utilities, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality (Ayres and Wallace 1997; Doody *et al.* 2003; Winooski *et al.* 2006). Threatened species most likely to become trapped in pits or other excavations during development of the proposal are ground dwelling species that are capable of moving across modified areas in the absence of woodland or forest habitat such as Black-striped wallaby, Pale-headed snake and Koala.

The unmitigated potential occurrence of fauna species injuries or mortalities can be permanent where mortality to the species occurs, or temporary where the species is rehabilitated and re-released.

5.2.1.3 Reduction in biological viability of soil to support plant growth due to soil compaction

Compaction of soil as a result of the proposal activities may result in direct impacts to soil consistency (i.e. the strength and coherence of a soil) and soil structure (i.e. the arrangement of soil particles). Changes to soil consistency and structure can affect the productive capacity of the soil for agricultural practices, the suitability of the soils for various land uses, how the soil and landscape will respond to management practices, and the flow paths by which water moves within the soil and landscape (Fitzpatrick *et al.* 1999).

The most direct effect of soil compaction is an increase in the bulk density of soil which can restrict plant root growth and function. Due to the increase in bulk density, large pores essential for water and air movement in soil are primarily affected. This influence over water and air movement can impact root penetration, seedling emergence and plant growth (Fitzpatrick *et al.* 1999; Duiker 2004). Threatened flora species most likely to be affected by this impact include *Desmodium campylocaulon*, *Homopholis belsonii*, *Dichanthium setosum*, and *Swainsona murrayana*. This impact may also affect TECs in the long term, with a reduction in recruitment leading to a gradual decline in condition.

Soil biota may also be affected by compaction, for example earthworm numbers and activity can be reduced in compacted soils. In addition, water infiltration and percolation are slower in compacted soils, thereby inhibiting root growth, leading to the potential reduced uptake of immobile nutrients such as phosphorus and potassium; and increased nitrogen losses can be expected because of prolonged periods of saturated conditions in compacted soils.

Larger non-burrowing soil animals such as mites and springtails may also be affected by soil compaction. Burrowing animals such as earthworms, termites, ants, and beetles can defend themselves better but may still suffer negative effects.

The unmitigated potential impacts of soil compaction resulting from the proposal are generally short-term and temporary.

5.2.1.4 Displacement of flora and fauna species from invasion of weed and pest species

Weed and pest species have the potential to impact on terrestrial biodiversity as native species can become displaced through predation and competition with exotic biota. Pest species can also damage native vegetation by grazing and trampling (Adair and Groves 1998; Clarke *et al.* 2000; Thorp and Lynch 2011).

Proliferation of weed and pest species is an indirect impact (i.e. not a direct result of the proposal activities) that may have cumulative effects as each proposal activity, as well as agricultural practices and other resource proposal activities, may act in conjunction to increase the chances of weed and pest proliferation throughout the proposal area and adjoining areas. Proliferation of weed and pest species has the potential to occur during all phases of all proposal activities, especially during the construction phase, however the highest likelihood of weed and pest species occurring is from vegetation clearing and soil disturbance from agricultural land practices.

The effects of proliferation of weed and pest species may not be noticeable immediately or even in the short-term, as visible signs may take several months or seasons to impact on ecological receptors and processes. These potential impacts are likely to be long-term and affect all ecological receptors in the subject land, including affecting the quality and integrity of TECs. TECs in the subject land that are most likely to be affected include Poplar box grassy woodland on alluvial plains, Natural grasslands on basalt and fine-textured alluvial plains, and Semi-evergreen vine thickets. PCTs, habitat for threatened species, wetlands and waterways may also be affected.

Numerous non-native species have been recorded within the subject land. Of these, 13 species are listed under the provisions of the Biosecurity Act as high threat exotic weeds or exotic weeds. Without appropriate management strategies, the proposal activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited or occur in low densities.

Proposal activities also have the potential to introduce new weed species into the subject land area. The most likely causes of weed dispersal and introduction associated with the proposal include earthworks, movement and disturbance of soil, and attachment of seed (and other propagules) to vehicles and machinery during all phases. Weed dispersal by vehicles along access tracks and roads is a key source of weed invasion (Birdsall *et al.* 2012). Weed invasion is an indirect impact that may degrade the quality of habitats, potentially resulting in habitat loss.

Soil disturbance during construction may increase the risk of invasion from weed and/or pest species, which can further reduce habitat quality and compromise the integrity of adjacent areas such as TECs.

Large areas of the subject land have significant weed growth, particularly non-native grasses, which have been introduced as part of historic agricultural land use of the area. Therefore, the potential for habitat modification from weed invasion resulting from the proposal is highest where proposal activities take place in relatively intact areas, such as those identified as containing intact remnant vegetation that currently has low weed diversity and abundance.

Eight pest animal species have been recorded in the subject land, including two birds and six mammals.

Unmitigated proposal activities have the potential to disperse pest (animal) species from the subject land into the surrounding landscape, due to habitat removal, noise disturbance, and human presence during the construction and operation phases of the proposal. Construction of access tracks and the rail infrastructure through large patches of intact vegetation may result in the establishment of pest species (particularly predators such as foxes and cats) into areas where they are currently absent or in low numbers. Therefore, unmitigated potential impacts of the displacement of native species through the invasion of non-natives may be temporary or permanent.

5.2.1.5 Reduction in the connectivity of biodiversity corridors

Biodiversity corridors can be defined as systems of linear habitat which enhance the connectivity of wildlife populations and may help to overcome the main consequences of habitat fragmentation (Wilson and Lindenmayer 1995). Corridors can assist ecological functioning at a variety of spatial and temporal scales from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions. Some connectivity, especially around waterways and some roadsides is present throughout much of the subject land. Several borrow pits exist as isolated islands surrounded by agricultural activity. These islands may act as 'stepping stones' for species movement across the landscape.

Most of the study area exists within a generally fragmented broader landscape. Within the subject land, some functional connectivity is retained through local linkages of remnant and regrowth vegetation, associated with riparian corridors linking larger patches of vegetation on private land. These linkages are likely to provide landscape permeability for mobile species such as birds, mammals and reptiles. Riparian vegetation associated with the Macintyre River is the most significant corridor in the region and traverses the subject land.

The potential impacts of linear infrastructure traversing these biodiversity corridors include habitat fragmentation, edge effects and barrier effects. These potential impacts are discussed further in the sections below. An additional potential impact upon biodiversity corridors resulting from the proposal is the proliferation of weeds and pest species, as mentioned previously. Receptors involving threatened species which utilise these corridors and wildlife refugia are most likely to be impacted due to the overall importance of high quality linkages at a local and regional landscape scale. Threatened fauna species most likely to utilise biodiversity corridors in the study area include Spot-tailed quoll, Squirrel glider, Red goshawk, and Australasian bittern.

The unmitigated potential impacts to biodiversity corridors resulting from the proposal are likely to be long-term and irreversible.

5.2.1.6 Edge effects

Edge effects refer to the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along habitat edges can promote the growth of different vegetation types (including weed species), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident native animals (Moenting and Morris 2006). Edge zones can be subject to higher levels of predation by introduced mammalian and native avian predators. The distance of edge effect influences can vary and has been previously recorded from 50 m to greater than 1 km from an edge (Forman *et al.* 2000; Bali 2005).

Within the subject land, many patches of vegetation are small, irregularly shaped, and fragmented, and as such are already subject to considerable edge effects. Therefore, it is unlikely that the proposal would increase the overall extent of edge effects in these areas. However, in large habitat patches with low edge to area ratios, proposal activities may create edge effects resulting in habitat degradation and a reduction of the habitat available for a range of species. The proposal is most likely to create edge effects where vegetation clearing for the alignment reduces the size of existing native vegetation patches.

Edge effects have the potential to adversely impact threatened flora and fauna species identified as potentially occurring in the subject land, especially upon the species with specific micro-habitat requirements that are less tolerant to disturbance (i.e. Dunmall's snake, Speckled warbler, Brown treecreeper, and Australian painted snipe). Birds a particularly sensitive to disturbance during breeding and may abandon nests.

Conversely, some threatened plant species appear to respond positively to edge effects, particularly ground disturbance, and are able to colonise these edge areas reasonably quickly (e.g. *Dichanthium setosum*).

The unmitigated potential impacts of edge effects resulting from the proposal are considered to be both short-term in some instances and irreversible in others.

5.2.1.7 Habitat fragmentation

Habitat fragmentation relates to the physical dividing up of a continuous habitat into separate smaller fragments (Fahrig 2002). The habitat fragments tend to be smaller and separated from each other by a matrix of less suitable habitat. The new habitat type situated between fragments is often artificial and less suitable to the species remaining within these newly created fragments (Bennett 1990) or is generally only used by adaptive and aggressive generalist species (i.e. Noisy miners) (Loyn *et al.* 1983) which further decreases population levels of other species remaining in the fragments.

The landscape in which the proposal is situated is highly fragmented with most vegetation occurring as small fragments due to agricultural practices such as pasture and cropping. The proposal activities will contribute to further fragmentation. Receptors involving threatened species, regionally significant vegetation, bioregional corridors and wildlife refugia may be impacted upon the most from habitat fragmentation. This is due to the importance of connectivity, dispersal opportunities and habitat quality for species at a local scale and the cumulative impacts at a regional scale.

Proposal activities may result in some further localised fragmentation which has the potential to be detrimental to the dispersal of relatively sedentary species, such as small mammals, frogs, and reptiles which can lead to crowding effects and increased competition within habitat patches. Woodland specialist species with limited dispersal capabilities are most likely to be affected by habitat fragmentation. Receptors with limited dispersal capability in fragmented landscapes include Brown treecreeper, Five-clawed worm-skink, Squirrel glider and Eastern pygmy-possum.

Mobile species such as larger mammals, birds, and bats may not be affected by this small-scale fragmentation, as the landscape in which they currently exist is fragmented and the predicted level of fragmentation would not be enough to restrict their dispersal between habitat patches providing that mitigation measures are in place to facilitate dispersal in these species.

The fragmentation of habitat resulting from the proposal is most likely to occur where the proposal intersects existing areas of native vegetation, such as along the Macintyre River. The unmitigated potential impacts of habitat fragmentation resulting from the proposal are considered to be long-term and irreversible.

5.2.1.8 Barrier effects

Barrier effects occur where particular species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a barrier. This can include a habitat type that has become unsuitable or a physical barrier such as a fence. Species most vulnerable to barrier effects include uncommon species, smaller ground-dwelling species, and relatively sessile species with smaller home ranges.

Various proposal activities may create barrier effects, particularly those that may create a hard barrier that restricts fauna movement (e.g. access tracks, easements). This impact may affect small mammals, frogs, reptiles and threatened species such as Dunmall's snake, Five-clawed worm-skink, Kultarr, Pale-headed snake, Stripe-faced dunnart, Squirrel gliders, and Woma. Mobile species such as larger mammals, birds, and bats may not be affected to the same extent.

Human activity and infrastructure are likely to create a barrier as many species are known to avoid areas of human activity resulting in indirect habitat loss. Human presence may affect species in different ways. Some species display avoidance behaviour while others may habituate and become attracted to areas of human activity. Predators and prey may respond differentially to human activity, causing a disruption of community interaction and potentially disrupting ecological processes (Caro 2005). Human presence and activities are likely to produce avoidance responses in larger mammalian predators that are sensitive to disturbance (i.e. Spot tailed quoll), while species such as macropods (i.e. kangaroos and wallabies) and smaller amphibian and reptile species are more likely to habituate to human presence.

Similarly, barrier effects may be experienced by native animals in the form of increased patrolling and predation by pest animals along barriers, such as a cleared corridor. Foxes and wild dogs target these barrier areas as prey becomes more exposed and easier to detect and catch.

Barrier effects resulting from the proposal are most likely to occur where cutting or embankments are required for flood immunity.

Given a large proportion of the proposed works will occur within the existing rail corridor much of the most permanent barrier related to the proposal already exists. The unmitigated potential impacts of barrier effects resulting from the proposal are considered to be in most cases short-term and temporary but may in some cases may be long-term and irreversible where new infrastructure is developed.

5.2.1.9 Noise, dust and light impacts

Noise, dust, and light are direct impacts that have the potential to occur as a result from the proposal activities during all phases and may also have cumulative effects. The likelihood of potential impacts is anticipated to be greatest where the proposal activities take place near vegetated areas and known habitat, during the construction and rehabilitation phases. Operating rail lines will generate noise and vibration and it is likely that many species will habituate as a result of the regularity of generated noise.

The proposal will result in impacts from light spill into adjacent receiving environments (e.g. fauna habitat) due to the operation of plant and equipment throughout the construction phase of the proposal and installation of lighting on infrastructure required for the operation of the proposal. Impacts associated with light spill may include direct impacts (e.g. increased susceptibility to predation from increased light) or indirect impacts related to altered foraging and habituation in areas exposed to increased lighting. Insectivorous microbats may benefit from artificial light sources at night that attract insect prey. Light impacts associated with construction will be temporary in nature, however operational lighting impacts will be long term and localised (e.g. infrastructure) or transient in nature (i.e. vehicle movement).

Ecological receptors affected by these potential impacts include all threatened flora and fauna species listed under the provisions of the EPBC Act and/or BC Act. Ecological receptors involving remnant vegetation and habitat may also be impacted to a lesser extent. These types of impacts are likely to be short in duration and localised.

5.2.1.10 Increase in litter (waste)

The act of littering has the potential to impact the surrounding environment by causing injury to wildlife, poses threats to human health and is aesthetically displeasing. When discarded as litter, human-made materials such as plastic, glass and aluminium have the potential to cause external injury to wildlife, entanglement, and if accidentally ingested, may cause starvation or suffocation. Littered objects may also provide suitable habitat for disease-spreading insects, such as flies and mosquitoes (Healthy Waterways 2014).

According to the National Litter Index, across Australia the most littered items are cigarette butts; and plastic objects are the most littered by volume of material. Cigarette butts and small plastic items are often mistaken for food resources and have been found in the stomachs of juvenile birds. In addition, littering of cigarette butts also poses a bushfire risk (Healthy Waterways 2014).

Ecological receptors affected from this potential impact include all threatened flora and fauna species listed under the provisions of the EPBC Act and BC Act. This type of impact has the potential to be long in duration due to the varying times of decomposition; however, it is likely to be localised and manageable.

5.2.1.11 Erosion and sedimentation

Terrestrial impacts associated with erosion and sedimentation include compaction of soil, loss of soil structure, nutrient degradation, and increased soil salinity all of which can lead to reductions in the carrying capacity of the terrestrial environment as a result of decreasing habitat value.

The transport of sediment and eroded material can be washed off areas of exposed soil, stockpile locations, or localised areas in proximity to proposal infrastructure (e.g. culverts and bridges) during rainfall events. In addition, it may also result from activities that interfere directly with waterways (e.g. augmentation to channels, uncontrolled livestock access and removing riparian vegetation).

Erosion and subsequent sedimentation can be damaging to the ecological health of waterways and the surrounding terrestrial environment and may be a proximate cause of environmental degradation. Mobilised coarse sandy sediment tends to accumulate in areas of slow-flow and may smother bottom-dwelling organisms and their habitats. Deep permanent river pools, that are valuable habitats for aquatic fauna and refuges for wildlife during summer and drought, may become filled by course sediments, which may render them ineffective in relation to their ability to support aquatic and terrestrial species.

Large sediment accumulations can cause upstream flooding or deflect the flow into the adjacent stream bank or even onto adjacent land, causing further erosion and transported sediments can fill the deep permanent pools of rivers to ruin this critical refuge habitat. Threatened species dependent on water sources include in the subject land include Australasian bittern, Australian painted snipe, Diamond firetail, Freckled duck, Turquoise parrot, and Black-necked stork.

5.2.1.12 Disturbance to specialists breeding and foraging habitat

Many fauna species have specific requirements for breeding and foraging. Hollow nesting birds often have a limited range in the size of hollows that they will use for breeding purposes. Masked owls require a hollow which is at least 20 cm in diameter in tall trees while Glossy black cockatoos require hollows of at least 15 cm in diameter which are at least 5 m above ground (DPIE 2019) and are specialist feeders on Allocasuarina and Casuarina species.

Works associated with the proposal will have both direct and indirect effect on specialist habitat. Direct impacts will include the removal of hollow bearing trees and feed trees while indirect impacts such as noise during project works and rail line operations may affect where these species choose to nest and feed. Species which may be impacted due to the disturbance of these habitat features include Masked owls, Barking owls, Glossy black cockatoos and Squirrel gliders. These impacts are likely to be long term in relation to the removal of hollow bearing trees and may be short or long term in relation to operational noise depending upon individual species resilience.

5.2.1.13 Trampling of threatened species

Trampling of threatened species has the potential to reduce an individual plants resilience or kill it. This, in turn, can lead to a reduction in the number of individuals of a threatened species found within a location, thus further increasing its risk of extinction at a local or broader level.

Project works have the potential to impact on areas of native vegetation during the construction phase if workers choose to leave the work areas during breaks or to park in non-designated areas. To date no threatened flora species have been identified within the study area. Species which may be impacted by trampling include Native milkwort, listed native grasses and listed Swainsona species.

5.2.1.14 Fallen timber and bush rock collection or removal

The removal of fallen timber and bush rock causes a decrease in habitat for small reptiles, small mammals, arachnids, and flora species. Fallen timber and bush rock create microclimates by increasing shade and reducing wind effects thus providing habitat for small fauna to hide from predators, hunt for food, shelter and escape from fires. Species which may be affected by the removal of fallen timber and bush rock removal include the Border thick-tailed gecko.

Wood and bush rock collection is not considered to be an increased risk in relation to the proposed works outside of those areas which will be directly impacted by the works. Borrow pits 1 and 2 have the highest amount of surface bush rock areas of which will be removed as part of the development of those borrow pits should that occur. Access to remnant vegetation areas are not likely to change as a result of the proposed works therefore no additional removal of habitat material is considered likely to occur. Species which may be impacted by the removal of fallen timber and bush rock include Spot-tailed quoll and Border thick-tailed gecko.

5.2.1.15 Fertiliser drift

Fertiliser drift has the potential to cause damage to native remnant vegetation communities by changing the growth rate of some species in relation to others, often exotic species are more likely to benefit from the addition of fertiliser over that of native species. Fertiliser drift also has the potential to change the native species composition of ecological communities which in turn can affect the habitat suitability for threatened species.

Some listed native grasses may benefit from a small amount of fertiliser drift however other species such as Swainsona may be crowded out grass species. An increase in grass density may also reduce the ability of forbs and tree species to germinate and/or grow above the grass height and reach maturity. Fertiliser drift is usually associated with highly intensive agricultural activities such as cotton farming or viticulture however a limited amount may already occur in areas where the existing native vegetation is located directly adjacent to areas of intensive agriculture. The removal of native vegetation as part of the project works may lead to a new area of vegetation becoming exposed to fertiliser drift due to the removal of that vegetation buffer. However, the distance between any farming practices and remnant vegetation will remain the same as clearing will be associated with project works which do not include the use of fertiliser and not farming practices which may.

Plant communities which may be adversely affected by fertiliser drift include Weeping Myall and Brigalow, while growth rates and densities of individual listed species such Bluegrass, Finger panic grass, Belsons' panic and Swainsona may also be affected.

5.2.1.16 Increased fire risk

An increase in fire frequency is likely to disrupt the life cycle of flora and fauna and often results in a change in vegetation structure which includes loss of fallen timber and stags and is often followed by an increase in shrub density. While many Australian flora species have developed mechanisms to cope with fire in the landscape frequent fires will decrease the resilience of the plant communities. Some flora species may be burnt before they are mature enough to seed thus reducing the diversity of the vegetation community which in turn can further reduce its habitat quality. Excessively hot fires also have the potential to sterilise the ground by killing the seedbank and further altering the vegetation structure.

The loss of fallen timber and stags decreases habitat availability for many native species and is likely to increase stress and resource pressure on fauna species. The loss of these habitat features may also increase the risk of predation of species by both native and introduced fauna.

The proposal may increase the risk of fire due to hot works during construction activities and the chance of sparks occurring off the train wheels during times of hot and dry conditions. Species which may be impacted upon by an increased fire frequency include hollow dependant species such as Barking and Masked owls, Squirrel gliders and large cockatoo species. Flora which may be impacted by increased fire frequency include Scant pomaderris, Native milkwort and *Tylophora linearis*.

5.2.1.17 Potential impact to fauna species-credit species which have been identified within the subject land

Squirrel glider

This species was identified within the riparian vegetation of the Macintyre River (PCT 36), within PCT 244 *Eucalyptus populnea* woodland and within PCT 55 Belah woodland. Figure 4.2 shows the location of the species records in relation to the subject land.

The Squirrel glider is a small, nocturnal, tree dependent gliding marsupial that feed on nectar, pollen, plant exudates (*Acacia* gum and *Eucalyptus* spp.), invertebrates and honeydew. This species live in social groups of two to nine individuals in leaf lined nests in tree hollows generally within a 5 to 15 ha home range (Goldingay, Sharpe and Dobson 2010). Home range varies according to habitat quality, especially presence of feed trees and habitat trees with suitable hollows. This species has a strong affinity with their home range and even if clearing claims most of the home range they typically do not move to adjacent vegetation (Wildlife Preservation Society Queensland 2016).

Squirrel glider occurrence is highly localised and dependent on availability of suitable foraging habitat with tree hollows. Colonies require multiple den trees within their home ranges. High population density is only achievable in habitats with abundant hollow bearing trees (>4 habitat trees/ha) and abundant food trees (Sharpe and Goldingay 2010. Dead trees (stags) are an important habitat component and are used when available. A high abundance of tree hollows (including stags) and food trees were observed in multiple sites throughout the subject land, particularly within the riparian corridors of the Macintyre River and the major creeks.

Tree hollows utilised can have entrance sizes of 2.5 to 12 cm diameter, although hollows with entrances ≤ 5 cm wide are used most frequently. Gliders select small entrances (about 3 to 5 cm entrance diameter) to exclude competitors and predators. Most foraging is within about 400 m of dens.

The main threats are loss and degradation of habitat, habitat fragmentation and resulting population fragmentation, loss of tree hollows, road kill, frequent fire, predation, collision with barbed wire fencing, weed invasion, and removal of dead wood and dead trees (OEH 2017). Habitat loss and degradation has the potential to reduce the local abundance of the species, particularly when hollow-bearing trees are removed. The loss of suitable hollow-bearing trees may make habitat unsuitable. Habitat fragmentation and resulting population fragmentation has the potential to reduce the genetic diversity of the local population and therefore reduce species resilience. As described in Section 5.2.1.2, direct mortality resulting from train strike may reduce the local abundance of the species.

Koala

This species was identified within the riparian vegetation of the Macintyre River (PCT 36), Figure 4.2 shows the location of the species record in relation to the subject land.

The Koala is a medium-sized arboreal marsupial with a highly specialised diet of Eucalypt leaves. The distribution of the Koala ranges from north east Queensland to south east South Australia, including most of New South Wales except the far north west. The Koala is sexually dimorphic, with males generally larger than females. Individuals in the north of the species range are typically smaller than individuals in the south. The average weight of males is 6.5 kg in Queensland and 12 kg in Victoria. Female Koalas typically produce a single offspring annually, during October to May (Martin and Handasyde 1999). Joeys remain in the pouch for six to eight weeks, when they move to their mother's back and remain dependent until 12 months of age.

Foraging occurs during dawn, dusk and night, and is restricted to the foliage of trees from the *Eucalyptus*, *Angophora*, *Lophostemon* and *Corymbia* genera. Specific food trees differ between regions, with Koala habitat at most sites supporting one or a few suitable food tree species. Suitable habitat for the species includes temperate, sub-tropical and tropical forest, woodland and semi-arid vegetation communities dominated by *Eucalyptus* spp. (Martin and Handasyde 1999). Shelter trees from a range of genera are an important component of Koala habitat and play an essential role in thermoregulation (Crowther et al. 2013). The Koala is not territorial but forages within home ranges that overlap with the home ranges of other individuals. Males usually have a larger home range than females. Home ranges vary in size from less than 10 ha to over 100 ha, depending on habitat quality.

The main threats to the Koala are habitat loss and fragmentation, vehicle strike, predation by dogs, disease, climate change, and drought. Historical land clearing in eastern Australia has significantly reduced the extent of habitat available for Koala. Remaining habitat is often fragmentated and ultimately unviable due to isolation. Local declines and extinctions in isolated Koala sub-populations may be contributed to *Chlamydia* infection, which reduces female fertility (NSW DECC 2008).

5.2.1.18 Groundwater dependent ecosystems

High potential aquatic GDEs were identified over 1 km from the proposed alignment at Malgarai Lagoon and in an upstream portion of the Macintyre River. High potential terrestrial GDEs were identified in several of the ephemeral waterbodies crossed by the proposal (Section 4.1.2.5). Proposal activities are not anticipated to affect shallow groundwater near these high priority GDEs given their distance from the alignment and / or the fact that construction works are not anticipated to intersect groundwater.

Only a very limited impact on groundwater levels is expected (refer EIS Chapter 14: Groundwater). As such, there is unlikely to be any adverse impacts upon the identified high potential terrestrial GDEs and these are not addressed further within this report.

5.3 Impact mitigation

This section outlines the impact mitigation measures included as part of the proposal design. The mitigation measures proposed to manage predicted environmental impacts are also described. The impacts are initially assessed with consideration of the design mitigation measures and then reassessed to determine residual impact after the inclusion of the proposed mitigation measures.

5.3.1 Avoidance options

Following the hierarchical approach to environmental management, options to avoid and minimise impacts have been considered. These options include use of the existing rail corridor wherever feasible, the location of temporary infrastructure to be within non-native vegetation or highly disturbed vegetation where possible, and the siting of bridges has been altered throughout the early development phase. Site selection for the proposal was informed by previous studies of potential alignment areas (refer Table 3-6).

Where possible the proposal footprint was restricted to avoid areas of MNES, BC Act listed ecological receptors and their associated habitat as far as practical, to that required to safely and efficiently construct and operate the proposal, thereby minimising significant adverse residual impacts to these matters.

Details of alternative options are provided in EIS Chapter 3: Alternatives and proposal options.

5.3.2 Design considerations

The mitigation measures and controls presented in Table 5-2 have been factored into the feasibility designs for the proposal. These design considerations are proposed to minimise the environmental impacts of the proposal on flora and fauna and therefore contribute to a lowering of the initial impact risk rating for each potential impact.

Table 5-2 Initial mitigations of relevance to terrestrial ecology

Aspect	Initial mitigations
Minimisation of impacts to ecology	■ Portions of the proposal are located within the existing rail corridor and wherever possible, has been aligned to be co-located with existing road infrastructure, minimising the need to develop natural and rural landscapes that have not previously been subject to disturbance to the greatest extent possible. However, the alignment is within a protected corridor, so avoidance opportunities are limited ■ Multiple potential borrow pits have been identified and assessed in an effort to reduce overall impact to receptors ■ Disturbance footprints will be limited to those areas required to construct and operate the works, as practical for safety, especially in regard to the clearing of existing vegetation communities ■ The rail corridor is an average of 40 m wide, with wider areas to provide temporary and permanent erosion and sediment control measures/pollution control measures, only where required ■ Disturbance footprints are limited to that required to construct the works and associated environmental management controls

Aspect	Initial mitigations
	■ Design defines temporary and permanent storm water, erosion and sediment/pollution control measures in an Erosion and Sediment Control Plan and Reinstatement and Rehabilitation Plan, that complies with the relevant regulatory requirements and guidance. Temporary and permanent measures must be appropriate to the site conditions, responding to the erosion risk assessment, ecological receptors, climatic zone and seasonal factors. The aforementioned plans are to also establish and specify the monitoring and performance objectives for handover on completion of construction ■ Watercourse crossing structures (including culverts and bridges) are designed to minimise the need for ongoing maintenance and inspection to maintain aquatic fauna (e.g. fish) passage and minimise the risk of blockages in reference to fish passage requirements (Faifull and Witheridge 2003) and the Policy and guidelines for fish habitat conservation (DPI 2013) ■ Bridges and waterway crossings are designed to minimise impacts to bed, banks and environmental flows, in accordance with relevant regulatory requirements (as per requirements of DPI and the FM Act 1994) ■ Fauna crossing opportunities have been co-located with waterway crossing structures to maintain habitat connectivity and where possible, these align with potential fauna movement corridors or areas of important fauna habitat i.e. areas which are considered to be fauna habitat corridors such as treed waterways ■ Fauna crossing structures will be installed where suitable to enhance connectivity for threatened fauna and may include glider poles, culvert furniture and rope bridges ■ Fauna fencing will be incorporated into the design to minimise risk to fauna and channel fauna toward safe movement opportunities. Whilst no specific guidelines exist for NSW, design specification for fauna fencing will be guided by the *Fauna Sensitive Road Design Manual, Volume 2* (TMR 2010).

5.3.3 Mitigation measures

In order to manage and mitigate proposal risks during construction, mitigation measures have been proposed. In the construction phase of the proposal, dust sources will be variable and transitory in nature and the potential for impacts will vary with proximity to ecological receptors. Construction phase mitigations have been identified with consideration of this potential for variability.

The proposed additional mitigation measures are presented in Table 5-3. These proposed mitigation measures respond to proposal specific issues and opportunities, address legislative requirements, and incorporate industry standard practice. The measures have been presented separately for each phase of the proposal.

These proposed mitigation measures have been segregated with the phase during which they would be implemented:

- Detailed design
- Pre-construction
- Construction
- Operation.

The proposed mitigation measures are outlined in Table 5-3.

Table 5-3 Proposed additional mitigation measures

Delivery phase	Aspect	Proposed mitigation measures
Detailed design	Flora and fauna/biodiversity	■ Undertake detailed design and/or construction planning to minimise the construction footprint and avoid impacts to vegetation as far as practicable. Clearing of vegetation will be limited as far as practicable and disturbance is to only occur within the approved footprint ■ A Biodiversity Management Sub-plan will be developed as part of the CEMP. This plan should include appropriate criteria, directives and procedures in relation to: – Methods and sequencing of threatened plant surveys, in accordance with the requirements of NSW Guide to Surveying Threatened Plants (OEH 2016) – Methods and sequencing of pre-clearance fauna surveys, including terrestrial, aquatic and breeding habitats (including burrows and hollow bearing trees/logs, existing culverts and structures). – Staging works to avoid animal breeding periods where possible. ■ Develop a Soil Management Sub-plan which includes procedures and protocols relevant to potential impacts to the receiving environment: – Soil/land conservation objectives for the proposal – Management of problem soils (refer EIS Chapter 15: Land Resources and Contamination), such as: ■ Cracking clays (vertosols) that are expected to be encountered directly south of the Macintyre River ■ Saline soils, particularly in potential expression areas such as soil salt stores, artificial restrictions and roads. – Specification of the type and location of erosion and sediment controls. The erosion and sediment control measures, developed in accordance with the 'Managing Urban Stormwater' series (Bluebook) to be implemented during construction of the proposal include: ■ Minimise disturbance of areas identified as susceptible to erosion ■ Where possible use existing tracks. Design new access tracks (permanent and temporary) with the aim of minimising disturbance of substrates and vegetation ■ Water quality and erosion control measures that consider site specific soil types ■ Prescribed erosion and sediment controls relevant to the site risk.
	Riparian vegetation and aquatic habitats	■ The design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with relevant policies and guidelines, including: – Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 – Guidelines for controlled activities on waterfront land (DPI 2012).
	Water quality	■ A Surface Water Management Sub-plan will be developed as a component of the CEMP. The Sub-plan will provide a surface water monitoring framework for the proposal that establishes: – Frequency, testing requirements and location of surface water sampling during construction of the proposal, with consideration for: ■ Construction activities with potential to impact water quality ■ Seasonality ■ Sensitivity of receiving watercourse.

Delivery phase	Aspect	Proposed mitigation measures
		– A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment, including definition of instances (including accidental discharge of contaminants and sediments) that trigger contingency and ameliorative measures – Responses to impact threshold exceedances.
	Fauna passage	■ Fauna movement opportunities identified during the reference design process will be developed and refined during detailed design. Development of these opportunities will involve: – Assessment of the compatibility of each approach with the general design principles at each location – Assessment of adjacent habitat and connectivity (including existing adjacent land use) – Consideration of safety requirements for the rail corridor and adjoining properties. – Elevated fauna crossing structures may be required to provide clearance over double-stacked trains (e.g. glider poles). To be determined at detailed design taking into account safety requirements (e.g. for higher bridges or viaducts, rope-bridges may be more practical) – For higher bridges or viaducts, rope-bridge underpasses may be more practical – Fauna crossing structures that may be suitable include glider poles, rope-bridge underpasses and fauna furniture within culverts – Fauna exclusion fencing will be used to channel fauna towards crossing structures.
	Fauna fencing	■ Fauna fencing opportunities will be further developed during detailed design. Development of these opportunities will involve: – Assessment of the compatibility of each approach with the general fencing principles at each location and existing land use – Consideration of safety requirements for the rail corridor and adjoining properties. For example, rail corridor fencing has not been proposed across the Macintyre River floodplain to prevent the possibility of debris accumulation in fencing during flood events – Consideration for maintenance constraints that a fauna connectivity or fencing opportunity may introduce. ■ Priority will be given to fauna fencing in areas identified as State, regional or local fauna movement corridors to channel fauna toward safe movement options (i.e. culverts) to limit vehicle strikes and associated incidents.
	Flora	■ Construction areas including compounds, stockpiles, fuel storage areas, laydown areas and staff parking will be located and established outside the tree protection zone as defined in AS4970-2009 Protection of trees on development sites.
	Weeds and pests	■ A Biosecurity Management Sub-plan will be developed as a component of the CEMP in accordance with the Biosecurity Act 2015 ■ Property-specific biosecurity requirements will be agreed with the relevant landowner/operator prior to pre-construction/construction activities occurring on that property. Agreed protocols will be documented in individual property management agreements, to be signed by ARTC and the landowner/operator.
	Rehabilitation	■ A Rehabilitation and Landscaping Management Sub-plan will be developed for the proposal, as a component of the CEMP. This Sub-plan will be based on the Inland Rail Landscape and Rehabilitation Strategy, the Inland Rail Landscape and Rehabilitation Framework and property-specific reinstatement commitments. As a minimum it will establish the following: – Location-specific objectives for rehabilitation of borrow pit sites, reinstatement and/or stabilisation. Objectives will differ for within the rail corridor and outside of the rail corridor. Outside of the rail corridor, property-specific and township-specific (e.g. North Star) rehabilitation and landscaping requirements may apply – Timeframes for rehabilitation and/or reinstatement/stabilisation works to be achieved

Delivery phase	Aspect	Proposed mitigation measures
		– Details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, consistent with the agreed objectives – Include rehabilitation requirements such as: ▪ Milling and removal of bitumen pavement ▪ Removal of any decommissioned culverts ▪ Tyning and ripping of base and sub-base material ▪ Application of soil ameliorants ▪ Topsoiling and/or compost blanket ▪ Stabilisation and rehabilitation (e.g. planting and or seeding). – Consideration for maintenance or performance issues of rehabilitation e.g. vegetation that does not grow and obscure signals or impact the longevity of rail infrastructure – Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilisation areas – Where temporary construction facilities/borrow pits are required, land shall be returned to a stable condition that complies with the conditions of applicable landowner agreements and regulatory approvals.
	Offsets	▪ Biodiversity offsets will be developed in consultation with the Department of Agriculture, Water and the Environment (Commonwealth) and the Department of Planning, Industry and Environment (NSW)
Pre-construction/Construction	Flora and fauna/biodiversity	▪ Scheduling of construction activities to minimise time of works in or adjacent to drainage lines, waterways or watercourses, particularly during periods of flow ▪ Clearly mark designated 'No go' areas and clearing extents/site boundary/limit of works prior to any vegetation clearing. ▪ Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species ▪ A qualified ecologist with relevant NSW licences will undertake pre-clearance surveys of remnant and regrowth vegetation ▪ The ecologist will supervise the subsequent clearing of where damage to any trees 3 m or greater in height, where arboreal fauna has been identified in or adjacent to the clearing front, known and potential habitat trees, log piles, burrows, stags and nests may occur and areas identified as containing threatened fauna species, habitat and mapped PCT/TECs ▪ Scheduling of clearing activities will be done to avoid breeding seasons as far as reasonably practical. Where this is not practical, and where breeding sites are identified within the corridor during pre-clearance surveys, a suitably qualified person will provide mitigation measures for exclusion zones/ relocation requirements relevant to the specific species identified ▪ Clearing extents will be limited to the area of the permanent and temporary works, avoiding impacts to native vegetation and habitats as far as practicable.
	Riparian vegetation and aquatic habitats	▪ Plant maintenance activities and refuelling must be carried out a minimum of 50 m from riparian vegetation and waterways, where practical, with appropriate interception measures in place to avoid impacts to waterways, aquatic habitats, and groundwater. Where this cannot be achieved, as risk management approach will be applied with additional management controls applied appropriate to the level of environmental risk ▪ The Surface Water Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ▪ Works within or adjacent to watercourses will be conducted in accordance with the intent of:

Delivery phase	Aspect	Proposed mitigation measures
		– Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 – Guidelines for controlled activities on waterfront land (DPI 2012) – The salvage and relocation of fish within isolated aquatic environments will be managed in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 – Why do fish need to cross the road? Fish passage requirements for waterway crossings (Fairfull and Witheridge 2003). ■ In the event of a spill incident during construction any impacted aquatic environments, will be assessed for the presence of fauna. If necessary, salvage and recovery efforts will be undertaken.
	Flora	■ Minimise clearance of remnant vegetation to that necessary for construction. Ensure all necessary permits and approvals are in place prior to the commencement of construction ■ Clearly mark designated revegetation/rehabilitation zones and other no go areas (including large significant trees) prior to any vegetation clearing. High visibility tape, barricade webbing or similar should be utilised. All contractors are to be briefed on clearing requirements and restrictions (including fines) to prevent over-clearing of these areas. ■ Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species ■ Topsoil stockpiles will be a maximum of 2.5 m in height to avoid heat sterilisation of the seed bank ■ Topsoil stockpiles will be managed to maintain the viability of soil seed banks for threatened flora species such as Slender Darling-pea, Silky Swainson-pea and Winged peppercress.
	Fauna fencing	■ Any required fauna fencing will be installed in accordance with the fencing strategy which will be finalised and documented in the detailed design.
	Weeds and pests	■ The Biosecurity Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ■ The effectiveness of weed hygiene measures will be monitored as a component of the environmental monitoring procedure for the proposal ■ Vegetation material will be managed with a general biosecurity duty to prevent, eliminate or minimise any cross contamination due to the spreading of known weeds ■ ARTC's Enviroline will be advertised for the proposal to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.
	Erosion and sediment control	■ Implement the Soil Management Sub-plan including erosion and sediment controls as a component of the CEMP.
	Rehabilitation and landscaping	■ The Rehabilitation and Landscaping Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ■ Rehabilitation of disturbed areas will be undertaken progressively and in accordance with the rehabilitation management sub-plan.
Operation	Riparian vegetation and aquatic habitats	■ Maintenance activities within or adjacent to watercourses will be conducted in accordance with relevant NSW policies and guidelines.

Delivery phase	Aspect	Proposed mitigation measures
	Weeds and pests	■ Weed management protocols for the operational rail corridor and other ARTC facilities will be in accordance with the requirements of the *Biosecurity Act 2015* and incorporated into the OEMP. These protocols will include: – Site hygiene and waste management procedures to deter pest animals – Weed surveillance and treatment during operation and maintenance activities – Requirements in relation to pesticide and herbicide use, including any limitations on use. Restrictions may apply in proximity to watercourses, known areas of MNES or BC Act listed receptors habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides. – Erosion and sediment control risks associated with broad scale weed removal or treatment. ■ ARTC's Enviroline will be advertised for the proposal to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.
	Fauna fencing	■ Fauna fencing, and adjacent vegetation clearance zones (3 m) will be inspected and maintained during operation to retain the fauna fencing integrity ■ Vegetation maintenance on the habitat side of the fauna exclusion fencing associated with fauna passages would be required to ensure that species cannot use vegetation to climb onto the exclusion fencing.

6 Impact assessment

As identified in Section 3.2, separate impact assessment have been performed, those prescribed under the BC Act using the BAM (refer Section 6.1) and those to assess receptors that are not subject to the BC Act, utilising the methodologies outlines in the SIAM (refer Section 7). This section presents the results associated with these assessments. Further to this each borrow pit has been assessed as an individual proposal but been reported as part of the whole assessment. This will enable ease of offsetting for those borrow pits which will be developed and allow segmented offsets to be implemented prior to borrow pits being utilised.

6.1 Impact assessment under Biodiversity Assessment Methodology

The information below is based on the assumed presence of all ecosystem and species-credit species listed within the BAM C as detailed in Table 4-16. The outputs of the BAM C have been reproduced below.

6.1.1 Impacts not triggering further assessment

Impacts not requiring further assessment under Section 3.1 of the BAM guidelines include areas within the subject land that do not contain native vegetation, or do not meet the minimum vegetation integrity score of 20 and do not require offsetting for impacts. The subject land contains 161.7 ha of non-native vegetation (refer Appendix A, Figure C.3) and a further 4.9 ha of land scoring below the vegetation integrity threshold as defined by the BAM. Borrow pit 4 is located entirely within non-native vegetation and has not been further assessed under the BAM. Further detail is located in Section 4.2.2.15. The definition of ‘native vegetation’ is defined under the LLS Act.

Many non-threatened flora and fauna species were recorded within the subject land during on-ground surveys. These species do not require specific offsetting under the BAM guidelines as they are considered to be covered as part of the PCT offsets.

Areas of non-native vegetation have been included within the PCT mapping located in Appendix C and shapefiles will be provided to DPIE as required to support this reporting documentation (i.e. the BDAR).

6.1.2 Plant Community Types and threatened species requiring offset

6.1.2.1 Ecosystem credits

Ecosystem credits measure the offset requirements for impacts to TECs and threatened species habitat for species that can reliably be predicted to occur within the PCTs assessed.

Offsets are required for all impacts of development associated with:

(a) A vegetation zone that has a vegetation integrity score of ≥ 15 where the PCT is representative of an endangered or critically endangered ecological community, or

(b) A vegetation zone that has an integrity score of ≥17 where the PCT is associated with threatened species habitat (as represented by ecosystem credits) or is representative of a vulnerable ecological community, or

(c) A vegetation zone that has a vegetation integrity score of ≥ 20 where the PCT is not representative of a TEC or associated with threatened species habitat.

Subsequently, Table 6-1 details the vegetation zones and associated PCTs which require offsetting. The number of ecosystem credits required for their offset are a direct output of the BAM C. Full copies of the BAM C reports are located in Appendix G. One PCT (35 Brigalow) spread over several locations is candidate Serious and Irreversible Impacts (SAII) and this is discussed in Section 6.1.4. Maps showing the locations of those areas requiring and not requiring offsetting are located in Appendix A.

A total of 7,755 credits are required for impacts within the alignment and a further 4,624 for impacts within the borrow pits. This amounts to a total of 12,379 ecosystem credits for the proposal.

Table 6-1 Plant Community Types requiring offset and the total ecosystem credits required within Rail Alignment and Borrow pits

IBRA sub-region	Vegetation zone	Associated PCT	SAII Candidate	Vegetation Integrity score	Total area to be impacted (ha)	Ecosystem credits required
Rail alignment						
Northern Basalts	35_NB_Low	35	**Yes**	1.34	4.9	0
Northern Basalts	35_NB_High	35	**Yes**	85.2	10	425
Northern Basalts	53_NB_Medium	53	No	79.5	5.8	202
Northern Basalts	55_NB_High	55	No	26.0	0.5	7
Northern Basalts	56_NB_Low	56	No	19.6	38.4	377
Northern Basalts	56_NB_Medium	56	No	49.3	12.3	304
Northern Basalts	56_NB_High	56	No	62.1	27.9	866
Northern Basalts	98_NB_High	98	No	67.7	1.8	45
Northern Basalts	244_NB_Low	244	No	18.3	1.1	10
Northern Basalts	244_NB_Medium	244	No	51.0	4.7	120
Northern Basalts	244_NB_High	244	No	46.1	10.1	234
Total					**117.5**	**2,590**
Northern Outwash	27_NO_Low	27	No	19.0	4.3	41
Northern Outwash	27_NO_Medium	27	No	71.4	0.01	1
Northern Outwash	35_NO_Low	35	**Yes**	26.2	4.7	61
Northern Outwash	35_NO_High	35	**Yes**	84.6	4.2	176
Northern Outwash	36_NO_Medium	36	No	55.4	0.5	12
Northern Outwash	36_NO_High	36	No	65.5	0.4	13
Northern Outwash	56_NO_Low	56	No	28.0	47.4	665
Northern Outwash	56_NO_Medium	56	No	29.1	2.3	33
Northern Outwash	56_NO_High	56	No	43.1	2.7	57
Total					**66.51**	**1,059**
Castlereagh-Barwon	36_CB_Medium	36	No	69.5	5.6	171
Castlereagh-Barwon	36_CB_High	36	No	86.5	0.7	27
Castlereagh-Barwon	52_CB_Medium	52	No	84.3	42.0	1,768
Castlereagh-Barwon	56_CB_Low	56	No	41.0	14.3	293
Castlereagh-Barwon	56_CB_Medium	56	No	69.5	14.7	509
Castlereagh-Barwon	192_CB_Low	192	No	25.0	3.0	28
Castlereagh-Barwon	192_CB_Medium	192	No	45.0	5.3	89
Castlereagh-Barwon	244_CB_Low	244	No	37.3	9.5	177
Castlereagh-Barwon	244_CB_Medium	244	No	64.6	3.6	115
Castlereagh-Barwon	247_CB_Low	247	No	39.8	4.4	76

IBRA sub-region	Vegetation zone	Associated PCT	SAII Candidate	Vegetation Integrity score	Total area to be impacted (ha)	Ecosystem credits required
Castlereagh-Barwon	247_CB_Medium	247	No	40.2	6.9	121
Castlereagh-Barwon	628_CB_Medium	628	No	86.9	11.7	509
Castlereagh-Barwon	628_CB_Low	628	No	21.2	21.1	223
Total					**142.8**	**4,106**
Total Alignment					**326.81**	**7,755**
Borrow pits						
Northern Basalts	BP9_35_High	35	Yes	76.3	21.8	834
Northern Basalts	BP11_35_Low	35	Yes	31.3	0.9	14
Northern Basalts	BP11_35_High	35	Yes	54.8	18.5	506
Northern Basalts	BP25_35_High	35	Yes	30.6	2.4	36
Northern Basalts	BP8_56_Medium	56	No	74.4	21.1	787
Northern Basalts	BP1_147_Medium	147	No	56.1	3.1	88
Northern Basalts	BP1_147_High	147	No	51.4	1.5	38
Northern Basalts	BP9_418_Low	418	No	5.9	1.04	0
Northern Basalts	BP9_418_Medium	418	No	39.4	6.07	90
Northern Basalts	BP9_418_High	418	No	63.3	21.19	503
Northern Basalts	BP25_418_Low	418	No	17.2	2.1	13
Northern Basalts	BP25_418_Medium	418	No	42.3	1.5	23
Total					101.2	2,932
Northern Outwash	BP7_35_Low	35	Yes	25.5	7.7	99
Northern Outwash	BP7_35_High	35	Yes	58.3	17.5	511
Northern Outwash	BP2_35_Low	35	Yes	28.4	3.2	46
Northern Outwash	BP26_35_Low	35	Yes	27.8	0.9	13
Northern Outwash	BP26_35_Medium	35	Yes	51.1	3.3	84
Northern Outwash	BP26_35_High	35	Yes	61.54	1.1	32
Northern Outwash	BP7_56_Low	56	No	28.3	0.8	11
Northern Outwash	BP7_56_High	56	No	36.6	21.3	390
Northern Outwash	BP13_98_Low	98	No	17.4	1	6
Northern Outwash	BP13_98_High	98	No	54.4	1.5	30
Northern Outwash	BP5_192_Low	192	No	29.0	2.5	27
Northern Outwash	BP5_192_Medium	192	No	32.8	7.6	94
Northern Outwash	BP5_192_High	192	No	45.6	10.0	172
Northern Outwash	BP2_418_Medium	418	No	25.0	7.3	68
Northern Outwash	BP2_418_High	418	No	35.7	8.2	109
Total					93.9	1,692
Total Borrow pits					195,1	4,624
Total Overall					521.91	12,379

6.1.2.2 Species credits

Species credits measure the offset requirement for impacts on individual threatened species or their area of habitat. As discussed earlier in Section 4.2.4 all species-credit species with the exception of Shrub sida, Yetman Wattle, Sloane's froglet and Squatter pigeon have been assumed present where suitable habitat exists, until such time as all targeted surveys have been completed. Should any of those excluded species be located during additional surveys they will be reintroduced into the offset calculations. Table 6-2 details the species-credit species requiring offset within the subject land. A copy of the Credit Summary Report for each IBRA subregions is located in Appendix G. Two species credit species have been identified as candidate SAII and this is discussed in Section 6.1.4. A total of 88,735 species credits are required to offset the clearing impacts of this proposal as detailed in Table 6-2.

Table 6-2 Species-credit species requiring offset for works within the Alignment and the number of species credits required

Species name	Scientific name	SAII Candidate	Northern Basalts area of impact (ha)	Northern Basalts Number of credits (Alignment)	Northern Outwash area of impact (ha)	Northern Outwash Area Number of credits (Alignment)	Castlereagh-Barwon area of impact (ha)	Castlereagh-Barwon Area Number of credits (Alignment)	Alignment Total
Flora									
Belson's panic	*Homopholis belsonii*	No	111.73	2,436	65.44	1032	83.97	2,862	6,330
Bluegrass	*Dichanthium setosum*	No	83.46	1,908	65.44	1,032		N/A	2940
Braid fern	*Platyzoma microphyllum*	Yes	5.8	346	-	N/A	11.24	338	684
Creeping tick-trefoil	*Desmodium campylocaulon*	No	14.89	458	13.14	278	41.95	1,768	2504
Cyperus conicus	*Cyperus conicus*	No	79.13	1554	52.28	754	28.96	802	3110
Finger panic grass	*Digitaria porrecta*	No	108.87	2366	65.44	1,032	116.75	3,594	6992
Native Milkwort	*Polygala linariifolia*	No	-	N/A	-	N/A	8.23	156	156
Phyllanthus maderaspatensis	*Phyllanthus maderaspatensis*	No	-	N/A	-	N/A	17.12	435	435
Pine donkey orchid	*Diuris tricolor*	No	22.45	464	-	N/A	-	N/A	464
Scant Pomaderris	*Pomaderris queenslaindica*	No	-	N/A	-	N/A	-	N/A	0
Silky swainson-pea	*Swainsona sericea*	No	96.32	1,971	-	N/A	-	N/A	1971
Slender darling pea	*Swainsona murrayana*	No	108.96	2,366	62.05	988	127.99	3,819	7173
Slender tylophora	*Tylophora linearis*	No	-	N/A	-	N/A	-	N/A	0
Winged peppercress	*Lepidium monoplocoides*	No	-	N/A	-	N/A	127.99	3819	3819

Species name	Scientific name	SAII Candidate	Northern Basalts area of impact (ha)	Northern Basalts Number of credits (Alignment)	Northern Outwash area of impact (ha)	Northern Outwash Area Number of credits (Alignment)	Castlereagh-Barwon area of impact (ha)	Castlereagh-Barwon Area Number of credits (Alignment)	Alignment Total
Fauna									
Border thick-tailed gecko	*Uvidicolus linearis*	No	-	N/A	-	N/A	-	N/A	0
Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	*Setirostris eleryi*	No	111.73	2,436	62.08	293	88.91	1,462	4191
Cotton Pygmy-Goose	*Nettapus coromandelianus*	No	5.8	231	-	N/A	-	N/A	231
Glossy black-cockatoo	*Calyptorhynchus lathami*	No	55.55	1,531	5.42	108	45.45	1,549	3188
Koala	*Phascolarctos cinereus*	No	-	N/A	-	N/A	0.72	31	31
Masked owl	*Tyto novaehollandiae*	No	67.3	2,016	-	N/A	33.73	1,040	3056
Pale imperial hairstreak	*Jalmenus eubulus*	**Yes**	9.98	638	4.17	265	-	N/A	903
Pale-headed snake	*Hoplocephalus bitorquatus*	No	115.24	2,600	57.5	872	109.32	3,453	6925
Squirrel Glider	*Petaurus norfolcensis*	No	0.52	241	-	N/A	9.45	31	272
Zigzag Velvet Gecko	*Amalosia rhombifer*	No	-	N/A	-	N/A	-	N/A	0
Total of all Alignment species credits			**-**	**23,168**	**-**	**6,654**	**-**	**24,541**	**54,363**

Table notes:

N/A applies where there is no known or predicted habitat for the species within the disturbance area
BP = Borrow pit

Table 6-3 Species-credit species requiring offset for works within borrow pits species credits required and impact area (ha)

Species name	Scientific name	SAII Candidate	BP5	BP7	BP8	BP9	BP11	BP13	BP25	BP26	BP1	BP2
Flora												
Belson's panic	*Homopholis belsonii*	No	N/A	1,011 47.3ha	787 21.14ha	834 21.84ha	518 19.4ha	49 2.44ha	36 5.29ha	129 5.23ha	126	46
Bluegrass	*Dichanthium setosum*	No	N/A	1,011 47.3ha	787 21.14ha	834 21.84ha	520 19.4ha	N/A	85 5.92ha	129 5.23ha	N/A	283 18.73ha
Braid fern	*Platyzoma microphyllum*	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Creeping tick-trefoil	*Desmodium campylocaulon*	No	N/A	610 25.26ha	N/A	834 21.84ha	520 19.4ha	N/A	36 2.38ha	129 5.23ha	N/A	46 3.24ha
Cyperus conicus	*Cyperus conicus*	No	N/A	401 22.04ha	787 21.14ha	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Finger panic grass	*Digitaria porrecta*	No	N/A	1,011 47.3ha	787 21.14ha	834 21.84ha	518 19.4ha	N/A	36 2.38ha	129 5.23ha	N/A	46 3.24ha
Native Milkwort	*Polygala linariifolia*	No	389 20.12ha	N/A	N/A	790 27.26ha	N/A	N/A	49 3.54ha	N/A	N/A	237 15.49ha
Phyllanthus maderaspatensis	*Phyllanthus maderaspatensis*	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pine donkey orchid	*Diuris tricolor*	No	N/A	N/A	590 21.14ha	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Scant Pomaderris	*Pomaderris queenslaindica*	No	N/A	N/A	N/A	790 27.26ha	N/A	N/A	49 3.54ha	N/A	N/A	N/A
Silky swainson-pea	*Swainsona sericea*	No	N/A	N/A	787 21.14ha	790 27.26ha	N/A	N/A	49 3.54ha	N/A	N/A	N/A
Slender darling pea	*Swainsona murrayana*	No	N/A	610 25.26ha	787 21.14ha	834 21.84	518 19.4ha	N/A	85 5.92ha	129 5.23 ha	N/A	46 3.24ha
Slender tylophora	*Tylophora linearis*	No	N/A	N/A	N/A	790 27.26ha	N/A	N/A	49 3.54ha	N/A	N/A	237 15.49ha
Winged peppercress	*Lepidium monoplocoides*	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Species name	Scientific name	SAII Candidate	BP5	BP7	BP8	BP9	BP11	BP13	BP25	BP26	BP1	BP2
Fauna												
Border thick-tailed gecko	*Uvidicolus linearis*	No	N/A	N/A	N/A	790 27.26ha	N/A	N/A	49 3.54ha	N/A	N/A	N/A
Bristle-faced free-tailed bat, Hairy-nosed Freetail Bat	*Setirostris eleryi*	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cotton Pygmy-Goose	*Nettapus coromandelianus*	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Glossy black-cockatoo	*Calyptorhynchus lathami*	No	350 17.4ha	390 21.27ha	787 21.14ha	790 27.26ha	N/A	N/A	31 1.46ha	N/A	N/A	237 15.49ha
Koala	*Phascolarctos cinereus*	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Masked owl	*Tyto novaehollandiae*	No	N/A	N/A	787 21.14ha	1,624 49.1ha	504 18.41ha	N/A	N/A	N/A	126	N/A
Pale imperial hairstreak	*Jalmenus eubulus*	**Yes**	N/A	767 17.54ha	N/A	1250 21.84ha	756 18.41ha	N/A	55 2.38ha	173 4.32 ha	N/A	N/A
Pale-headed snake	*Hoplocephalus bitorquatus*	No	389 20.12ha	401 22.04	787 21.14ha	787 27.16ha	N/A	N/A	N/A	N/A	N/A	237 15.49ha
Squirrel Glider	*Petaurus norfolcensis*	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zigzag Velvet Gecko	*Amalosia rhombifer*	No	N/A	N/A	N/A	790 49.1ha	N/A	N/A	49 3.54ha	N/A	N/A	N/A
Total of all species credits			**1,128**	**6,212**	**7,673**	**13,361**	**3,350**	**49**	**627**	**818**	**126**	**1,415**

6.1.3 Paddock tree assessment

A total of two paddock trees within the alignment study area were assessed using aerial imagery. These trees were identified to species level using a combination of aerial imagery and field data. As the trees were not assessed individually and to follow the precautionary principle they have been designated as high value habitat trees containing hollows. A map of the location of the habitat trees is located in Appendix C and Table 6-4 details the number, species and IBRA subregion of those trees.

Table 6-4 Paddock Tree assessment results

Location	PCT	Common name	Scientific name	Number	DBH Category	Contain Hollows	Class	Ecosystem Credits
Northern Outwash	56	Poplar Box	*Eucalyptus populnea* subsp. *bimbil*	1	>50 cm	True	3	1
Castlereagh -Barwon	36	River red gum	*Eucalyptus camaldulensis*	1	>50 cm	True	3	1
Total Number Paddock Trees				**2**				**2**

6.1.4 Serious and irreversible impacts

One PCT and two species-credit species were identified by the BAM C as possibly being candidates for SAII (refer Appendix G) as listed below:

- PCT35 – Brigalow – Belah open forest/woodland known to occur
- Pale imperial hairstreak (*Jalmenus eubulus*)
- *Platyzoma microphyllum* (Braid fern).

SAIIs are determined by the following four criteria (refer to following section):

- Principle 1 – species or ecological community currently in a rapid rate of decline
- Principle 2 – species or ecological communities with very small population size
- Principle 3 – species or area of ecological community with very limited geographic distribution
- Principle 4 – species or ecological community that is unlikely to respond to management and is therefore irreplaceable.

Given that targeted surveys have not been completed for the two species their presence has been assumed as per the BAM guidelines.

6.1.4.1 PCT 35 Brigalow – Belah open forest/woodland

Serious and irreversible impacts are expected on PCT Brigalow-Belah based in Principle 1 and 2 and further details are provided below including additional impact assessment.

The Brigalow community is a low woodland or forest community dominated by Brigalow (*Acacia harpophylla*), with pockets of Belah (*Casuarina cristata*) and Poplar Box (*Eucalyptus populnea* subsp. *bimbil*). The canopy tends to be quite dense and the understorey and ground cover are only sparse. This community has been extensively cleared for agriculture, with most surviving remnants along roadsides and paddock edges (NSW EES Threatened Species Database 2019, Benson *et al*. 2006).

The historical coverage of Brigalow communities within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregion within NSW is not known however based on soil mapping completed in the 1960s it is estimated to have been around 115,300 ha (Isbell 1962) and is shown in the Threatened Biodiversity Database as 120 000 ha with around 30 000ha within the Moree Plains Shire. Mapping of the vegetation community within the northern wheatbelt in around 1995 estimated the total area of Brigalow community within these bioregions to be reduced to 12 000 ha which is largely fragmented (DPIE 2019).

Some of the treats listed by NSW EES include land clearing and fragmentation, invasion and establishment of weed species changing community structure and floristic composition, overgrazing by domestic stock, spray drift of herbicides and pesticides, fragmentation resulting in edge effects, lack of value and understanding of the TEC by landholders. A modelling study by Bradley et al (2010) based on brigalow communities in the BBS in southern Queensland indicated that it may take up to 90 years post clearing for regrowth to reach 90 per cent of pre-clearing species richness and structural complexity.

The total area of impact for PCT35 (including low-quality vegetation which requires no further assessment under BAM) is 101.1 ha. This includes vegetation within the alignment corridor and six borrow pits one of which (BP7) overlaps the alignment corridor. This represents a removal of 0.008 per cent of the remaining Brigalow community within NSW based on current mapping.

The patch of vegetation through which the existing rail line is located is approximately 30 ha in size with around 1.5 ha of low-quality brigalow being impacted as part of the proposal. Relocation of the rail line to avoid this section of vegetation would result in further clearing and disturbance of other areas of brigalow. Wherever possible disturbance to this vegetation community will be reduced to the least area practicable for construction purposes. Wherever practicable no laydown or access roads will be developed through this vegetation community.

Borrow pit 7 (BP7) crosses the existing rail alignment and includes both PCT 56 and PCT 35. The total area of BP7 is 66.79 ha; of this, 17.5 ha is mapped as high-quality Brigalow vegetation which means it includes both mature and semi mature brigalow trees and understory species. A total of 7.7 ha is low-quality Brigalow containing very few highly scattered or no mature trees. The site is part of a larger mosaic of woody vegetation which joins Mobbindry and Back creeks. During the site visit in June 2019 the borrow pit appeared active and had increased in size since the last site visit in December 2018. Due to the highly degraded nature of the low-quality vegetation, it is considered that in its current state it does not meet benchmark conditions for a Brigalow Community. Removal of 17.5 ha of high-quality Brigalow represents a loss of just over 0.001 per cent of the remnant community within NSW.

Borrow pit 9 (BP9) is located 14 km east of the existing rail alignment. The proposed clearing sits within a mixed vegetation patch of PTC 35 and 418 in varying conditions. The patch size is over 100 ha. Total clearing for BP9 is expected to be 50.16 ha of which 21.8 ha is high quality mature and semi mature Brigalow which equates to just under 0.002 per cent of the remnant community.

Borrow pit 11 (BP11) is located 15 km east of the alignment and 3 km south of BP9 within approximately 55 ha of remnant Brigalow. The proposed clearing includes 18.5 ha of mature and semi mature Brigalow and 0.9 low-quality vegetation which contains few or no Brigalow. The vegetation patch is isolated from other reasonably sized > 5 ha patches of woodland vegetation by around 0.6 km which may restrict movement of some smaller fauna. The remaining area of Brigalow within the patch would be around 35 ha. The low-quality vegetation community is not likely to meet the benchmarks for a Brigalow community in its current state.

Borrow pit 25 (BP25) is located 12.5 km east of the existing rail corridor and 5km south west of BP11. It is located within an area of 7.5 ha of wooded vegetation comprising PCT 418 and 35. The proposed borrow pit would remove a total of 2.4 ha containing semi-mature Brigalow. Given the degraded nature of the site and the low density of remnant or regrowth Brigalow this vegetation association may not meet currently meet the benchmarks for a Brigalow community.

Borrow pit 26 is located 10 km west of the existing rail alignment small patch of relatively disturbed Brigalow. The proposed clearing would remove a total of 1.1 ha high quality Brigalow community (mature and semi-mature trees with native understory), 3.3 ha of medium quality (mainly Poplar Box with some suckering Brigalow outside of the BAM plots) and 0.9 ha of low-quality with no remaining Brigalow component. At the time of field survey on 22 June 2019, the borrow pit appeared to be active and had increased in size since the scoping visit in December 2018. It is considered that the medium and low-quality areas of this mapped PCT do not currently meet the definition of a Brigalow community as defined in the BioNet Threatened Species Data base benchmark descriptions due to lack of structural integrity and species richness.

Borrow pit Site 2 is located 9 km south of North Star. It is located on a rise in an open paddock. The patch is circular in shape and is 38 ha the majority of which is PCT 418. There is a ring of low-quality Brigalow at the base of the hill which is approximately 7.5 ha and contains very few remnant trees. The mapping of Brigalow is based on the surrounding vegetation and the conclusion of what would have been growing there prior to very heavy disturbance, including clearing and spray drift from the paddock surrounding the remnant stand. Evidence of the spray drift was documented during field survey and is shown in Photograph 6.1. The proposed borrow pit will remove 3.2 ha of mapped low-quality Brigalow. This vegetation is in such poor condition that it would not meet the condition requirements as set out in Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (BC Act) or the Brigalow (*Acacia harpophylla* dominant and co-dominant) (EPBC Act) descriptions.

Photograph 6.1 Dieback due to spray drift noted at Borrow pit 2

It is worth noting that not all borrow pits may be used for the proposal. This assessment is reporting on the 'worst case' scenario which would see all borrow pits cleared resulting in the clearing of 101.8 ha of Brigalow community representing 0.008 per cent of the remnant vegetation community within the BBS of NSW.

6.1.4.2 Pale imperial hairstreak (*Jalmenus eubulus*)

SAII Threshold – Principle 2 and 3

Serious and irreversible impacts may occur on the Pale imperial hairstreak based on Principle 2 and 3 and further details are provided below including additional impact assessment.

In NSW, this species is found only in Brigalow-dominated open forests and woodlands in northern areas of the state. Until recently it was known only from a single record in northern NSW near Boggabilla; however, it has since been found at four additional sites, one of which is located between two of the proposed borrow

pits. It is thought the species dispersal ability is less than 100 m and/or follows a specific dispersal corridor (Taylor 2014). This species is listed as critically endangered under the BC Act.

Suitable habitat for the species is dominated by *Acacia harpophylla* and *Casuarina cristata* on clay soils on flat to gently undulating plains, usually with only scattered emergent eucalypts such as *Eucalyptus populnea* and low trees of *Geijera parviflora* (OEH 2019). The species is only known from stands of Brigalow which contain young Brigalow (0.1 -3m) (Taylor 2014) and does not appear to colonise regrowth habitats following clearing or other major disturbance. The understory composition does not appear to influence the presence or absence of the species. Given that the current literature indicates that the species will not colonise regrowth habitat but does require young Brigalow this indicates that suitable habitat only occurs in areas of remnant vegetation with successional regeneration occurrences.

Actions and measure taken to avoid impacts

Options to avoid and minimise impacts have been considered and include use of the existing rail corridor wherever feasible, the location of temporary infrastructure to be within non-native vegetation or highly disturbed vegetation where possible, and the siting of bridges has been altered throughout the early development phase. Site selection for the proposal was informed by previous studies of potential alignment areas (refer Table 3-6).

Where possible the proposal footprint was restricted to avoid areas of MNES, BC Act listed ecological receptors and their associated habitat as far as practical, to that required to safely and efficiently construct and operate the proposal, thereby minimising significant adverse residual impacts to these matters.

Details of alternative options are provided in EIS Chapter 3: Alternatives and proposal options.

Size of the local population

Suitable habitat of up to 78.6 ha does occur within the subject land over both the alignment and potential borrow pits, targeted surveys for the species have not been conducted, therefore presence of this species has been assumed where suitable habitat occurs. To date only 5 populations of the species are known to occur within NSW and at least one of those populations is located within 10 km of the subject land. The size of the local population is unknown however in 2017 was reported at one site in 2017 to be 22 caterpillars, 6 pupae and 23 old pupae cases, while assessment of a second site resulted in an estimate of over 200 individuals including adults, caterpillars and pupae (P. Bell 2017.*Unpublished report for OEE*). Several other sites were investigated as part of the above survey in 2017 however no other site or population data was made available, it is the assessors understanding that these results indicate that the species was only present at two sites. Given the limited dispersal characteristics of the species it would indicate that there are currently two disjunct 'local' populations which do not interbreed. It is worth noting however that during the 2017 survey one old pupal case was found on the adjacent side of the road to the counted populations and that it was stated within the report that "*Future searching …(in this location).. is likely to be rewarding*". Indicating that at least one population may be larger than reported.

Extent to which the impacts exceed any threshold

The Pale imperial hairstreak has been allocated an area threshold of 0 ha. As per the precautionary principle the species is assumed to be present within 78.6 ha of suitable habitat within the subject land. Future targeted surveys may confirm the absence of the species in this area and reduce the expected magnitude of impact to the species.

The total area of impact for potential habitat is 78.6ha. This includes vegetation within the alignment corridor and six borrow pits one of which (BP7) overlaps the alignment corridor.

The patch of vegetation through which the existing rail line is located is approximately 30 ha in size with around 1.5 ha of low-quality brigalow, which does not contain suitable habitat, being impacted as part of the proposal. Relocation of the rail line to avoid this section of vegetation would result in further clearing and disturbance of other areas of brigalow. Wherever possible disturbance to this vegetation community will be

reduced to the least area practicable for construction purposes. Wherever practicable no laydown or access roads will be developed through this vegetation community.

Borrow pit 7 (BP7) crosses the existing rail alignment and includes both PCT 56 and PCT 35. The total area of BP7 is 66.79 ha; of this, 17.5 ha is mapped as high-quality Brigalow vegetation which means it includes both mature and semi mature brigalow trees and understory species. A total of 7.7 ha is low-quality Brigalow containing very few highly scattered or no mature trees. The site is part of a larger mosaic of woody vegetation which joins Mobbindry and Back creeks.

Borrow pit 9 (BP9) is located 14 km east of the existing rail alignment. The proposed clearing sits within a mixed vegetation patch of PTC 35 and 418 in varying conditions. Total clearing for BP9 is expected to be 50.16 ha of which 21.8 ha is high quality mature and semi mature Brigalow which may provide suitable habitat for the species.

Borrow pit 11 (BP11) is located 15 km east of the alignment and 3 km south of BP9 within approximately 55 ha of remnant Brigalow. The proposed clearing includes 18.5 ha of mature and semi mature Brigalow. The vegetation patch is isolated from other reasonably sized > 5 ha patches of woodland vegetation by around 0.6 km which would restrict the species colonise the area if it is not currently present, or dispersing from the area if it is present. The remaining area of Brigalow within the patch would be around 35 ha. The low-quality vegetation community is not likely to meet habitat requirements for the species in its current state.

Borrow pit 25 (BP25) is located 12.5 km east of the existing rail corridor and 5km south west of BP11. It is located within an area of 7.5 ha of wooded vegetation comprising PCT 418 and 35. The proposed borrow pit would remove a total of 2.4 ha containing semi-mature Brigalow. Given the degraded nature of the site and the low density of remnant or regrowth Brigalow this vegetation association may not currently meet the habitat requirements for the species.

Borrow pit 26 is located 10 km west of the existing rail alignment small patch of relatively disturbed Brigalow. The proposed clearing would remove a total of 1.1 ha high quality Brigalow community (mature and semi-mature trees with native understory), 3.3 ha of medium quality (mainly Poplar Box with some suckering Brigalow outside of the BAM plots) and 0.9 ha of low-quality with no remaining Brigalow component. At the time of field survey on 22 June 2019, the borrow pit appeared to be active and had increased in size since the scoping visit in December 2018. It is considered that the medium and low-quality areas of this mapped may not currently meet the habitat requirements for Pale imperial hairstreak.

Likely impact on habitat of the local population

Suitable habitat of up to 78.6 ha occurs within the subject land. The species is restricted to Brigalow-Belah forest and woodland (PCT 35). The region is currently suffering drought conditions and some of the area is actively grazed by cattle, however given the sensitivity of the species and lack of targeted surveys the presence of this species has been assumed. Therefore, the loss of 78.6 ha of suitable habitat will likely impact the local population that is assumed to be present as a worst case scenario. Targeted surveys for Pale imperial hairstreak within these areas of suitable habitat may reduce the expected impacts to the local population, if the species absence is confirmed. Should the species be present within borrow pits this is likely to result in these borrow pits being considered less feasible for use.

Likely impact on the ecology of the local population

The Pale imperial hairstreak is dependent on the continuous availability of young Brigalow as a host plant and has an obligate relationship with specific ants, usually *Iridomyrmex* (Braby, 2000). In addition, the species is not known to colonise regrowth Brigalow following disturbance (OEH 2019). The loss of Brigalow habitat resulting from the proposal is likely to adversely impact the ecology of the species. Direct and indirect impacts to Brigalow and specific ants is likely to adversely impact the ecology of the local population where present.

Fragmentation and isolation impacts

The proposal is expected to result in the loss of up to 78.6 ha of suitable habitat for the species where it is assumed to be present. The loss of this habitat will fragment and isolate suitable habitat for the species that is adjacent to the subject land. It is important to note however that suitable Brigalow habitat in the region has been extensively cleared and already in a highly fragmented state. The species is considered highly sensitive to isolation due its low dispersal ability (<100m).

Relationship with other populations of the species

Known populations of Pale imperial hairstreak in the region are highly fragmented and the species does not occupy all areas of suitable habitat (Taylor 2014). It is likely that the species has limited dispersal ability of less than 100m (Taylor 2014), although the relationship between the local population and other populations is unknown.

Increase in threats and indirect impacts including invasive flora and fauna

The main threats listed for the species are loss and disturbance to old growth brigalow dominated woodland, lack of knowledge about the species, lack of ecological information, the combination of the extensive reduction in habitat, specialised habitat requirements, the dependence on a single species of host plant, and an obligate relationship with specific ants (Braby, 2000). The proposal will contribute to the loss and disturbance of Brigalow woodland through the clearing of PCT 35. Suitable Brigalow habitat is also sensitive to indirect impacts from edge effects, weeds and fire. A Biosecurity Management Sub-plan will be developed as a component of the CEMP in accordance with the Biosecurity Act 2015 to mitigate impacts from invasive flora and fauna.

Area, or number of populations and size of populations within NSW reserve system, IBRA region and IBRA subregion

The known population of the species within NSW occur south of Boggabilla and at four additional sites in the region, one of which is located between two of the proposed borrow pits. The populations south of Boggabilla occurs across a 47.2 km^2 extent of occurrence (Taylor 2014). The size of the four additional populations is unknown. The exact location of these populations is sensitive and undisclosed. BioNet records for Pale imperial hairstreak occur within the Dthinna Dthinnawan National Park to the east of the subject land.

Measures proposed to contribute to the recovery of the species in the IBRA subregion

Offset requirements associated with the proposal for the loss of PCT 35 will contribute to the recovery of the Pale imperial hairstreak. As stated for the Brigalow SAII not all borrow pit sites are expected to be utilised as part of this project and should the hairstreak be located within one of these borrow pits it is likely to reduce the feasibly of that site.

6.1.4.3 *Platyzoma microphyllum* (Braid fern)

Serious and irreversible impacts may occur on the Braid fern based on Principle 2 and 3 and further details are provided below including additional impact assessment.

In NSW, this species is only known from the district in which the proposal occurs (OEH 2018a).The species is on the southern boundary of its distribution. It is known from locations east of the proposal in Dthinna Dthinnawan National Park and nearby. The species is listed as endangered under the BC Act.

The habitats the species have been recorded in NSW include sandy or swampy soils next to streams and lagoons subject to periodic flooding. It has been found on deep sandy soils associated with *Leptospermum* and *Lomandra* species, and in sandy soils associated with *Callitris* and *Angophora*-dominated woodland The species can be recorded at most times of the year when conditions suit. It is very localised in NSW and can form colonies several metres across (OEH 2018a).

Actions and measure taken to avoid impacts

Options to avoid and minimise impacts have been considered and include use of the existing rail corridor wherever feasible, the location of temporary infrastructure to be within non-native vegetation or highly disturbed vegetation where possible, and the siting of bridges has been altered throughout the early development phase. Site selection for the proposal was informed by previous studies of potential alignment areas (refer Table 3-6).

Where possible the proposal footprint was restricted to avoid areas of MNES, BC Act listed ecological receptors and their associated habitat as far as practical, to that required to safely and efficiently construct and operate the proposal, thereby minimising significant adverse residual impacts to these matters.

Details of alternative options are provided in EIS Chapter 3: Alternatives and proposal options.

Size of the local population

The species has a limited distribution in NSW and the proposal is near the southern limit of its range. Individuals occur in highly localised populations where suitable habitat exists. The size of the local population is unknown. Targeted surveys for the species have not been completed and therefore the species is assumed to be present where suitable conditions occur.

Extent to which the impacts exceed any threshold

No thresholds have been identified for the species.

Likely impact on habitat of the local population

Suitable habitat of up to 11.24 ha occurs within the subject land. The species is restricted to lignum swamp (PCT247). The region is currently suffering drought conditions and some of the area is actively grazed by cattle, however given the sensitivity of the species and lack of targeted surveys the presence of this species had been assumed, although the species has not been recorded within the subject land. Therefore, the loss of 11.24 ha of suitable habitat will likely impact the local population that is assumed to be present as a worst case scenario. Targeted surveys for Braid fern within this area of suitable habitat may reduce the expected impacts to the local population, if the species absence is confirmed.

Likely impact on the ecology of the local population

The ecology of the species is dependent upon the local hydrology and typically occurs in habitat prone to inundation. The proposal may impact the hydrology of suitable habitat, where the local population is assumed to occur. Changes to the local hydrology of suitable habitat within and adjacent to the subject land are also likely to have indirect and adverse impacts on the viability of seedbanks and recruitment of the species. Indirect impact to the local population will be minimised though specific mitigation strategies:

- Bridges and waterway crossings are designed to minimise impacts to bed, banks and environmental flows, in accordance with relevant regulatory requirements (as per requirements of DPI and the FM Act 1994)
- The design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with relevant policies and guidelines, including:
  - Policy and Guidelines for Fish Habitat Conservation and Management Update 2013

- Guidelines for controlled activities on waterfront land (DPI 2012).

- A Surface Water Management Sub-plan will be developed as a component of the CEMP. The Sub-plan will provide a surface water monitoring framework for the proposal that establishes:
  - Frequency, testing requirements and location of surface water sampling during construction of the proposal, with consideration for:
    - Construction activities with potential to impact water quality
    - Seasonality
    - Sensitivity of receiving watercourse.
  - A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment, including definition of instances (including accidental discharge of contaminants and sediments) that trigger contingency and ameliorative measures
  - Responses to impact threshold exceedances.

Fragmentation and isolation impacts

The species is assumed to occur with two discrete patches of PCT 247 within the subject land (refer Figure 3.5b-c). The Braid fern naturally occurs in isolated and clumped populations northern NSW (OEH 2018a). The proposal will fragment one of these patches into two patches. The patches are already intersected by the existing rail although vegetation clearing and the construction of embankments will increase the degree of isolation between the patches of PCT 247. Connectivity between the patches is currently maintained through culverts, although in some places the existing embankments of the existing rail appears to have increased flooding and the suitability of habitat for Braid fern. Fragmentation and isolation impacts to the Braid fern will be mitigated as far as practicable through specific mitigation strategies:

- Bridges and waterway crossings are designed to minimise impacts to bed, banks and environmental flows, in accordance with relevant regulatory requirements (as per requirements of DPI and the FM Act 1994)
- The design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with relevant policies and guidelines, including:
  - Policy and Guidelines for Fish Habitat Conservation and Management Update 2013
  - Guidelines for controlled activities on waterfront land (DPI 2012).

Relationship with other populations of the species

In NSW the Braid fern naturally occurs in isolated and clumped populations (OEH 2018a). It is likely that there is limited gene flow between populations, although there is a paucity of information regarding the ecology of the species. The local population within the subject land may interact with other nearby populations through gene flow during flood events.

Increase in threats and indirect impacts including invasive flora and fauna

The main threats listed for the species are loss and disturbance to the sandy damp habitat the species requires, including grazing and trampling by livestock and feral pigs. The habitats the species requires are generally highly ephemeral. The proposal will further the threat of habitat loss for the Braid fern. The proposal is not expected to contribute further to indirect impacts resulting from invasive flora and fauna. A Biosecurity Management Sub-plan will be developed as a component of the CEMP in accordance with the Biosecurity Act 2015 to mitigate impacts from invasive flora and fauna.

Area, or number of populations and size of populations within NSW reserve system, IBRA region and IBRA subregion

In NSW the Braid fern is restricted to the Northern Basalts IBRA subregion of the Brigalow Belt South region and the Castlereagh-Barwon IBRA subregion of the Darling Riverine Plains region (OEH 2018a). BioNet records for Braid fern occur within the Dthinna Dthinnawan National Park to the east of the subject land. The size of these populations in unknown.

Measures proposed to contribute to the recovery of the species in the IBRA subregion

Offset requirements associated with the proposal for the loss of PCT 247 will contribute to the recovery of the Braid fern.

6.2 Prescribed biodiversity impacts

Under the BC Act, a series of actions are prescribed as impacts and must be assessed under the offset scheme. Impacts relevant to this proposal include:

a) Impacts of development on the habitat of threatened species or ecological communities associated with
   i) Karst, caves, crevices and cliffs
   ii) Rocks
   iii) Human made structures
   iv) Non-native vegetation

b) Impacts of development on the connectivity of different areas of habitat of threatened species that facilitate the movement of those species across their range

c) Impacts of development on movement of threatened species that maintains their lifestyle

d) Impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities

e) The impacts of wind turbine strikes on protected animals,

f) Impacts of vehicle strikes on threatened species or on animals that are part of a TEC.

Prescribed biodiversity impacts can be difficult to quantify, replace or offset, making avoiding and minimising impacts essential. Table 6-5 and Table 6-6 considers relevant prescribed impacts to native vegetation and threatened species, highlights the mitigation measures to reduce impacts and describes the nature, extent and duration of the impact and provides a prediction of impact consequences.

Table 6-5 Prescribed biodiversity impacts on native vegetation

Prescribed Impact Category	Specific feature	Species or community to be impacted	Mitigation measure	Nature, extent and duration of impact	Importance of impact within bioregion	Consequence of impact
Habitat connectivity	Habitat corridors	All vegetation types	Refer Section 5.3.3	Increased 'edge' effect for all communities where vegetation clearing has occurred. Duration of impact permanent.	Moderate	Increased fragmentation of already fragmented landscapes. The existing rail line is often situated on the edge of the road alignment or adjacent to a farm access track. The final width of the proposed work is not consisted likely to greatly decrease the existing connectivity of the region for flora species. Larger pollinators such as birds and larger mammals will continue to traverse the rail line while smaller ones may already have limited mobility due to existing conditions. The location of some borrow pits may result in further fragmentation of the landscape depending on the final areas to be cleared.
Threatened species movement	Changes to roadside and riparian corridors	Wind or ant dispersed species	Refer Section 5.3.3	Changes to the topography of the landscape will alter wind patterns across the landscape on a permanent basis. Clearing of vegetation types will alter the distribution of ant species, thereby changing the potential distances ant dispersed species may be dispersed.	Moderate	Consequences within the alignment are likely to be minimal, however also difficult to predict due to a lack of information about dispersal mechanisms of local species and changes to dispersal vectors (e.g. ants, wind). The removal/reduction in size of some vegetation islands at borrow pit locations is likely to reduce threatened species dispersal should they be found to be present.
Water quality, hydrological processes	Changes to drainage patterns throughout greater subject land	PCT 55 – Belah woodland, PCT 247 – Lignum swamp	Refer Section 5.3.3	Changes to the hydrology within and surrounding the impact area may permanently change the composition of vegetation communities. Belah woodland may be favoured over Poplar box which was observed throughout the subject land from changes to hydrology when the previous rail line was in operation. In addition, if drainage is cut off to Lignum swamps, it is likely that these communities would be unable to persist into the long-term.	Moderate/High	Permanent change to vegetation communities dependent on particular hydrological conditions. These changes will depend upon the final design.

Table 6-6 Prescribed biodiversity impacts on threatened species

Prescribed Impact Category	Specific feature	Species or community to be impacted	Mitigation measure	Nature, extent and duration of impact	Importance of habitat within bioregion	Consequence of impact
Habitat	Man-made structures – Removal of timber bridges	Micro-bats	Refer Section 5.3.3	Removal of old timber bridges – Permanent	Limited	Unknown until design is finalised. Considered to be low with the removal of two small bridges which did not appear to supply habitat for microbat species to the open nature of their timber construction. Micro-bats are known to utilise new concrete structures which are associated with bridges and larger culverts, these new structures may provide higher quality habitat that what is planned for replacement.
Habitat	Man-made Structures – 'Dam' removal	Fish Amphibians Reptiles Crustaceans	Refer Section 5.3.3	Removal of 'dam' and changed waterflow regimes - Permanent	Medium	There is a small waterhole which has developed under the existing rail line due to lack of maintenance over many years. This waterhole may provide habitat for fish species as well as turtles and waterbirds. There are other shallow waterbodies including an adjacent dam and a natural pool within Forest Creek which may provide habitat for those more mobile species, however any less mobile species are likely to be permanently displaced.
Habitat	Man-made Structures – Ballast removal/ replacement	Reptiles Arachnids Small mammals	Refer Section 5.3.3	Removal and replacement of rail ballast – Temporary	Medium	The existing rail ballast is likely to provide sheltering habitat for a variety of animal species which will be displaced during works. The level of displacement and impact on populations is unknown. The ballast will be replaced as part of works so provided the species still reside within the vicinity they may return.
Habitat	Removal of rock cover Borrow pits 1 and 2	Reptiles Arachnids Small mammals	Refer Section 5.3.3	Removal of loose rock over the surface of the borrow pit area – Permanent	Habitat	The existing rock cover is likely to provide sheltering habitat for a variety of animal species which will be displaced during works. The level of displacement and impact on populations is unknown.
Habitat connectivity	Habitat corridors	Koalas Possums Gliders Small birds Reptiles	Refer Section 5.3.3	Increase in distance between areas of habitat – Permanent	Medium/high	The existing environment within the alignment is highly fragmented, and the existing fauna usage is not considered to be greatly impacted once construction work has been completed. Clearing for borrow pits is considered likely to have a larger impact upon species movement especially where vegetation islands will be cleared or highly modified as a result of the works.
Threatened species movement	Changes to roadside and riparian corridors	Koalas Gliders Small mammals Small birds	Refer Section 5.3.3	Clearing – During construction	Medium/high	The existing alignment environment is highly fragmented. Noise, vibration and lighting during the construction phase is likely to impact fauna movement. Clearing for borrow pits is considered likely to have a larger impact upon species movement especially where vegetation islands will be cleared or highly modified as a result of the works.

Prescribed Impact Category	Specific feature	Species or community to be impacted	Mitigation measure	Nature, extent and duration of impact	Importance of habitat within bioregion	Consequence of impact
Threatened species movement	Changes to roadside and riparian corridors	Koalas Possums Gliders Small birds	Refer Section 5.3.3	Maintenance – During operation	Low/medium	The existing rail alignment is highly fragmented, and the existing fauna usage is not considered to be greatly impacted once construction work has been completed. Clearing for borrow pits is considered likely to have a larger impact upon species movement especially where vegetation islands will be cleared or highly modified as a result of the works.
Water quality, hydrological processes	Changes to drainage patterns throughout study region	Fish Amphibians Crayfish Molluscs	Refer Section 5.3.3	Permanent flow changes -During construction	Low	The existing environment is in a state of altered patterns due the existing rail line, road network, drains, dams and farming practices. It is not considered likely that the construction works will significantly alter the current state. The final landform for the borrow pits may create further water storage/wetland areas.
Water quality, hydrological processes	Changes to drainage patterns throughout study region	Fish Amphibians Crayfish Molluscs	Refer Section 5.3.3	During operation	TBA	The final design of the proposal will take into consideration the mitigation measures outlined in Section 5.3.3. The final landform for the borrow pits may create further water storage/wetland areas which may in time become habitat for native aquatic species.
Vehicle impact on threatened species	Construction vehicles	Terrestrial species	Refer Section 5.3.3	During construction	Low	Provided mitigation measures outlined in Section 5.3.3 are adhered to the number of vehicle strikes should be very low. The threatened species predicted to occur are generally mobile and as such there should be very limited impact on threatened species
Vehicle impact on threatened species	Operational phase - Trains	Terrestrial species	Refer Section 5.3.3	During operation	Low	Provided mitigation measures outlined in Section 5.3.3 are adhered to the number of vehicle strikes over time should be low. The threatened species predicted to occur are highly mobile and the trains will be audible as they approach and as such there should be very limited impact on threatened species.

6.3 Summary of impacts on matters of national environmental significance assessed under Biodiversity Assessment Methodology

6.3.1 Introduction

Under the Commonwealth EPBC Act the approval of the Commonwealth Minister for the Environment is required for any action that may have a significant impact on MNES. These matters are:

- Listed threatened species and communities
- Migratory species protected under international agreements
- Ramsar wetlands of international importance
- The Commonwealth marine environment
- The Great Barrier Reef Marine Park
- World Heritage properties
- National Heritage places
- Nuclear actions
- A water resource, in relation to coal seam gas development and large coal mining development.

The proposal has been referred (EPBC number: 2018/8222) to the Department of Agriculture, Water and the Environment (DAWE) and was determined to be a controlled action by the department on 12th June 2018 because the department considers that the proposed action has the potential to significantly impact MNES and must therefore assess the significance of any potential impacts on MNES threatened species and communities. Based on advice received within the SEARs subsequent to the referral, assessments of significance were undertaken for the following MNES:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC
- Weeping myall woodland TEC
- Poplar box woodland on alluvial soils TEC
- White box-Yellow box-Blakely's red gum grassy woodland and derived native grassland (TEC)
- Natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland (TEC)
- Coolibah-Black box woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (TEC)
- *Cadellia pentastylis* (Ooline)
- *Homopholis belsonii* (Belson's panic)
- *Tylophora linearis* (Slender tylophora)
- Koala (*Phascolarctos cinereus*)
- Squatter pigeon (southern) (*Geophaps scripta scripta*)
- Painted honeyeater (*Grantiella picta*)
- Murray cod (*Maccullochella peelii*)
- Large-eared pied bat (*Chalinolobus dwyeri*)
- Corben's long-eared bat (*Nyctophilus corbeni*)

- *Dichanthium setosum* (Bluegrass)
- Five clawed worm skink (*Anomalopus mackayi*)
- Adorned delma (*Delma torquata*)
- Dunmall's snake (*Furina dunmalli*).

6.3.2 Summary of Commonwealth Matters Assessment

Based on the direct and permanent impacts associated with the proposal that are summarised in Section 5.2 and the range of avoidance, mitigation and management measures described in Section 5.3, the proposal is considered likely to result in a significant impact on three ecological communities and 15 threatened flora and fauna species subject to the BAM assessment pathway that are also protected under the EPBC Act. Impacts of the proposal on these MNES assessed through BAM may be offset in accordance with the BAM guidelines, as detailed in Table 6-7. As stated in the SEARs the Commonwealth Minister for the Environment may rely on specified environmental impact assessment processes of the State of New South Wales in assessing action under the EPBC Act. The offsets described in Table 6-7 quantify the credits required to satisfy offset obligation under the BOS for species-credit species and TECs also listed as threatened under the EPBC Act. As stated in the SEARs the Commonwealth Minister for the Environment. More detail is provided in Section 7.

Table 6-7 Like-for-like offsets within the Biodiversity Assessment Method

Matter	Proposal impact (BAM)	Like-for-like Offset in accordance with BAM guidelines
TECs		
Brigalow (*Acacia harpophylla*) dominant and co-dominant) community	At total of up to 101.2 ha of this vegetation community will be removed as part of the proposal	601 and 1,919 ecosystem credits will be retired within the alignment and borrow pits respectively to offset impacts to this TEC, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines. This aligns with the high value PCT 35.
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	At total of up to 4.6 ha of this vegetation community will be removed as part of the proposal	71 ecosystem credits will be retired for impacts on this TEC within Borrow pit 1, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines
Poplar box grassy woodland on alluvial plains	A total of up to 232.2 ha of this vegetation community will be removed as part of the proposal	2,213 and 1,188 ecosystem credits will be retired within the alignment and borrow pits respectively to offset impacts to this TEC, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines.
Species-credit species	**These credits are based on assumed presence over all potential habitats**	
Belson's panic *(Homopholis belsonii)*	A total of up to 389 ha of potential habitat will be removed as part of the proposal.	6,330 and 3,536 species credits will be retired to offset impacts to this species for the alignment and borrow pits respectively, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines.
Bluegrass *(Dichanthium setosum)*	A total of up 288.46 ha of potential habitat will be removed as part of the proposal.	2,940 and 3,649 species credits will be retired to offset impacts to this species for the alignment and borrow pits respectively, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines.
Slender darling pea *(Swainsona murrayana)*	A total of up to 401 ha of potential habitat will be removed as part of the proposal.	7,173 and 1,009 species credits will be retired to offset impacts to this species for the alignment and borrow pits respectively, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines.
Slender tylophora *(Tylophora linearis)*	A total of up to 46.29 ha of potential habitat will be removed as part of the proposal	1,076 species credits will be retired to offset impacts to this species within the borrow pits, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines.

Matter	Proposal impact (BAM)	Like-for-like Offset in accordance with BAM guidelines
Winged peppercress *(Lepidium monoplocoides)*	A total of up to 127.99 ha of potential habitat will be removed as part of the proposal.	3,819 species credits will be retired to offset impacts to this species within the alignment, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines
Border thick-tailed gecko (*Uvidicolus sphyrurus*)	A total of up to 30.8 ha of potential habitat will be removed as part of the proposal.	839 species credits will be retired to offset impacts to this species within the borrow pits, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines
Koala *(Phascolarctos cinereus)*	A total of up to 17.12 ha of potential habitat will be removed as part of the proposal.	31 species credits will be retired to offset impacts to this species for the alignment, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines.
Large-eared pied bat *Chalinolobus dwyeri*	A total of up to 3 ha of potential habitat will be removed as part of the proposal.	188 species credits will be retired to offset impacts to this species for Borrow pit 1, if used, in accordance with the Programme Biodiversity Offset Strategy and the BAM guidelines
Ecosystem-credit Species	**These credits are based on habitat values found within a PCT where that species is considered reliably likely to occur; as such no individual credits are assigned to each species. Relevant PCTs are listed below**	
Australasian bittern *(Botaurus poiciloptilus)*	36,39,53,247	Combined PCT values refer Appendix G
Swift parrot (*Lathamus discolor)*	36,39,55,56,98,247	Combined PCT values refer Appendix G
Spotted-tailed quoll *(Dasyurus maculatus)*	36,192,244,628	Combined PCT values refer Appendix G
Corben's long-eared Bat (*Nyctophilus corbeni*)	35,36,55,56,98,192,244,247	Combined PCT values refer Appendix G
Five-clawed worm-skink (*Anomalopus mackayi)*	39,53	Combined PCT values refer Appendix G
Painted honeyeater *(Grantiella picta)*	35,36,55,56,98,192,244,247	Combined PCT values refer Appendix G
Superb parrot (*Polytelis swainsonii)*	35,36,52,56,98,244,	Combined PCT values refer Appendix G
Grey-headed flying-fox *(Pteropus poliocephalus)*	35,36,56,147,244,628	Combined PCT values refer Appendix G
Squatter pigeon *Geophaps scripta scripta*	None	Not present on site

6.4 Key threatening processes

There are 37 terrestrial Key Threatening Processes (KTPs) listed under the BC Act and 15 under the EPBC Act. Table 6-8 lists each these threatening processes and their applicability to the proposal.

Table 6-8 Key threatening processes and their applicability to the proposal

Key threatening process	BC Act/EPBC Act/ FM Act	Applicable	Comments
Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy miners (*Manorina melanocephala*)	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP. The Noisy miner is already ubiquitous across the landscape in degraded and fragmented woodland and forest habitats
Alteration of habitat following subsidence due to longwall mining	BC Act	No	The proposal is not considered likely to trigger this KTP
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	BC Act	Yes	Design considerations to reduce any impact on flow regimes are part of the detailed design process. Mitigation measures are outlined in Section 5.3
Anthropogenic climate change	BC and EPBC	No	The proposal is not considered likely to trigger this KTP
Bushrock removal	BC Act	Yes	The proposal will trigger to trigger this KTP should Borrow pit 1 or 2 be developed as part of the proposal.
Clearing of native vegetation	BA and EPBC Act	Yes	The detailed design will determine the final area of native vegetation to be cleared. Section 6 discusses the impacts of native vegetation clearing as a result of the proposal.
Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*)	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP
Competition and habitat degradation by Feral goats (*Capra hircus*)	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP
Competition from feral honey bees (*Apis mellifera*)	BC Act	No	The proposal is not considered likely to trigger this KTP
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners (*Manorina melanophrys*)	BC Act	No	The proposal is not considered likely to trigger this KTP
Habitat degradation and loss by Feral horses (*Equus caballus*)	BC Act	No	The proposal is not considered likely to trigger this KTP
Herbivory and environmental degradation caused by feral deer	BC Act	No	The proposal is not considered likely to trigger this KTP
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	BC Act	No	The proposal is not considered likely to trigger this KTP
Importation of Red Imported Fire Ants (*Solenopsis invicta*)	BC and EPBC	Possible	The proposal is not considered likely to trigger this KTP. Mitigation measures outlined in Section 5.3 including vehicle and soil hygiene will reduce the risks associated with the KTP.

Key threatening process	BC Act/EPBC Act/ FM Act	Applicable	Comments
Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations	BC Act	No	The proposal is not considered likely to trigger this KTP
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP.
Infection of native plants by *Phytophthora cinnamomi*	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP. Fill material will be locally sourced. *P. cinnamomi* is not known to the local area
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	BC Act	No	The proposal is not considered likely to trigger this KTP
Introduction of the Large Earth Bumblebee (*Bombus terrestris*)	BC Act	No	The proposal is not considered likely to trigger this KTP
Invasion and establishment of exotic vines and scramblers	BC Act	No	The proposal is not considered likely to trigger this KTP. Where exotic vines already occur within the subject land mitigation measures around the control of weeds will be designed to reduce this risk.
Invasion and establishment of Scotch Broom (*Cytisus scoparius*)	BC Act	No	The proposal is not considered likely to trigger this KTP
Invasion and establishment of the Cane Toad (*Bufo marinus*)	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP as the successful expansion of the species is restricted to their natural climatic ranges.
Invasion of native plant communities by African Olive (*Olea europaea* subsp. *cuspidate*)	BC Act	No	The proposal is not considered likely to trigger this KTP
Invasion of native plant communities by Chrysanthemoides monilifera	BC Act	No	The proposal is not considered likely to trigger this KTP
Invasion of native plant communities by exotic perennial grasses	BC Act	Potential	There are large patches on introduced grasses within and adjacent to the proposed works. The mitigation measures outlined in Section 5.3 will be further developed to address this issue.
Invasion of the Yellow Crazy Ant (*Anoplolepis gracilipes*) into NSW	BC Act	No	The proposal is not considered likely to trigger this KTP
Invasion, establishment and spread of Lantana (*Lantana camara*)	BC Act	Potential	While not recorded within the proposal area Lantana is known to colonise disturbed areas. Mitigation measures outlined in Section 5.3 including vehicle wash down will help reduce the risks associated with this KTP
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	BC and EPBC Act	Potential	There are several invasive weed species currently recorded within the proposal area. The mitigation measures outlined in Section 6.5 will help reduce the risk associated with this KTP

Key threatening process	BC Act/EPBC Act/ FM Act	Applicable	Comments
Loss of Hollow-bearing Trees	BC Act	Yes	The subject land extended out to 500 m from the proposed centreline and areas within the borrow pits. Many known HBTs occur within this area. The mitigation measures outlined in Section 5.3 will help reduce the risk associated with this KTP.
Loss or degradation (or both) of sites used for hill-topping by butterflies	BC Act	No	The proposal is not considered likely to trigger this KTP
Predation and hybridisation by Feral Dogs, Canis lupus familiaris	BC Act	No	The proposal is not considered likely to trigger this KTP
Predation by *Gambusia holbrooki* Girard, 1859 (Plague Minnow or Mosquito Fish)	BC Act	No	The proposal is not considered likely to trigger this KTP
Predation by the European Red Fox *Vulpes vulpes* (Linnaeus 1758)	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP
Predation by the Feral Cat *Felis catus* (Linnaeus 1758)	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP
Predation by the Ship Rat *Rattus rattus* on Lord Howe Island	BC Act	No	The proposal is not considered likely to trigger this KTP
Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa*	BC and EPBC Act	No	The proposal is not considered likely to trigger this KTP
Removal of dead wood and dead trees	BC Act	Yes	The removal of native vegetation within the final footprint is likely to trigger this KTP. Mitigation measures outlined in Section 5.3 including restoration of habitat will help to address this issue
Invasion of northern Australia by Gamba Grass and other introduced grasses	EPBC Act	No	The proposal is not located within northern Australia
Novel biota and their impact on biodiversity	EPBC Act	Potential	The proposal does not involve the introduction of novel biota into Australia. Mitigation measures around weed and pest management as outlined in Section 5.3 will assist in reducing this risk.

7 Significant Impact Assessment Methodology outside of the Biodiversity Assessment Method

7.1 Introduction

The Significant Impact Assessment Methodology (SIAM) provides a framework for the assessment of impacts to terrestrial ecological receptors regulated by the EPBC Act.

An overview of the stages involved in the assessment methodology and modelling employed for receptors regulated by the EPBC Act is provided graphically in Figure 7.1. A brief description of the modelling used as part of the identification of terrestrial ecological constraints is provided below. Further information regarding the development of these models is provided in Appendices I and Appendix J. Representatives from Future Freight Joint Venture (FFJV) and ARTC met with the representatives from the Department of the Environment and Energy (DoEE) (currently DAWE) and the Office of Environment and Heritage (OEH) (currently DPIE) on 21 September 2018 to discuss the proposed approach to impact assessment. Representatives from the Commonwealth and State Government Departments were present at this meeting. To increase the validity of the predictive habitat mapping approach (refer Section 7.1.1), targeted field surveys at defined locations (refer Section 3.4) in addition to opportunistic site investigations associated with pre-clearance work for geotechnical investigators were used to supplement desktop-based datasets and validate predictive, species specific mapping for target threatened species.

For the purposes of this technical report, modelling was used to identify, map and provide a direct input into the significance assessment of potential impacts to ecological receptors. Modelling utilised existing datasets applicable to ecological receptors and as well as field derived data from both targeted investigations (refer Section 3.4) and those associated with geotechnical flora/fauna investigations to feed data back into the model to increase its robustness and accuracy. Two distinct stages in the modelling process were undertaken as follows:

- Predictive habitat and TEC modelling methodology (refer Section 7.1.1). This modelling was used to identify constraints through predictive modelling which incorporated site derived datasets where available.
- Adverse Impacts Assessment Methodology (AIAM) model (refer Section 7.1.3). This model was used following the initial assessment of proposal impacts, to identify areas where the proposal is considered likely to have a significant residual adverse impact upon EPBC Act listed species that are not BC Act listed species (and associated habitat). The AIAM has been designed to provide for a transparent, consistent, repeatable and defendable approach to assessing significant adverse residual impacts. Information inputs are sourced from published, peer-reviewed scientific literature, field validated data and expert opinion.

Each of these stages were intrinsically linked (i.e. the predictive habitat and TEC modelling), following field validation and the incorporation of field-based datasets associated with this present investigation, was one of the inputs into the AIAM, which in turn, quantified the potential impacts upon significant receptors. The interaction of each stage of the modelling process and the model outputs are represented schematically Figure 7.1. This approach was also applied to the assessment of threatened species, communities and populations listed under the FM Act. The methodology was developed and applied following consultation with DPIE (formerly OEH) in 2018 and again in 2020.

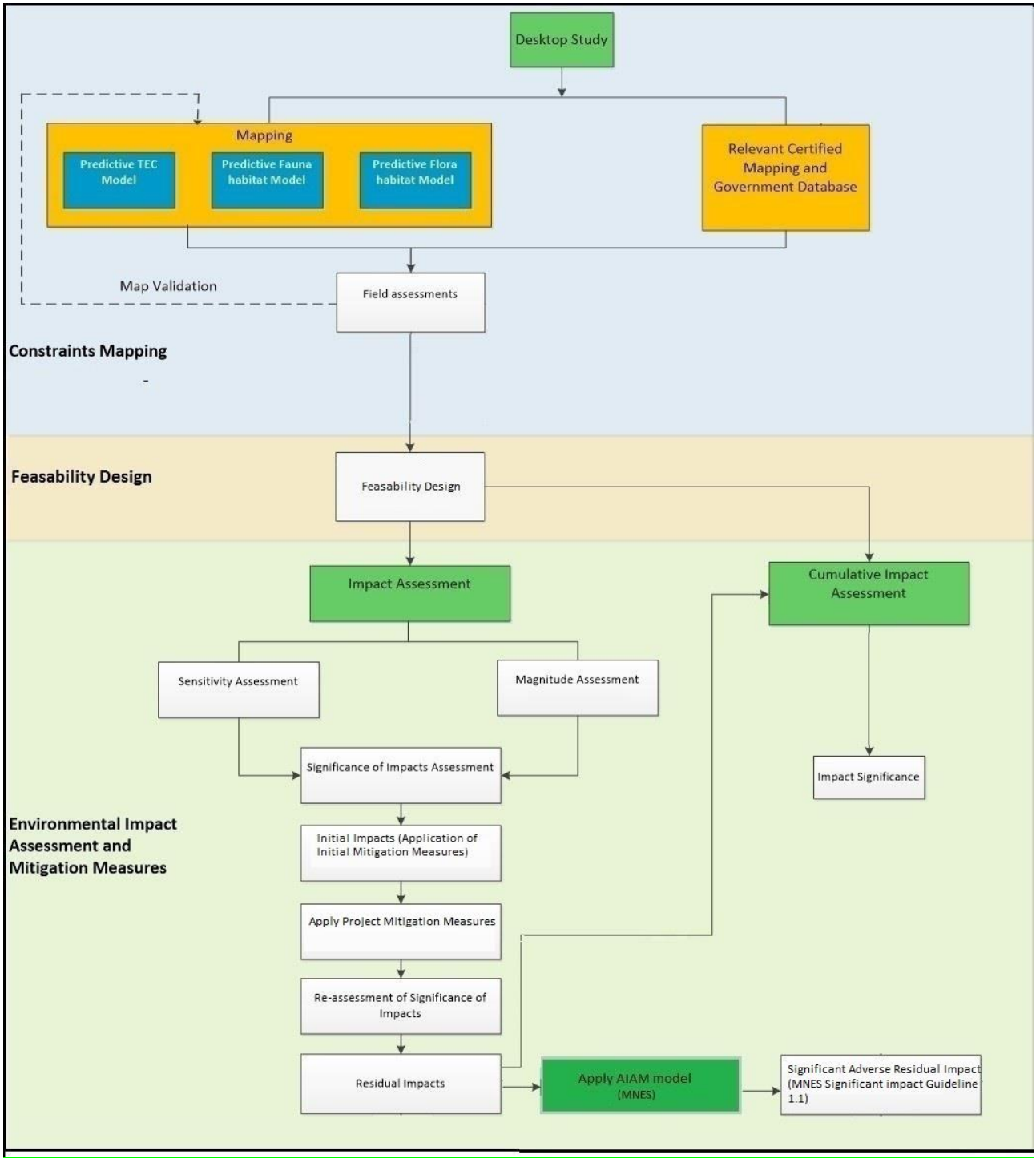

Figure 7.1 **Significant impact assessment methodology for receptors outside of the Biodiversity Assessment Method**

7.1.1 Predictive habitat modelling

7.1.1.1 Predictive threatened ecological community modelling

The TEC model for EPBC Act listed communities was produced following a review of existing government databases and assessment of the conservation listing advice for each TEC considered to potentially occur within the subject land. Assumptions associated with the development of the TEC model are outlined in Appendix A. A predictive TEC map was created in GIS from the predictive TEC model in order to provide increased resolution to satisfy the matters of the EIS SEAR (refer Appendix I).

TECs were identified by extrapolation using DotEE conservation listing advice contained on the Species Profile and Threats Database (SPRAT), for each TEC identified during the desktop review phase. Analogous vegetation communities (i.e. PCTs) as mapped on the NSW State Vegetation Type Map were identified which were then used to spatially map out the extent of each of the identified TECs. Identified TECs and the analogous PCTs used to map each of the TECs as stipulated by the SPRAT is presented in Table 7-1. Where field investigations had identified/conformed/rejected the presence of the TEC, this was incorporated into the mapping.

Table 7-1 EPBC Act listed threatened ecological community assumptions used to map areas of occurrence within the impact assessment area

TEC name	EPBC Act status	Habitat requirements for analogous PCTs
Weeping myall woodland	Endangered	The following High and Medium condition PCTs are considered to be General habitat: 26, 27, when ≥ 0.5 ha
Brigalow (*Acacia harpophylla*) dominant and co-dominant)	Endangered	The following High and Medium condition PCTs are considered to be General habitat: 35, 445, 629, when ≥0.5 ha
Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland	Critically endangered	The following High and Medium condition PCTs are considered to be General habitat: 52, 102, 250, 320, 460, 484, 619, 633, 710, 795, 796, 799, 800, 1076, 1179, 1324, 1698, when ≥0.5 ha
Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	The following High and Medium condition PCTs are considered to be General habitat: 37, 39, 40, when ≥5 ha
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	The following High and Medium condition PCT is considered to be General habitat: 147
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	The following High and Medium condition PCTs are considered to be General habitat: 56, 87, 101, 244, when ≥ 1 ha
White-box – Yellow box – Blakely's red gum grassy woodland and derived native grassland	Critically endangered	The following High and Medium condition PCTs are considered to be General habitat: 382, 702 when ≥0.1 ha

7.1.1.2 Predictive habitat modelling for threatened flora and fauna

Predictive habitat modelling was undertaken to identify and map areas that were identified as having the potential to provide habitat for threatened species in accordance with the NS2B SEAR.

State based GIS base layers datasets used as habitat delineators, were incorporated into the predictive habitat model where applicable for each species. This included PCT mapping, perennial waterways, natural drainage lines and areas prone to inundation. The model was designed to recognise specific requirements of each conservation significant species, which were identified through the broader desktop analysis. This approach to habitat mapping represents a highly conservative methodology (i.e. where doubt exists, habitat is included rather than excluded) so as not to underestimate potential habitat for threatened species.

Databases (including data from recovery plans where available) and other information that were used to feed into the predictive GIS based model are identified in Section 3.3. In addition to database information, data collected during field-based assessments (refer Section 3.4) was used to verify and "fine-tune" model outputs (refer Figure 7.1). To adequately capture known records of threatened species (e.g. historic records and those identified during field assessment), all areas (regardless of existing vegetation communities) within a 1 km radius of the record were "automatically" assigned as habitat for the specific species to which the record belonged. This distance adequately accounts for the potential movement and dispersal for the relevant species and would also mitigate potential issues associated with record precision.

The habitat in the predictive threatened species habitat model was categorised as core, essential and general using current scientific knowledge and pre-existing data derived from historic surveys, state based mapping and scientific publications and industry recognised experts. The specific habitat assumptions for each species are provided in Appendix I (Appendix A: Species and Communities Profiles).

The predictive habitat modelling provides greater certainty in predicting the likelihood of a threatened flora and fauna species (EPBC Act) occurring with the subject land, when compared to limited and or sporadic field investigations, and is one of the inputs into the AIAM model used to quantify significant residual impacts from the project.

As part of the predictive fauna habitat modelling, species-specific assumptions allowed the following areas to be identified for each threatened species:

- Core habitat
- Essential habitat
- General habitat
- Unlikely habitat.

An overview of each of these categories is provided in the sections below.

Core habitat

Core habitat consists of essential habitat in which the species is known, and the habitat is recognised under relevant recovery plans or other relevant plans, policies and regulations (such as Species Recovery Plans or Approved Conservation Advice for EPBC Act species (refer Appendix I). Where essential habitat intersects with any identified areas, these areas have been elevated to the core habitat category. Species specific assumptions associated with the mapping of core habitat areas are detailed in Appendix I.

Essential habitat

Essential habitat consists of areas containing resources that are considered essential for the maintenance of populations of the species (e.g. potential habitat for breeding, roosting, foraging, shelter) or areas that have been confirmed as containing suitable habitat as identified by a specimen backed record or indirect evidence of the species (i.e. scat, trace, track, fur/feather, distinctive vocalisation or other site based evidence). Essential habitat has been defined from known records (Post 1980), generally with a 1 km buffer or site-based observation of the species during site investigations. In addition, if the 1 km buffer from the known record intersects an area identified as general habitat the general habitat rating was elevated to essential habitat. Species specific assumptions associated with the mapping of essential habitat are detailed in Appendix A.

General habitat

General habitat consisted of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present from a desktop perspective). General habitat also includes habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. General habitat may include areas of suboptimal habitat for species. As potential habitat for many species may include most of the plant community types (PCTs) of the specific bioregion, the general habitat category restricts the habitat to a more limited and realistic set of environmental parameters which are supported by literature and field-based observation. Species specific assumptions that define the general habitat category are identified in Appendix A.

Unlikely habitat

Unlikely habitat consisted of areas that do not contain specimen backed records of the particular species (i.e. no point data derived from the positive identification/confirmation of a species in the field) and contain no evidence of habitat values to support the presence or existence of resident individuals or populations of the species.

7.1.2 Initial significant Impact Assessment

The terrestrial impact assessment for the MNES terrestrial ecological receptors of the proposal, that are listed under the EPBC Act, uses a significance-based impact assessment framework to identify and assess proposal related impacts in relation to ecological receptors.

For the purpose of assessment, the relevant receptors were assessed qualitatively, informed by a quantitative assessment of magnitude. A significant impact depends upon the sensitivity of an ecological value, the quality of the environment which is impacted, and upon the intensity, duration, magnitude and potential spatial extent of the potential impacts. Determination of the sensitivity or vulnerability of the ecological receptor and the magnitude of the potential impacts facilitate the assessment of the significance of potential ecological impacts. The sections below discuss and define impact magnitudes, ecological receptor sensitivity and impact significance.

Magnitude of impacts

The magnitude of a potential impact informs the determination of its level of significance on receptors. For the purposes of this assessment, impact magnitude is defined as being comprised of the nature and extent of the potential impacts, including direct and indirect impacts. The magnitude of disturbance is assessed in the context of the extent of the relevant ecological receptor in the local area (i.e. within a 1km buffer of the alignment centreline). The impact magnitude is divided into five categories (refer Table 7-2). The magnitude of impacts is determined using techniques and tools (i.e. GIS) that facilitate an estimation of the **extent**, **duration** (refer Table 7-3) and **frequenc**y of the impacts.

Table 7-2 Criteria for magnitude

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the ecological receptor. Avoidance through appropriate design responses or the implementation of environmental management controls are required to address the impact (e.g. greater than 50% of the habitat within the greater area disturbed).
High	An impact that is widespread, long lasting and results in substantial and possibly irreversible change to the ecological receptor. Avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact (e.g. between 13-50% of the habitat within the greater area disturbed).
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the proposal is being developed. The impacts are short term and result in changes that can be ameliorated with specific environmental management controls (e.g. between 2-13% of the habitat within the greater area disturbed).
Low	A localised impact that is temporary or short term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls (e.g. between 1-2% of the habitat within the greater area disturbed).
Negligible	An extremely localised impact that is barely discernible and is effectively mitigated through standard environmental management controls (e.g. less than 1% of the habitat within the greater area disturbed).

Table 7-3 Timeframes for duration terms

Duration term	Timeframe – to be defined for each activity type
Temporary	Days to months (e.g. 1 to 2 seasons; 3 to 6 months)
Short term	Up to 2 years (i.e. 6 to 24 months)
Medium term	From 2 to 10 years[1]
Long-term/long lasting	From 10 to 20 years[2]
Permanent or irreversible	More than 20 years[3]

Table notes:

1 Derived from the term 'moderate' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)
2 Derived from the term 'major' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)
3 Derived from the term 'catastrophic' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)

Sensitivity

To assess the significance of potential impacts on receptors, sensitivity categories are applied to each of the receptors. The sensitivity categories are split into five discrete groups as described in Table 7-4. These groupings are based on qualitative assessments utilising information related to the sensitivity of the ecological receptor, in addition to the potential of an ecological receptor's occurrence within the receiving environment.

Through the determination of sensitivity categories for each of the receptors, the receptors are then able to be assessed through a matrix against the magnitude of the potential proposal impact type to indicate the level of significance for each of the impact types on the receptors.

Receptors are treated individually. In the case where there are conflicting classes, the "worst-case" is assumed.

Table 7-4 Sensitivity criteria for ecological receptors within the subject land

Sensitivity	Description
Major	▪ The ecological receptor is listed on a recognised or statutory state, national or international register as being of conservation significance ▪ The ecological receptor is **entirely** intact and **wholly** retains its intrinsic value ▪ The ecological receptor is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, country or the world ▪ It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the ecological receptor. ▪ Proposal activities would have an adverse effect on the ecological receptor.
High	▪ The ecological receptor is listed on a recognised or statutory state, national or international register as being of conservation significance ▪ The ecological receptor is **relatively** intact and **largely** retains its intrinsic value ▪ The ecological receptor is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region ▪ The ecological receptor has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the ecological receptor. ▪ Proposal activities would have an adverse effect on the ecological receptor.
Moderate	▪ The ecological receptor is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers ▪ The ecological receptor is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements ▪ The ecological receptor is relatively well represented in the systems/areas in which it occurs but its abundance and distribution are exposed to threatening processes ▪ Threatening processes have reduced the ecological receptor's resilience to change. Consequently, changes resulting from proposal activities may lead to degradation of the ecological receptor ▪ Replacement of unavoidable losses is possible due to its abundance and distribution.

Sensitivity	Description
Low	▪ The ecological receptor is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations (e.g. historical societies) ▪ The ecological receptor is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value ▪ It is not unique or rare and numerous representative examples exist throughout the system/area ▪ It is abundant and widely distributed throughout the host systems/areas ▪ There is no detectable response to change or change does not result in further degradation of the ecological receptor ▪ The abundance and wide distribution of the ecological receptor ensures replacement of unavoidable losses is achievable.
Negligible	▪ The ecological receptor is not listed on any recognised or statutory register and is not recognised locally by relevant suitably qualified experts or organisations ▪ The ecological receptor is not unique or rare and numerous representative examples exist throughout the system/area ▪ There is no detectable response to change or change does not result in further degradation of the ecological receptor.

Significance of impact

The significance of a potential impact is a function of an impacted ecological receptors' **sensitivity** and the **magnitude** of the potential impact. Although the sensitivity of the ecological receptor will not change (i.e. is determined qualitatively by the interaction of the ecological receptor's condition, adaptive capacity and resilience), the **magnitude** of the potential impact is variable and may be categorised quantitatively to facilitate the prediction of the significance of the potential impact.

Once the ecological receptor has been identified, and the **sensitivity** of the ecological receptor and the **magnitude** of the potential impact have been determined, this will facilitate the assessment of the significance of the potential impact through use of a five by five matrix (refer Table 7-5).

Table 7-5 Significance assessment matrix

Magnitude of impact	Sensitivity				
	Major	High	Moderate	Low	Negligible
Major	Major	Major	High	Moderate	Low
High	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Low	Moderate	Moderate	Low	Negligible	Negligible
Negligible	Moderate	Low	Low	Negligible	Negligible

Table note:

Significance categories as identified in Table 7-5 are defined Table 7-6

Table 7-6 Significance classifications

Significance rating	Description
Major	Arises when an impact will potentially cause irreversible or widespread harm to an ecological receptor that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation. A post-mitigation rating of 'major' may constitute a potential significant residua adverse impact. In these instances, impacts were assessed using the AIAM to confirm impact significance (refer Section 7.5.1).
High	Occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the ecological receptor. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status. A post-mitigation rating of 'high' may constitute a significant residual adverse impact. In these instances, impacts were assessed using the AIAM to confirm impact significance (refer Section 7.5.1).

Significance rating	Description
Moderate	Results in degradation of the ecological receptor due to the scale of the impact or its susceptibility to further change even though it may be reasonably resilient to change. The abundance of the ecological receptor ensures it is adequately represented in the region, and that replacement, if required, is achievable. A post-mitigation rating of 'moderate' may constitute a significant residual adverse impact. In these instances, impacts were assessed using the AIAM to confirm impact significance (refer Section 7.5.1).
Low	Occurs where an ecological receptor is of local importance and temporary or transient changes will not adversely affect its viability provided standard environmental management controls are implemented.
Negligible	Does not result in any noticeable change and hence the proposed activities will have negligible effect on ecological receptors. This typically occurs where the activities are located in already disturbed areas.

Following the identification of the initial level of significance, additional mitigation measures were then applied to the initial impacts (incorporating design mitigation measures) to identify the residual (mitigated) impacts in a tabular form. The initial assessment of impacts was undertaken to identify which MNES may be subject to residual adverse impacts following mitigation. It is important to note that the initial impact assessment does not assess impacts against the MNES significant impact criteria and only considers direct impacts and not indirect impacts. Impacts that resulted in an initial significance rating of moderate or above, were then quantitatively processed using the AIAM to confirm the likelihood of significant impacts in accordance with the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DotE 2013). Impacts with a significance level of 'high' or 'major' were considered to constitute a significant residual impact. These impacts are offsettable under the MNES Offset Policy.

7.1.3 Adverse Impact Assessment Methodology

The EPBC Act Offsets Policy outlines the Commonwealth Government's approach to the use of offsets under the EPBC Act. The policy defines offsets as "measures that compensate for the residual adverse impacts of an action on the environment" (DSEWPaC 2012).

The purpose of the Adverse Impact Assessment Methodology (AIAM) is to identify areas within the proposal area where the proposal's activities will result in a significant residual adverse impact to MNES their associated habitat following initial proposal impact assessment (refer Figure 7.1). To identify these areas, an assessment ranking approach was used to develop an assessment matrix to provide a consistent, transparent and repeatable method by which the proposal's impacts to MNES could be ranked and reflected in a GIS model. The structure and implementation of the assessment ranking approach and assessment matrix were influenced by risk assessment theory and application. Table 7-7 details the incorporation of significant impact criteria, as per the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DotE 2013), into the assessment matrix for threatened species. Table 7-8 details the incorporation of significant impact criteria, as per the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DotE 2013), into the assessment matrix for TECs.

To ensure that the adversely impacted areas are captured, the assessment methodology assesses proposal impact to the target MNES at the time of disturbance, which is the point in which the greatest impact to MNES is anticipated (i.e. directly after habitat removal or modification) (refer Appendix J).

Further details regarding assessment via the AIAM is provided in Appendix J.

Table 7-7 Incorporation of significant impact criteria for threatened species

Significant impact criteria	Assessment matrix input (refer Appendix J for detailed methodology and AIAM questions identified below)
Lead to a long-term decrease in the size of a population	**Species resilience** (Q1 – Q12 of the AIAM) – Provides for assessment of the species capacity to recover from disturbance **Habitat suitability** – Provides for assessment on species important habitat **Landscape attributes** – Provides for reference to impacts on local fauna assemblages

Significant impact criteria	Assessment matrix input (refer Appendix J for detailed methodology and AIAM questions identified below)
Reduce the area of occupancy of the species	**Habitat suitability** – Accounts for species area of occupancy by reflecting the category of habitat present for the species (i.e. 'core', 'essential', 'general')
Fragment an existing important population into two or more populations	**Landscape attributes** – The connectivity assessment conducted as part of the landscape attribute assessment provides for assessment of potential proposal impact on fragmentation **Species resilience** (Q5 – Q6 of the AIAM) – Provides for assessment of the species capacity to colonise new areas and its reliance on habitat linkages
Adversely affect habitat critical to the survival of a species	**Species resilience** (Q1 – Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Habitat suitability** – Provides for assessment on species important habitat
Disrupt the breeding cycle of a population	**Species resilience** (Q8 of the AIAM) – Provides for assessment of species resilience to breeding cycle disruptions
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Species resilience** (Q1 – Q4 of the AIAM) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** - Provides for assessment of potential impacts on species habitat within proximity to the disturbance area by assessing proposal impacts on the size of habitat patch, connectivity and habitat availability.
Result in invasive species that are harmful to MNES species becoming established in the MNES species' habitat	**Species resilience** (Q10, Q12 of the AIAM) – Assesses proposal impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species
Introduce disease that may cause the species to decline	**Species resilience** (Q11 of the AIAM) – Assesses impact on disease prevalence and the species capacity to respond
Interfere with the recovery of the species	**Species resilience** (Q1 – Q12 of the AIAM) – Provides for assessment of the species capacity to recover from disturbance **Landscape attribute assessment** - Provides for assessment of the ability of the affected habitat patch to support the target species post disturbance
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	**Species resilience** (Q1 – Q4 of the AIAM) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attribute assessment** – Provides for assessment of potential impacts on regionally available habitat by assessing impacts on the size of habitat patch, connectivity and habitat availability
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Species resilience** (Q10, Q12 of the AIAM) – Assesses proposal impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	**Species resilience** (Q1 – Q9 of the AIAM) – Provides for assessment of species ability to disperse and its capacity to respond to disturbances to breeding and non-breeding habitat and resource fluctuations

Table 7-8 Incorporation of significant impact criteria for threatened ecological communities

Significant impact criteria	Assessment matrix input (refer Appendix J for detailed methodology and AIAM questions identified below)
Reduce the extent of an ecological community	**Habitat suitability** – Accounts for community's area of occupancy by reflecting the category of habitat present (i.e. 'general habitat') **TEC's resilience** (Q2) – Provides for assessment for a reduction in area as a result of the proposal
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**Landscape attributes** – The connectivity assessment conducted as part of the landscape attribute assessment provides for assessment of potential proposal impact on fragmentation **TEC's resilience** (Q5 – Q6) – Provides for assessment of the community's capacity to recolonise colonise following disturbance
Adversely affect habitat critical to the survival of an ecological community	**TEC's resilience** (Q1 – Q3) – Provides for assessment of community's capacity to respond to disturbances to habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Habitat suitability** – Provides for assessment on species important habitat
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	**TEC's resilience** (Q1 – Q3, Q5) – Provides for assessment of the community's capacity to respond to disturbances to habitat and resource availability **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing project impacts on the size of habitat patch, connectivity and habitat availability.
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	**TEC's resilience** (Q1, Q3, Q5, Q8) – Provides for assessment of proposal impact on change including weed invasion and habitat disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing proposal impacts on the size of habitat patch, connectivity and habitat availability. **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance habitat
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: (a) assisting invasive species, that are harmful to the listed ecological community, to become established, or (b) 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	**TEC's resilience** (Q1 – Q3, Q5, Q7, Q8) – Provides for assessment of species capacity to respond to disturbances to habitat and weed invasion/disease **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing proposal impacts on the size of habitat patch, connectivity and habitat availability. **Habitat suitability** – Provides for assessment on species important habitat
Interfere with the recovery of an ecological community	**TEC's resilience** (Q1, Q2, Q3, Q7, Q8) – Provides for assessment of community's capacity to respond to disturbances to habitat **Landscape attributes** – Provides for an provides for an assessment of the ability of the affected habitat patch to support the target community post disturbance.

7.2 Desktop assessment results – terrestrial flora and fauna

In addition to the SEARS, the results of the desktop assessed were used to identify terrestrial ecological receptors listed under the EPBC Act that may be impacted by the Project and inform the predictive habitat modelling process.

7.2.1 Threatened flora

A total of eight threatened flora species listed under provisions of the EPBC Act were identified as potentially occurring within the search area by database searches (refer Table 7-9). Of the eight species identified in databases, five are derived exclusively from the EPBC Act PMST (Australian Government 2018a) which is a predictive search tool that does not rely on specimen backed records. Six flora species are considered a likely or possible occurrence within the search area are subject to predictive habitat mapping and impact assessment under the SIAM (refer Section 7.3).

Two flora species, *Westringia parvifolia* and *Androcalva procumbens*, were considered unlikely occurrences due to the absence of suitable habitat and/or an absence of historical records in the region and are not considered further.

Table 7-9 Threatened flora species listed under the EPBC Act identified from database searches

Family	Species name	Common name	Conservation status		Data source	Likelihood of occurrence^
			BC Act	EPBC Act		
Poaceae	*Dichanthium setosum*	Bluegrass	V	V	BioNet, PMST, SEAR	Likely
Poaceae	*Homopholis belsonii*	Belson's panic	E	V	BioNet, PMST, SEAR	Possible
Surianaceae	*Cadellia pentastylis*	Ooline	V	V	PMST	Possible
Apocynaceae	*Tylophora linearis*	Slender tylophora	V	E	PMST, SEAR	Possible
Malvaceae	*Androcalva procumbens*	-	V	V	PMST	Unlikely, suitable habitat does not occur within or adjacent to the search area, and no records exists within the region
Fabaceae	*Swainsona murrayana*	Slender Darling-pea	V	V	PMST	Possible
Santalaceae	*Thesium australe*	Austral toadflax	V	V	PMST	Possible
Lamiaceae	*Westringia parvifolia*	-	-	V	PMST	Unlikely, suitable habitat does not occur within or adjacent to the search area

Table notes:

1 Listing under the *Biodiversity Conservation Act 2016* (New South Wales): E = Endangered; V = Vulnerable.
2 Listing under the *Environment Protection and Biodiversity Conservation Act 1999*: E = Endangered; V = Vulnerable.
- Species not listed or no common name
^ Further details regarding MNES likelihood of occurrence within the subject land and habitat descriptions are provided in Appendix A.

7.2.2 Threatened fauna

A total of 19 threatened fauna species listed under provisions of the EPBC Act were identified as potentially occurring within the search area by database searches (refer Table 7-10). Of the 19 species identified in database searches, 10 are derived exclusively from the EPBC Act PMST (Australian Government 2018a) which is a predictive search tool that does not rely on specimen backed records. One species, Australasian bittern (*Botaurus poiciloptilus*), was observed within the search area and therefor considered likely to occur. A total of 15 fauna species are considered a likely or possible occurrence within the search area are subject to predictive habitat mapping and impact assessment under the SIAM (refer Section 7.3).

Four species were considered unlikely occurrences due to the current distribution of the species and/or the absence of suitable habitat, including Squatter pigeon (*Geophaps scripta scripta*), Regent honeyeater (*Anthochaera phrygia*), Collared delma (*Delma torquata*), and Greater glider (*Petauroides volans*) and are not considered further.

Table 7-10 Threatened fauna species listed under the EPBC Act identified from database searches

Family	Species name	Common name	Conservation status		Data source	Likelihood of occurrence^
			BC Act	EPBC Act		
Accipitridae	*Erythrotriorchis radiatus*	Red goshawk	CE	V	PMST	Possible
Apodidae	*Hirundapus caudacutus*	White-throated needletail	-	V, M	BioNet, PMST	Likely, several historical records occur within the search area
Ardeidae	*Botaurus poiciloptilus*	Australasian bittern	E	E	PMST	Likely, recorded in the subject land
Columbidae	*Geophaps scripta scripta*	Squatter pigeon	CE	V	PMST, SEAR	Unlikely, study area is outside of the current known distribution for the species
Dasyuridae	*Dasyurus maculatus maculatus*	Spot-tailed quoll (Southeastern mainland population)	V	E	PMST	Possible
Elapidae	*Furina dunmalli*	Dunmall's snake	-	V	PMST, SEAR	Possible
Meliphagidae	*Anthochaera phrygia*	Regent honeyeater	CE	CE	PMST	Unlikely, suitable habitat does not occur within or adjacent to the study area
Meliphagidae	*Grantiella picta*	Painted honeyeater	V	V	BioNet, PMST, SEAR	Possible
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	V	BioNet, PMST, SEAR	Possible
Pteropodidae	*Pteropus poliocephalus*	Grey-headed flying-fox	V	V	PMST	Possible
Pygopodidae	*Delma torquatus*	Collared delma	-	V	PMST, SEAR	Unlikely, suitable habitat does not occur within or adjacent to the study area
Rostratulidae	*Rostratula australis*	Australian painted-snipe	E	E	PMST	Possible
Scincidae	*Anomalopus mackayi*	Five-clawed worm-skink	E	V	PMST, SEAR	Possible

Family	Species name	Common name	Conservation status		Data source	Likelihood of occurrence^
			BC Act	EPBC Act		
Scolopacidae	*Calidris ferruginea*	Curlew sandpiper	-	CE	PMST	Possible
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared pied bat	V	V	PMST, SEAR	Possible
Vespertilionidae	*Nyctophilus corbeni*	Corben's long-eared bat	V	V	PMST, SEAR	Possible
Psittacidae	*Lathamus discolor*	Swift parrot	E	CE	PMST	Possible
Petauridae	*Petauroides volans*	Greater glider	-	V	PMST	Unlikely, suitable habitat does not occur within or adjacent to the study area
Gekkonidae	*Uvidicolus sphyrurus*	Border thick-tailed gecko	V	V	PMST	Possible

Table notes:

1 Listing under the *Biodiversity Conservation Act 2016* (New South Wales): CE = Critically endangered; E = Endangered; V = Vulnerable.
2 Listing under the *Environment Protection and Biodiversity Conservation Act 1999*: CE = Critically endangered; E = Endangered; V = Vulnerable.
- Species not listed or no common name
^ Further details regarding MNES likelihood of occurrence within the subject land and habitat descriptions are provided in Appendix A.

7.2.3 Threatened ecological communities

A total of seven TECs identified under the provisions of the EPBC Act are were returned from the database interrogations (refer Table 7-11). These TECs have been identified exclusively from the EPBC Act PMST (Australian Government 2018a). All seven TECs are subject to predictive habitat mapping and impact assessment under the SIAM (refer Section 7.3).

Predictive mapping indicates that suitable habitat for White-box-Yellow box-Blakely's red gum grassy woodland and derived native grassland and Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TECs does not occur within the subject land. This was confirmed during site assessments and the TECs were not considered for further assessment as receptors.

Table 7-11 Threatened ecological communities (EPBC Act) identified in the Protected Matters Search Tool database search

Name	Status under the EPBC Act	Likelihood of occurrence
Brigalow (*Acacia harpophylla* dominant and co-dominant)	E	Known
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	E	Unlikely
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	CE	Known
Poplar Box Grassy Woodland on Alluvial Plains	E	Known
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	E	Known
Weeping Myall Woodlands	E	Known
White-box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	Unlikely

Table notes:

E = Endangered, CE = Critically endangered

7.2.4 Other matters of national environmental significance

World heritage properties

No world heritage properties were identified during database searches.

National heritage places

No national heritage places were identified during database searches.

Wetlands of international importance

Three wetlands of international importance were identified during database searches and are discussed in Section 4.1.2.2.

Great Barrier Reef Marine Park

No areas of the Great Barrier Reef Marine Park were identified during database searches.

Commonwealth Marine Area

No areas of a Commonwealth Marine Area were identified during database searches.

Critical habitat

No areas of critical habitat listed on the Register of Critical Habitat (EPBC Act) occurs within or adjacent to the study area.

7.3 Ecological values and receptors assessed under the Significant Impact Assessment Methodology

7.3.1 Ecological values

Consistent with the relevant legislation as stated in Section 2, the overarching ecological values adopted for the subject land for the proposal consisted of the following:

- NSW natural environmental and native flora, fauna and ecological communities
- Finite natural resources, including wetlands
- Land conducive to the maintenance of existing land forms, ecological health, biodiversity, riverine and wetland areas
- Biodiversity.

7.3.2 Ecological receptors

For threatened flora and fauna species regulated under the EPBC Act, predictive habitat mapping has been used to assess the species potential to occur within the subject land. In instances where species/communities did not have predicted habitat contained within the subject land, these species were not subject to impact assessment and were no longer considered to constitute receptors as the risk of impacts to any these species is considered low. The receptors identified for terrestrial ecology within the subject land are identified in Table 7-12 along with their assigned sensitivity value as determined by Table 7-4.

Table 7-12 EPBC Act listed ecological receptors assessed by the Significant Impact Assessment Methodology

Associated ecological value	Identified ecological receptors	Assigned sensitivity (refer Table 7-4)	Justification
▪ NSW natural environment and native flora and fauna ▪ Biodiversity	EPBC Act listed communities: ▪ Brigalow (*Acacia harpophylla* dominant and co-dominant) community ▪ Weeping Myall Open Woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions ▪ Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland ▪ Poplar Box Grassy Woodland on Alluvial Plains ▪ Semi-evergreen Vine Thickets of the Brigalow Belts (North and South) and the Nandewar Bioregions	High	▪ Conservation significant: protected by EPBC Act ▪ Relatively intact: TEC generally comprised of relatively good condition vegetation ▪ Unique to the environment: TECs are unique to the region ▪ Poorly represented in the region: the extent TECs in the region has been significantly reduced from their former extent ▪ Proposal activities would have an adverse impact on TECs: vegetation clearing within TECs would remove TECs
▪ Native flora and fauna ▪ Biodiversity	Threatened terrestrial flora and fauna species listed under the provisions of the EPBC Act (some species also BC Act listed): **Flora:** ▪ *Cadellia pentastylis* (Ooline) ▪ *Dichanthium setosum* (Bluegrass) ▪ *Homopholis belsonii* (Belson's panic) ▪ *Thesium australe* (Austral toadflax) ▪ *Tylophora linearis* (Slender tylophora) ▪ *Swainsona murrayana* (Slender Darling-pea) **Fauna:** ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Australian painted snipe (*Rostratula australis*) ▪ Border thick-tailed gecko (*Uvidicolus sphyrurus*) ▪ Curlew sandpiper (*Calidris ferruginea*) ▪ Dunmall's snake (*Furina dunmalli*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*) ▪ Koala (*Phascolarctos cinereus*) ▪ Large-eared pied bat (*Chalinolobus dwyeri*) ▪ Five-clawed worm-skink (*Anomalopus mackayi*) ▪ Painted honeyeater (*Grantiella picta*) ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Corben's long-eared bat (*Nyctophilus corbeni*) ▪ Spot-tailed quoll (*Dasyurus maculatus maculatus*) ▪ Swift parrot (*Lathamus discolor*) ▪ White-throated needletail (*Hirundapus caudacutus*)*	High	▪ Conservation significant: protected by EPBC Act ▪ Unique to the environment: species are unique to the region ▪ Poorly represented in the region: species are uncommon in the region ▪ Proposal activities would have an adverse impact on TECs: vegetation clearing within TECs would remove habitat for the species

Table note:

* Due to the aerial nature of White-throated needletail (*Hirundapus caudacutus*), impacts of the proposal on the species and its habitat are not considered to be significant. This species is not considered further in the SIAM assessment.

7.4 Impact assessment under the Significant Impact Assessment Methodology

7.4.1 Assessment and quantification of the magnitude of potential environmental impact to identified matters of national environmental significance

Estimation of the potential magnitude of disturbance was undertaken for each of the ecological receptors identified during the desktop and field components of the proposal (refer Table 7-12). This was achieved using predictive habitat modelling, which was supported by field validation, government GIS datasets and material gathered during the field component of the assessment. As described in Section 7.1.1, the predictive mapping outputs identified areas of general, essential and core habitat for each MNES including threatened flora and fauna, and TECs and is displayed in Appendix H.

In addition, the subject land was used to determining the initial disturbance area (including consideration of design mitigation measures) as a percentage of the extent of the ecological receptor within the broader proposal context (i.e. within a 1km buffer of the alignment centreline). The percentage was then used to determine relative disturbance magnitude as per the criteria presented in Table 7-2.

Calculated estimates of potential disturbance magnitudes for each of the ecological receptors is provided in Table 7-13.

Table 7-13 Estimation of potential magnitude of disturbance for each of the ecological receptors identified for the proposal

Ecological receptor	Total coverage of ecological receptor within the context area (1km buffer). Context area extent = 12783.38 ha	Total unmitigated potential disturbance area associated with the subject land. Subject land extent = 700.86 ha	Percentage (%) disturbance to receptors within the subject land based on the unmitigated potential disturbance	Magnitude of disturbance area (refer Table 7-2 for magnitude criteria)[#]
Threatened ecological communities (EPBC Act)				
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	665.50	41.98	6.31	Moderate
Brigalow (*Acacia harpophylla* dominant and co-dominant)	456.85	75.21	16.46	High
Weeping Myall Woodlands	32.16	0.03	0.09	Negligible
Poplar Box Grassy Woodland on Alluvial Plains	1505.51	119.48	7.94	Moderate
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	33.64	4.60	13.67	High
Threatened flora (EPBC Act)				
Dichanthium setosum (Bluegrass)	2951.24	282.22	9.56	Moderate
Homopholis belsonii (Belson's panic)	3404.65	389.24	11.43	Moderate
Tylophora linearis (Slender tylophora)	132.83	47.37	35.66	High
Cadellia pentastylis (Ooline)^	128.83	0.00	0.00	N/A
Swainsona murrayana (Slender Darling-pea)	3041.37	322.74	10.61	Moderate
Thesium australe (Austral toadflax)^	106.11	0.00	0.00	N/A

Ecological receptor	Total coverage of ecological receptor within the context area (1km buffer). Context area extent = 12783.38 ha	Total unmitigated potential disturbance area associated with the subject land. Subject land extent = 700.86 ha	Percentage (%) disturbance to receptors within the subject land based on the unmitigated potential disturbance	Magnitude of disturbance area (refer Table 7-2 for magnitude criteria)#
Threatened fauna (EPBC Act)				
Australasian bittern (*Botaurus poiciloptilus*)	3533.89	218.25	6.18	Moderate
Australian painted-snipe (*Rostratula australis*)	3478.57	192.89	5.55	Moderate
Border thick-tailed gecko (*Uvidicolus sphyrurus*)	194.68	67.18	34.51	High
Corben's long-eared bat (*Nyctophilus corbeni*)	3001.79	282.74	9.42	Moderate
Curlew sandpiper (*Calidris ferruginea*)	2977.18	91.96	3.09	Moderate
Dunmall's snake (*Furina dunmalli*)	459.29	75.39	16.42	High
Five-clawed worm-skink (*Anomalopus mackayi*)	3514.35	261.45	7.44	Moderate
Grey-headed flying-fox (*Pteropus poliocephalus*)	2662.68	277.87	9.91	Moderate
Koala (*Phascolarctos cinereus*)	2743.08	323.12	10.41	Moderate
Large-eared pied bat (*Chalinolobus dwyeri*)	357.15	71.79	20.10	High
Painted honeyeater (*Grantiella picta*)	3046.38	310.93	9.87	Moderate
Red goshawk (*Erythriorchis radiatus*)	61.23	4.03	6.57	Moderate
Spot-tailed quoll (Southeastern mainland population) (*Dasyurus maculatus maculatus*)	24.15	1.15	4.78	Moderate
Swift parrot (*Lathamus discolor*)	386.14	63.64	16.48	High

Table notes:

* There is potential for each of the ecological receptor impacts to overlap spatially. As a result, addition of disturbance values presented in the above table would not represent a true reflection of the total disturbance footprint.

\# Ecological receptors that recorded a magnitude of "N/A" were not subject to an assessment of impact significance (refer Section 7.4.2) as the ecological receptor was not subject to impacts.

^ Predictive habitat modelling predicted 0 ha of habitat for *Cadellia pentastylis* and *Thesium australe* within the subject land and was therefore no longer considered an ecological receptor within this technical report

7.4.2 Initial significance of potential impacts

The initial significance of impacts resulting from initial mitigation measures presented in Table 5-2 were determined for each phase of the proposal for the identified ecological receptors presented in Table 7-13 (except those with a magnitude of N/A). Each ecological receptor's sensitivity was determined using the criteria presented in Table 7-4 and presented in Table 7-12. Sensitivity of the ecological receptor and the magnitude of potential impacts to the ecological receptor allowed calculation of significance of impact in accordance with Table 7-5.

Following the calculation of significance for the initial mitigation scenario (including the design mitigation measures), the proposal impact mitigation measures presented in Table 5-3 (*excluding the use of Offsets*) were then considered and the significance was then recalculated using the adjusted magnitude where applicable. The calculated significance of impacts is presented in Table 7-14. The initial magnitude of impacts used in Table 7-14, take into consideration those associated with direct impacts associated with the direct removal of habitat (refer Table 7-13) and also considers those impacts associated Air Quality, Surface water and Hydrology, Groundwater, and Noise and vibration.

The impacts to ecological receptors displayed below in Table 7-14 have been grouped by:

- Ecological receptor type (e.g. Commonwealth listed threatened species, Commonwealth listed TEC)
- Sensitivity (e.g. low, moderate, high)
- Magnitude of direct disturbance (refer to Table 7-13).

Using the information presented within Section 7.3 the significance of initial impacts were determined for each phase of the proposal for the identified ecological receptors presented in Table 7-13 (except those with a magnitude of N/A). The initial impact assessment incorporated the design mitigation measures. Following the calculation of significance for the initial impact scenario, the proposed additional mitigation measures (refer Section 5.3.3) were then considered and the significance was then recalculated using the adjusted magnitude where applicable. The calculated significance of impacts is presented in Table 7-14.

In addition to the mitigation measures presented in Section 5.3.3, rehabilitation works may also be an effective mitigation measure to minimise potential impacts. However, the potential significant residual adverse impacts are likely to require some level of offset.

Table 7-14 Initial significance impact assessment of the proposal upon identified ecological receptors

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
Commonwealth significant ecological constraint (community listed under the EPBC Act): ■ Brigalow (*Acacia harpophylla* dominant and co-dominant) ■ Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	High	Construction	■ Habitat loss from vegetation clearing/removal ■ Fauna species injury or mortality ■ Reduction in biological viability of soil to support plant growth due to soil compaction ■ Displacement of flora and fauna species from invasion of weed and pest species ■ Reduction in the connectivity of biodiversity corridors ■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Noise, dust and light impacts ■ Increase in waste (litter) ■ Erosion and sedimentation ■ Aquatic habitat degradation	Major	Major	■ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ■ Aquatic fauna (design and construction) ■ Weeds and pests (preconstruction and construction mitigation measures) ■ Erosion and sediment control (pre-construction and construction) ■ Riparian vegetation and aquatic habitats (construction) ■ Fauna passage (design and construction)	High	Major (refer to Section 7.5.1 for impact assessment under the AIAM as per the Significant Impact Guidelines Version 1.1 – MNES)
		Commissioning and reinstatement	■ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	■ Flora and fauna (design, preconstruction and construction proposed mitigation measures)	Negligible	Low

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
						▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction) ▪ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)		
		Operation	▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▪ Weeds and Pests (operation) ▪ Riparian vegetation and aquatic habitats (operation) ▪ Fauna passage (design and construction) ▪ Fauna fencing (design and construction)	Negligible	Low

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
Commonwealth significant ecological constraint (community listed under the EPBC Act): ■ Poplar box grassy woodland on alluvial plains ■ Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	High	Construction	■ Habitat loss from vegetation clearing/removal ■ Fauna species injury or mortality ■ Reduction in biological viability of soil to support plant growth due to soil compaction ■ Displacement of flora and fauna species from invasion of weed and pest species ■ Reduction in the connectivity of biodiversity corridors ■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Noise, dust and light impacts ■ Increase in waste (litter) ■ Erosion and sedimentation ■ Aquatic habitat degradation	High	Major	■ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ■ Weeds and pests (preconstruction and construction mitigation measures) ■ Erosion and sediment control (pre-construction and construction) ■ Riparian vegetation and aquatic habitats (construction)	Moderate	High (refer to Section 7.5.1 for impact assessment under the AIAM as per the Significant Impact Guidelines Version 1.1 – MNES)

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
		Commissioning and reinstatement	▪ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction) ▪ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	Low
		Operation	▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts ▪ Aquatic habitat degradation	Low	Moderate	▪ Weeds and Pests (operation) ▪ Riparian vegetation and aquatic habitats (operation) ▪ Fauna passage (design and construction) ▪ Fauna fencing (design and construction)	Negligible	Low

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
Commonwealth significant ecological constraint (community listed under the EPBC Act): ▪ Weeping myall woodlands	High	Construction	▪ Habitat loss from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Reduction in biological viability of soil to support plant growth due to soil compaction ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Reduction in the connectivity of biodiversity corridors ▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Noise, dust and light impacts ▪ Increase in waste (litter) ▪ Erosion and sedimentation ▪ Aquatic habitat degradation	Low	Moderate	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction)	Negligible	Low
		Commissioning and reinstatement	▪ Displacement of flora and fauna species from invasion of weed and pest species	Low	Moderate	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Weeds and pests (preconstruction and construction mitigation measures)	Negligible	Low

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
						▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction) ▪ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)		
		Operation	▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts ▪ Aquatic habitat degradation	Low	Moderate	▪ Weeds and Pests (operation) ▪ Riparian vegetation and aquatic habitats (operation) ▪ Fauna passage (design and construction) ▪ Fauna fencing (design and construction)	Negligible	Low
Commonwealth significant ecological constraint (species listed under the EPBC Act): **Flora:** ▪ *Tylophora linearis* **Fauna:** ▪ Border thick-tailed gecko (*Uvidicolus sphyrurus*) ▪ Dunmall's snake (*Furina dunmalli*) ▪ Large-eared pied bat (*Chalinolobus dwyeri*)	High	Construction	▪ Habitat loss from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Reduction in biological viability of soil to support plant growth due to soil compaction ▪ Displacement of flora and fauna species from invasion of weed and pest species	Major	Major	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Aquatic fauna (design and construction) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction)	High	Major (refer to Section 7.5.1 for impact assessment under the AIAM as per the Significant Impact Guidelines Version 1.1 – MNES)

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
▪ Swift parrot (*Lathamus discolor*)			▪ Reduction in the connectivity of biodiversity corridors ▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Noise, dust and light impacts ▪ Increase in waste (litter) ▪ Erosion and sedimentation ▪ Aquatic habitat degradation			▪ Riparian vegetation and aquatic habitats (construction) ▪ Fauna passage (design and construction) ▪ Fauna fencing (design and construction)		
		Commissioning and reinstatement	▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts	Low	Moderate	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (construction) ▪ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	Low

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
		Operation	▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts ▪ Aquatic habitat degradation	Low	Moderate	▪ Weeds and Pests (operations) ▪ Riparian vegetation and aquatic habitats (operations) ▪ Fauna fencing (operations) ▪ Fauna passage (design and construction)	Negligible	Low
Commonwealth significant ecological constraint (Species listed under the EPBC Act): **Flora:** ▪ *Dichanthium setosum* (Bluegrass) ▪ *Homopholis belsonii* (Belson's panic) ▪ *Swainsona murrayana* (Slender darling-pea) **Fauna:** ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Australian painted-snipe (*Rostratula australis*) ▪ Corben's long-eared bat (*Nyctophilus corbeni*) ▪ Curlew sandpiper (*Calidris ferruginea*) ▪ Five-clawed worm-skink (*Anomalopus mackayi*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*)	High	Construction	▪ Habitat loss from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Reduction in biological viability of soil to support plant growth due to soil compaction ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Reduction in the connectivity of biodiversity corridors ▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Noise, dust and light impacts ▪ Increase in waste (litter) ▪ Erosion and sedimentation	High	Major	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Aquatic fauna (design and construction) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction) ▪ Fauna passage (design and construction) ▪ Fauna fencing (design and construction)	Moderate	High (refer to Section 7.5.1 for impact assessment under the AIAM as per the Significant Impact Guidelines Version 1.1 – MNES)

Ecological receptor(s)	Sensitivity (refer Table 7-4)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 5-2)		Proposed additional mitigation measures to be applied (refer Table 5-3)	Residual significance following the application of proposal mitigation measures presented in Table 5-3[2]	
				Magnitude	Significance		Magnitude (refer Table 7-13)	Significance[3]
▪ Koala (*Phascolarctos cinereus*) ▪ Painted honeyeater (*Grantiella picta*) ▪ Red goshawk (*Erythriorchis radiatus*) ▪ Spot-tailed quoll (Southeastern mainland population) (*Dasyurus maculatus maculatus*)			▪ Aquatic habitat degradation					
		Commissioning and reinstatement	▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts	Low	Moderate	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (construction) ▪ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	Low
		Operation	▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts ▪ Aquatic habitat degradation	Low	Moderate	▪ Weeds and Pests (operations) ▪ Riparian vegetation and aquatic habitats (operations) ▪ Fauna fencing (operations) ▪ Fauna passage (design and construction)	Negligible	Low

Table notes:

1 Potential impacts to terrestrial and aquatic receptors in the above table are based upon those identified in Section 5.2.

2 The use of offsets has not been considered as a mitigation measure for the purposes of proposal mitigation for the assessment of potential impacts. Refer Section 7 for information related to the use of offset to compensate proposal related impact that are not sufficiently reduced in the above table.

3 In instances where the mitigated significance returns a rating of High or above, offsets may be an option to reduce the residual Environmental impacts in the long term. Offset for biodiversity values are discussed further in Section 7. Refer AIAM for MNES where a “High” significance rating occurs for MNES.

7.5 Adverse Impact Assessment Methodology results

7.5.1 Habitat disturbance areas for matters of national environmental significance following application of the Adverse Impact Assessment Methodology

Each receptor with a residual significance following the application of proposal mitigation measures of moderate or greater (refer Table 7-14) has been subject to an assessment of species and habitat resilience and the subsequent AIAM assessment process (refer Appendix I for the detailed assessment). From this the disturbance area of habitat for each MNES representing the significant residual adverse impact to the species and/or its habitat values was defined. The assessment process has the potential to reduce the area of significant residual adverse impact as compared to the overall area of identified impacts (refer Table 7-13). This data is presented in Table 7-15. It should be noted there is significant overlap of the habitat area present between many of the MNES considered present.

A 'significant impact' is defined as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts' (DotE 2013).

The assessment calculations presented in Table 7-15 are associated with direct impacts (i.e. vegetation clearing) within the subject land only and do not account for offsite impacts to adjacent suitable habitat or the resilience of the MNES outside of the subject land.

The EPBC Act Offsets Policy states: 'Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures. These remaining, unavoidable impacts are termed 'residual impacts'. Offsets will be required to compensate for the significant adverse residual impacts on MNES as a result of the proposal. The majority of these TECs and threatened species may be offset under the BAM. Three species, Curlew sandpiper (*Calidris ferruginea*), Dunmall's snake (*Furina dunmalli*) and Red goshawk (*Erythrotriorchis radiatus*), were not assessed under the BAM and may require offsets as required under the EPBC Act.

Table 7-15 Disturbance area that constitutes a significant adverse residual impact for MNES ecological receptors

MNES	Disturbance that constitutes a Significant Adverse Residual Impact upon habitat (ha) for MNES (supported by Appendix I)	% of total disturbance within the subject land that does not constitute a Significant Adverse Residual Impact upon habitat (ha) for MNES
Flora		
Dichanthium setosum (Bluegrass)	237.10	15.99
Homopholis belsonii (Belson's panic)	346.62	12.30
Swaisona murrayana (Slender Darling-pea)	280.76	14.95
Tylophora linearis (Slender tylophora)	47.37	0.00
Terrestrial fauna		
Australasian bittern (*Botaurus poiciloptilus*)	111.41	48.95
Australian painted-snipe (*Rostratula australis*)	88.68	54.03
Border thick-tailed gecko (*Uvidicolus sphyrurus*)	67.18	0.00
Corben's long-eared bat (*Nyctophilus corbeni*)	280.36	0.84
Curlew sandpiper (*Calidris ferruginea*)	37.01	59.75
Dunmall's snake (*Furina dunmalli*)	75.39	0.00

MNES	Disturbance that constitutes a Significant Adverse Residual Impact upon habitat (ha) for MNES (supported by Appendix I)	% of total disturbance within the subject land that does not constitute a Significant Adverse Residual Impact upon habitat (ha) for MNES
Five-clawed work-skink (*Anomalopus mackayi*)	219.47	16.06
Grey-headed flying fox (*Pteropus poliocephalus*)	263.93	5.02
Koala (*Phascolarctos cinereus*)	285.47	11.65
Large-eared pied bat (*Chalinolobus dwyeri*)	71.79	0.00
Painted honeyeater (*Grantiella picta*)	292.73	5.85
Red goshawk (*Erythrotriorchis radiatus*)	4.03	0.00
Spot-tailed quoll (*Dasyurus maculatus*)	1.15	0.00
Swift parrot (*Lathamus discolor*)	63.64	0.00
TECs		
Brigalow (*Acacia harpophylla* dominant and co-dominant)	75.21	0.00
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	41.98	0.00
Poplar box grassy woodland on alluvial plains	119.48	0.00
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	4.60	0.00

Table note:

* In many instances, overlap in the location of a significant residual adverse impact exists between MNES.

8 Cumulative impact assessment

Cumulative impacts were assessed using the methodology identified in 3.2.2, incorporating the projects identified in Table 3-3 and depicted in Figure 3.2.

The cumulative impacts of multiple projects occurring in the vicinity of the subject land will likely include the continued loss of biodiversity in the Brigalow Belt South bioregion. The major potential impacts identified as a result of the proposal are common to all projects throughout the region and are therefore cumulative in nature. Twelve projects have been identified which are either currently underway or are going through the EIS process, all of which will likely result in some extent of:

- Habitat loss from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species from invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light
- Increase in litter (waste)
- Erosion and sedimentation

Cumulative impacts range from short-term to long-term. The magnitude of impact to ecological receptors contained within the footprint of the projects occurring within the cumulative impact assessment area, based on bioregional and State extents, is provided in Table 8-1.

The results of the significance assessment of these cumulative impacts are presented in Table 8-2.

As a result of the proposal and other similar projects, cumulative impacts of high significance are predicted to occur. The following potential impacts are predicted to result in high impact significance to terrestrial ecological receptors:

- Habitat loss from vegetation clearing/removal
- Edge effects
- Habitat fragmentation
- Barrier effects
- Reduction in connectivity of biodiversity corridors.

These cumulative impacts of high significance are predicted to impact the following receptors:

- TECs (EPBC and BC)
- Threatened flora and fauna (EPBC and BC Acts)
- State significant landscape feature – Great Artesian Basin.

In general, potential impacts with the greatest duration and probability resulted in high impact significance, whilst the magnitude of potential impacts with high impact significance varied.

Mitigation strategies, including avoidance options, design considerations and proposal specific mitigation measures are provided in Section 5.3. Specific mitigation measures that avoid ecological receptors or reduce impacts to ecological receptors through scheduling or a reduction in the duration of works are most likely to reduce the significance of cumulative impacts.

Table 8-1 Magnitude rating and justification of cumulative impacts within the cumulative impact assessment area

Ecological receptor	Magnitude rating (1-3)	Justification for ranking
Brigalow (*Acacia harpophylla*) dominant and co-dominant) community (EPBC Act)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Weeping Myall Open Woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions (EPBC Act)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Poplar box grassy woodland on alluvial plains	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Semi-evergreen vine-thicket of the Brigalow Belt (North and South) and Nandewar Bioregions	3	▪ Proportion of overall cumulative project impacts is moderate ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Dichanthium setosum (Bluegrass)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Homopholis belsonii (Belson's panic)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Lepidium monoplocoides (Winged peppercress)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Swainsona murrayana (Slender darling pea)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Tylophora linearis (Slender tylophora)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Australasian bittern (*Botaurus poiciloptilus*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Australian painted snipe (*Rostratula australis*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Border thick-tailed gecko (*Underwoodisaurus sphyrurus*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Dunmall's snake (*Calidris ferruginea*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution

Ecological receptor	Magnitude rating (1-3)	Justification for ranking
Dunmall's snake (*Furina dunmalli*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Grey-headed flying fox (*Pteropus poliocephalus*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Koala (*Phascolarctos cinereus*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Large-eared pied bat (*Chalinolobus dwyeri*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Five-clawed worm-skink (*Anomalopus mackayi*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Painted honeyeater (*Grantiella picta*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Red goshawk (*Erythrotriorchis radiatus*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Corben's long-eared bat (*Nyctophilus corbeni*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Spot-tailed quoll (*Dasyurus maculatus maculatus*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Superb parrot (*Polytelis swainsonii*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Swift parrot (*Lathamus discolor*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (BC Act)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions (BC Act)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Semi-evergreen vine thickets in the Brigalow Belt and Nandewar Bioregions (BC Act)	3	▪ Proportion of overall cumulative project impacts is moderate ▪ Regional extent of receptor is small ▪ Cumulative projects within known distribution

Ecological receptor	Magnitude rating (1-3)	Justification for ranking
Cyperus conicus	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Desmodium campylocaulon (Creeping tick-trefoil)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Digitaria porrecta (Finger panic grass)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Diuris tricolor (Pine donkey orchid)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Phyllanthus maderaspatensis	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is low ▪ Cumulative projects within known distribution
Platyzoma microphyllum (Braid fern)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Polygala linariifolia (Native milkwort)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Pomaderris queenslandica (Scant pomaderris)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Swainsona sericea (Silky swainson-pea)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is low ▪ Cumulative projects within known distribution
Australian bustard (*Ardeotis australis*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Barking owl (*Ninox connivens*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Black-breasted buzzard (*Hamirostra melanosternon*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Black-chinned honeyeater (*Melithreptus gularis gularis*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Black-necked stork (*Ephippiorhynchus asiaticus*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Black-striped wallaby (*Macropus dorsalis*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Blue-billed duck (*Oxyura australis*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution

Ecological receptor	Magnitude rating (1-3)	Justification for ranking
Bristle-faced free-tailed bat (*Setirostris eleryi*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Brolga (*Grus rubicunda*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Brown treecreeper (*Climacteris picumnus victoriae*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Bush stone-curlew (*Burhinus grallarius*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Cotton-pygmy goose (*Nettapus coromandelianus*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Diamond firetail (*Stagonopleura guttata*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Dusky woodswallow (*Artamus cyanopterus cyanopterus*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Eastern cave bat (*Vespadelus troughtoni*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Eastern grass owl (*Tyto longimembris*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Eastern pygmy-possum (*Cercartetus nanus*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Flame robin (*Petroica phoenicea*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Flock bronzewing (*Phaps histronica*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Freckled duck (*Stictonetta naevosa*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Glossy black-cockatoo (*Calyptorhynchus lathami*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis)*	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution

Ecological receptor	Magnitude rating (1-3)	Justification for ranking
Grey falcon (*Falco hypoleucos*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Hooded robin (south-eastern form) (*Melanodryas cucullata cucullata*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Kultarr (*Antechinomys laniger*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Little eagle (*Hieraaetus morphnoides*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Little lorikeet (*Glossopsitta pusilla*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Little pied bat (*Chalinolobus picatus*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Magpie goose (*Anseranas semipalmata*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Major Mitchell's cockatoo (*Lophochroa leadbeateri*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Masked owl (*Tyto novaehollandiae*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Northern free-tailed bat (*Mormopterus lumsdenae*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Pale imperial hairstreak (*Jalmenus eubulus*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Pale-headed snake (*Hoplocephalus bitorquatus*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Pied honeyeater (*Certhionyx variegatus*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Red-tailed black-cockatoo (inland subspecies) (*Calyptorhynchus banksii samueli*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Rufous bettong (*Aepyprymnus rufescens*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Scarlet robin (*Petroica boodang*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution

Ecological receptor	Magnitude rating (1-3)	Justification for ranking
Speckled warbler (*Chthonicola sagittata*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Spotted harrier (*Circus assimilis*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Square-tailed kite (*Lophoictinia isura*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Squirrel glider (*Petaurus norfolcensis*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Stripe-faced dunnart (*Sminthopsis macroura*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Turquoise parrot (*Neophema pulchella*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Varied sittella (*Daphoenositta chrysoptera*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
White-bellied sea eagle (*Haliaeetus leucogaster*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
White-fronted chat (*Epthianura albifrons*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Woma (*Aspidites ramsayi*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*)	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Zigzag velvet gecko (*Amalosia rhombifer*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Western olive perchlet (*Ambassis agassizii*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
PCTs of High condition	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
PCTs of Medium condition	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
PCTs of Low condition	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution

Ecological receptor	Magnitude rating (1-3)	Justification for ranking
Great Artesian Basin	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Area/s of connectivity joining different areas of habitat that intersect with the subject land and the areas of habitat that are connected	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution
Patches of native woody and non-woody vegetation	1	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is large ▪ Cumulative projects within known distribution
Important and local wetlands	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is small ▪ Cumulative projects within known distribution
Waterways and riparian buffers	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of ecological receptor is moderate ▪ Cumulative projects within known distribution

Table 8-2 Significance assessment of cumulative impacts within the cumulative impact area

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth significant ecological constraint (community listed under the EPBC Act): ▪ Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	▪ Habitat loss from vegetation clearing/removal	3	3	3	3	12	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	3	3	12	High
	▪ Fauna species injury or mortality	1	1	3	3	8	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	3	3	8	Medium
	▪ Increase in litter (waste)	1	1	3	3	8	Medium
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	3	3	9	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	3	3	8	Medium
	▪ Erosion and sedimentation	1	2	3	3	9	Medium
	▪ Aquatic habitat degradation	1	1	3	3	8	Medium
Commonwealth significant ecological constraint (community listed under the EPBC Act): ▪ Brigalow (*Acacia harpophylla*) dominant and co-dominant) community ▪ Weeping Myall Open Woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions ▪ Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	▪ Habitat loss from vegetation clearing/removal	3	3	2	3	11	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	2	3	11	High
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium
	▪ Increase in litter (waste)	1	1	2	3	7	Medium
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	2	3	8	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
	▪ Erosion and sedimentation	1	2	2	3	8	Medium
	▪ Aquatic habitat degradation	1	1	2	3	7	Medium
Commonwealth significant ecological constraint (community listed under the EPBC Act): ▪ Poplar box woodland on alluvial plains	▪ Habitat loss from vegetation clearing/removal	3	3	1	3	10	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	1	3	10	High
	▪ Fauna species injury or mortality	1	1	1	3	6	Low
	▪ Noise, dust and light and contaminant disturbance	1	1	1	3	6	Low
	▪ Increase in litter (waste)	1	1	1	3	6	Low
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
	▪ Erosion and sedimentation	1	2	1	3	7	Medium
	▪ Aquatic habitat degradation	1	1	1	3	6	Low
	▪ Habitat loss from vegetation clearing/removal	3	3	2	3	11	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	2	3	11	High
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium
	▪ Increase in litter (waste)	1	1	2	3	7	Medium
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	2	3	8	Medium

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth significant ecological constraint (species listed under the EPBC Act) (some species also BC Act listed): **Flora**: ■ *Homopholis belsonii* (Belson's panic) ■ *Swainsona murrayana* (Slender Darling-pea) ■ *Tylophora linearis* **Fauna**: ■ Australasian bittern (*Botaurus poiciloptilus*) ■ Australian painted snipe (*Rostratula australis*) ■ Curlew sandpiper (*Calidris ferruginea*) ■ Dunmall's snake (*Furina dunmalli*) ■ Large-eared pied bat (*Chalinolobus dwyeri*) ■ Red goshawk (*Erythrotriorchis radiatus*) ■ Spot-tailed quoll (*Dasyurus maculatus maculatus*) ■ Superb parrot (*Polytelis swainsonii*) ■ Swift parrot (*Lathamus discolor)*	■ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium
	■ Erosion and sedimentation	1	2	2	3	8	Medium
	■ Aquatic habitat degradation	1	1	2	3	7	Medium

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth significant ecological constraint (species listed under the EPBC Act) (some species also BC Act listed): **Flora:** ■ *Dichanthium setosum* (Bluegrass) ■ *Lepidium monoplocoides* (Winged peppercress) **Fauna**: ■ Border thick-tailed gecko (*Uvidicolus sphryrurus*) ■ Grey-headed flying fox (*Pteropus poliocephalus*) ■ Koala (*Phascolarctos cinereus*) ■ Five-clawed worm-skink (*Anomalopus mackayi*) ■ Painted honeyeater (*Grantiella picta*) ■ Corben's long-eared bat (*Nyctophilus corbeni*)	■ Habitat loss from vegetation clearing/removal	3	3	1	3	10	High
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	3	3	1	3	10	High
	■ Fauna species injury or mortality	1	1	1	3	6	Low
	■ Noise, dust and light and contaminant disturbance	1	1	1	3	6	Low
	■ Increase in litter (waste)	1	1	1	3	6	Low
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	■ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
	■ Erosion and sedimentation	1	2	1	3	7	Medium
	■ Aquatic habitat degradation	1	1	1	3	6	Low
Threatened Ecological Communities (BC Act): ■ Semi-evergreen vine thickets in Brigalow Belt and Nandewar Bioregions	■ Habitat loss from vegetation clearing/removal	3	3	3	3	12	High
	■ Edge effects ■ Habitat fragmentation ■ Barrier effects ■ Reduction in connectivity of biodiversity corridors	3	3	3	3	12	High
	■ Fauna species injury or mortality	1	1	3	3	8	Medium
	■ Noise, dust and light and contaminant disturbance	1	1	3	3	8	Medium
	■ Increase in litter (waste)	1	1	3	3	8	Medium
	■ Reduction in biological viability of soil to support growth due to soil compaction	1	2	3	3	9	Medium

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
	▪ Displacement of species from invasion of weed and pest species	1	1	3	3	8	Medium
	▪ Erosion and sedimentation	1	2	3	3	9	Medium
	▪ Aquatic habitat degradation	1	1	3	3	8	Medium
Threatened Ecological Communities (BC Act): ▪ Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions ▪ Carbeen Open Forest Community in the Darling Riverine Plains and Brigalow Belt South Bioregions ▪ Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions ▪ The Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River	▪ Habitat loss from vegetation clearing/removal	3	3	2	3	11	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	2	3	11	High
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium
	▪ Increase in litter (waste)	1	1	2	3	7	Medium
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	2	3	8	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium
	▪ Erosion and sedimentation	1	2	2	3	8	Medium
	▪ Aquatic habitat degradation	1	1	2	3	7	Medium
Threatened terrestrial flora and fauna species listed under the provisions of the BC Act: **Flora:** ▪ *Cyperus conicus* ▪ *Desmodium campylocaulon* (Creeping tick-trefoil)	▪ Habitat loss from vegetation clearing/removal	3	3	2	3	11	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	2	3	11	High
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
▪ *Digitaria porrecta* (Finger panic grass) ▪ *Diuris tricolor* (Pine donkey orchid) ▪ *Phyllanthus maderaspatensis* ▪ *Platyzoma microphyllum* (Braid fern) ▪ *Pomaderris queenslandica* (Scant pomaderris) ▪ *Swainsona sericea* (Silky swainson-pea) **Terrestrial fauna:** ▪ Black-chinned honeyeater (*Melithreptus gularis gularis*) ▪ Black-necked stork (*Ephippiorhynchus asiaticus*) ▪ Black-tailed godwit (*Limosa limosa*) ▪ Border thick-tailed gecko (*Underwoodisaurus sphyrurus*) ▪ Bristle-faced free-tailed bat (*Setirostris eleryi*) ▪ Brown treecreeper (*Climacteris picumnus victoriae*) ▪ Cotton-pygmy goose (*Nettapus coromandelianus*) ▪ Eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) ▪ Eastern cave bat (*Vespadelus troughtoni*) ▪ Eastern grass owl (*Tyto longimembris*) ▪ Eastern pygmy-possum (*Cercartetus nanus*)	▪ Increase in litter (waste)	1	1	2	3	7	Medium
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	2	3	8	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium
	▪ Erosion and sedimentation	1	2	2	3	8	Medium
	▪ Aquatic habitat degradation	1	1	2	3	7	Medium

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
▪ Freckled duck (*Stictonetta naevosa*) ▪ Kultarr (*Antechinomys laniger*) ▪ Little lorikeet (*Glossopsitta pusilla*) ▪ Magpie goose (*Anseranas semipalmata*) ▪ Major Mitchell's cockatoo (*Lophochroa leadbeateri*) ▪ Pale imperial hairstreak (*Jalmenus eubulus*) ▪ Red-tailed black-cockatoo (inland subspecies) (*Calyptorhynchus banksii samueli*) ▪ Rufous bettong (*Aepyprymnus rufescens*) ▪ White-bellied sea eagle (*Haliaeetus leucogaster*) ▪ White-fronted chat (*Epthianura albifrons*) ▪ Woma (*Aspidites ramsayi*) ▪ Zigzag velvet gecko (*Amalosia rhombifer*)							
Threatened terrestrial flora and fauna species listed under the provisions of the BC Act: **Flora:** ▪ *Digitaria porrecta* (Finger panic grass) ▪ *Diuris tricolor* (Pine donkey orchid) ▪ *Polygala linariifolia* (Native milkwort)	▪ Habitat loss from vegetation clearing/removal	3	3	1	3	10	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	1	3	10	High
	▪ Fauna species injury or mortality	1	1	1	3	6	Low
	▪ Noise, dust and light and contaminant disturbance	1	1	1	3	6	Low
	▪ Increase in litter (waste)	1	1	1	3	6	Low

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
Fauna: ▪ Australian bustard (*Ardeotis australis*) ▪ Barking owl (*Ninox connivens*) ▪ Black-breasted buzzard (*Hamirostra melanosternon*) ▪ Brolga (*Grus rubicunda*) ▪ Bush stone-curlew (*Burhinus grallarius*) ▪ Diamond firetail (*Stagonopleura guttata*) ▪ Dusky woodswallow (*Artamus cyanopterus cyanopterus*) ▪ Flame robin (*Petroica phoenicea*) ▪ Flock bronzewing (*Phaps histronica*) ▪ Glossy black-cockatoo (*Calyptorhynchus lathami*) ▪ Grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis)* ▪ Grey falcon (*Falco hypoleucos*) ▪ Hooded robin (south-eastern form) *(Melanodryas cucullata cucullata*) ▪ Little eagle (*Hieraaetus morphnoides*) ▪ Little pied bat (*Chalinolobus picatus*) ▪ Masked owl (*Tyto novaehollandiae*) ▪ Northern free-tailed bat (*Mormopterus lumsdenae*)	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
	▪ Erosion and sedimentation	1	2	1	3	7	Medium
	▪ Aquatic habitat degradation	1	1	1	3	6	Low

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
▪ Pale-headed snake (*Hoplocephalus bitorquatus*) ▪ Pied honeyeater (*Certhionyx variegatus*) ▪ Scarlet robin (*Petroica boodang*) ▪ Speckled warbler (*Chthonicola sagittata*) ▪ Spotted harrier (*Circus assimilis*) ▪ Square-tailed kite (*Lophoictinia isura*) ▪ Squirrel glider (*Petaurus norfolcensis)* ▪ Stripe-faced dunnart (*Sminthopsis macroura*) ▪ Turquoise parrot (*Neophema pulchella*) ▪ Varied sittella (*Daphoenositta chrysoptera*) ▪ Yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*)							
State Significant Ecological Constraint - PCTs (BC Act): ▪ PCTs of high condition ▪ PCTs of moderate condition	▪ Habitat loss from vegetation clearing/removal	3	3	1	2	9	Medium
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	1	2	9	Medium
	▪ Fauna species injury or mortality	1	1	1	2	5	Low
	▪ Noise, dust and light and contaminant disturbance	1	1	1	2	5	Low
	▪ Increase in litter (waste)	1	1	1	2	5	Low
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
	▪ Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
	▪ Erosion and sedimentation	1	2	1	2	6	Low
	▪ Aquatic habitat degradation	1	1	1	2	5	Low
State Significant Ecological Constraint - PCTs (BC Act): ▪ PCTs of low condition	▪ Habitat loss from vegetation clearing/removal	3	3	1	1	8	Medium
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	1	1	8	Medium
	▪ Fauna species injury or mortality	1	1	1	1	4	Low
	▪ Noise, dust and light and contaminant disturbance	1	1	1	1	4	Low
	▪ Increase in litter (waste)	1	1	1	1	4	Low
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	▪ Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low
	▪ Erosion and sedimentation	1	2	1	1	5	Low
	▪ Aquatic habitat degradation	1	1	1	1	4	Low
State Significant Ecological Constraint - Landscape features (BC Act): ▪ Great Artesian Basin	▪ Habitat loss from vegetation clearing/removal	3	3	2	3	11	High
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	2	3	11	High
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium
	▪ Increase in litter (waste)	1	1	2	3	7	Medium

Ecological receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance (refer to Section 5.3 for mitigation strategies)
		Probability	Duration	Magnitude	Sensitivity		
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	2	3	8	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium
	▪ Erosion and sedimentation	1	2	2	3	8	Medium
	▪ Aquatic habitat degradation	1	1	2	3	7	Medium
State Significant Ecological Constraint - Landscape features (BC Act): ▪ Patches of native woody and non-woody vegetation ▪ Area/s of connectivity joining different areas of habitat that intersect with the subject land and the areas of habitat that are connected ▪ Waterways and riparian buffers ▪ Important and local wetlands	▪ Habitat loss from vegetation clearing/removal	3	3	1	2	9	Medium
	▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Reduction in connectivity of biodiversity corridors	3	3	1	2	9	Medium
	▪ Fauna species injury or mortality	1	1	1	2	5	Low
	▪ Noise, dust and light and contaminant disturbance	1	1	1	2	5	Low
	▪ Increase in litter (waste)	1	1	1	2	5	Low
	▪ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	▪ Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
	▪ Erosion and sedimentation	1	2	1	2	6	Low
	▪ Aquatic habitat degradation	1	1	1	2	5	Low

Table notes:

Table 3-4 defines the consequences of the impact significance ratings, as follows:

- **Low** (sum of relevance factors = 1 to 6): Negative impacts need to be managed by standard environmental management practices. Special approval conditions unlikely to be necessary. Monitoring to be part of general proposal monitoring program
- **Medium** (sum of relevance factors = 7 to 9): Mitigation measure likely to be necessary and specific management practices to be applied. Specific approval conditions are likely. Targeted monitoring program required
- **High** (sum of relevance factors = 10 to 12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Specific approval conditions required. Targeted monitoring program necessary

9 Biodiversity credit report

9.1 Biodiversity credit report

ARTC has, where possible, altered the proposal to avoid and minimise ecological impacts in the proposal planning phase as required under the BAM, and a range of impact mitigation strategies have been included in the proposal to mitigate the impact on receptors (refer Section 5.3). The proposal and its assessment is therefore consistent with the BAM. This includes further potential to reduce the impact footprint where possible during the detailed design phase.

Full Credit Calculator reports are included in Appendix G.

Together, ecosystem credits, species credits and paddock tree credits are referred to as 'biodiversity credits'. Table 9-1 provides a summary of the ecosystem and species-credits that require offsetting as a result of work that is within and relating to the alignment. Table 9-2 provides a summary of the ecosystem and species credits that required offsetting as a result of works within and relating to the borrow pits. Table 9-3 provides a summary of all ecosystem, species and paddock tree credits that require retirement as a result of this proposal.

Table 9-1 All credits generated within the alignment

IBRA Sub region	Area of impact (ha)	Ecosystem-credits	Species-credits	Paddock Tree credits	Total credits
Northern Basalts	117.5	2,590	23,168	1	**25,759**
Northern Outwash	66.4	1,059	6,654	0	**7,713**
Castlereagh-Barwon	142.6	4,106	24,514	1	**28,621**
TOTAL Alignment	**326.5**	**7,755**	**54,426**	**2**	**62,093**

Table 9-2 All credits generated within the Borrow pits

Borrow pit and IBRA Sub region	Area of impact (ha)	Ecosystem credits	Species credits	Total credits
Northern Basalts (NB)				
BP8	21.14	787	7,673	**8,460**
BP9	50.14	1,427	13,361	**14,788**
BP11	50.14	520	3,350	**3,870**
BP25	19.39	72	627	**699**
BP1	4.59	126	126	**252**
NB total	145.4	2,932	25,137	**28,069**
Northern Outwash (NO)				
BP5	20.12	293	1,128	**1,421**
BP7	47.29	1011	6,212	**7,223**
BP13	2.5	36	49	**85**
BP26	5.43	129	818	**947**
BP2	18.47	223	1,415	**1,638**
NO total	93.81	1,692	9,622	**11,314**
TOTAL Borrow pits	**239.21**	**4,624**	**34,759**	**39,383**

Table 9-3 Total of all credits generated for the proposal

IBRA Sub region	Ecosystem credits	Species credits	Paddock tree credits	Total credits
Northern Basalts	5,522	48,305	1	53,828
Northern Outwash	2,751	16,186	0	19,027
Castlereagh-Barwon	4,106	24,514	1	28,621
Combined impacts	**12,379**	**89,005**	**2**	**101,476**

The information above is based on the assumption of assumed presence of all ecosystem and species credit species which have not undergone targeted survey within BAM specified months. The exceptions to this are Shrub Sida, Yetman Wattle, Sloane's froglet, Squatter pigeon and specific areas, containing habitat constraints, as outlined in Table 4-9 and Table 4-11.

As detailed in Table 9-1, Table 9-2 and Table 9-3 a total of 7,755 ecosystem credits, 54,336 species credits and 2 paddock tree credits are required to offset the direct impacts of the alignment and 4,624 ecosystem credits, 34,759 species credits are required for the combined borrow pits. Total credits of 12, 379 for ecosystem impacts, 89,095 for species credit species impacts and 2 credits for paddock trees will be required should all aspects of the proposal proceed. The above credit numbers assume that all borrow pits will be utilised, however this is unlikely to eventuate. Individual borrow pits have been assessed as separate areas in order to facilitate segmented offsetting if and when those areas are to be utilised. The number of credits required (i.e. biodiversity impacts) will be considered during the final selection of borrow pit sites.

10 Evaluation and conclusion

The subject land provides suitable habitat for a number of TECs and threatened species listed under the provisions of the EPBC Act and/or the BC Act. The subject land contains a suite of other ecological receptors including habitat connectivity, wetlands and waterways.

The subject land was assessed under the BAM for all BC Act listed entities and under the EPBC Act requirements where those species and or communities were not captured under BAM.

Multiple ecological receptors were identified within the subject land for the purposes of this assessment. These varied from broad scale receptors such as landscape features, down to finer species-scale receptors, including TECs (6 TECs listed under BC and/or EPBC Acts), and habitat for threatened flora and fauna significant species (16 flora species and 74 fauna species). As well as being assessed under the BAM many of these receptors were grouped into high, moderate and low sensitivity categories based on factors, including conservation status, exposure to threatening processes, resilience and representation in the broader landscape.

The construction and operation of the proposal has the potential to impact on ecological receptors through the following potential impacts:

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species by invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light impacts
- Increase in litter (waste)
- Erosion and sedimentation
- Disturbance to specialists breeding and foraging habitat
- Trampling of threatened species
- Fallen timber and bush rock collection and removal
- Fertiliser drift
- Increased fire risk

The nature of each unmitigated potential impact was considered in relation to the identified ecological receptors (EPBC Act regulated) to derive an initial assessment of impact significance for the proposal (refer Table 7-14). This was determined by assigning sensitivity and magnitude ratings which were then allocated a significance rating through the significance assessment matrix. The potential impacts upon the ecological receptors (EPBC Act regulated) were assigned a major, high, moderate, low or negligible rating (refer Table 7-14).

The proposed avoidance and mitigation measures for the proposal were identified in order to reduce the significance of the potential impacts upon the ecological receptors. The mitigation strategies associated with the proposal are presented in Section 5.3. Following the application of the mitigation hierarchy (i.e. avoid, minimise, mitigate), which included a range of mitigation measures and management plans, the residual impacts to the identified ecological receptors were generally reduced for threatened species but not for TECs (refer Table 7-15). Aside from avoidance and impact minimisation, the application of additional mitigation measures was not likely to significantly reduce impacts associated with the loss of vegetation through clearing/removal, resulting in an adverse residual impact to each of the terrestrial ecological receptors.

Impact assessment under the BAM identified Serious And Irreversible Impacts (SAII) for one Plant Community Type (PCT) and two species-credit species. Final targeted surveys are yet to be completed and as such many predicted threatened species and communities are assumed to be present, based on existing knowledge of the subject land and BAM requirements. The PCT and threatened species identified under BAM as SAII are:

- PCT35 – Brigalow – Belah open forest/woodland known to occur
- Pale imperial hairstreak (*Jalmenus eubulus*)
- *Platyzoma microphyllum* (Braid fern).

Through the SIAM significant impacts for MNES are predicted for four TECs, four threatened flora species, and 16 threatened fauna species.

The greatest potential predicted impacts (direct disturbance) as a result of the proposal may be upon the following ecological receptors:

- Painted honeyeater (*Grantiella picta*) – 310.93 ha
- Koala (*Phascolarctos cinereus*) – 323.12 ha
- Corben's long-eared bat (*Nyctophilus corbeni*) – 282.74 ha
- *Dichanthium setosum* (Bluegrass) – 282.22
- Grey-headed flying-fox (*Pteropus poliocephalus*) – 277.87 ha.

In addition to habitat loss, the unmitigated impacts of fauna injury and mortality, and a reduction in the connectivity of biological corridors are predicted to impact ecological receptors including threatened fauna. Threatened fauna species considered most likely to be adversely affected by an increase in mortality and a reduction in landscape connectivity as a result of the proposal include:

- Squirrel glider (*Petaurus norfolcensis*)
- Koala (*Phascolarctos cinereus*).

Processing of MNES using the Adverse Impact Assessment Methodology (AIAM) reduced the identified levels of potential impacts to those that are considered to constitute a significant adverse residual impact in accordance with the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DotE 2013). The significant adverse residual impact for the MNES noted above are:

- Painted honeyeater (*Grantiella picta*) – 292.73 ha
- Koala (*Phascolarctos cinereus*) – 285.47 ha
- Corben's long-eared bat (*Nyctophilus corbeni*) – 280.36 ha
- *Dichanthium setosum* (Bluegrass) – 237.1 ha
- Grey-headed flying-fox (*Pteropus poliocephalus*) – 263.93 ha.

Predicted cumulative impacts were assessed incorporating twelve projects within the vicinity of the proposal that have been identified as either currently underway or are going through the EIS process and are likely to contribute to the continued loss of biodiversity in the Brigalow Belt South and Darling Riverine Plains bioregions.

The cumulative impacts of multiple similar projects occurring in the vicinity of the proposal may include the following potential impacts:

- Habitat loss from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species from invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light
- Increase in litter (waste)
- Erosion and sedimentation.

High significance cumulative impacts as a result of the proposal and other similar projects are predicted to impact the following ecological receptors:

- TECs (EPBC and BC Acts)
- Threatened flora and fauna (EPBC and BC Acts)
- State significant landscape feature – Great Artesian Basin.

Mitigation measures presented in Section 5.3.3 will contribute to the reduction of potential cumulative impact to ecological receptors in the region.

During Phase 2 of the proposal (detailed design, post-EIS), sensitive ecological receptors identified during the EIS will be subject to further investigation, in order to more accurately determine the magnitude of the significant adverse impacts upon the identified ecological receptors. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable and the more significant adverse impacts are offset. The findings of these investigations will be used to refine the BAM C data for the proposal. The current requirements are 101,476 credits for BC Act offsets and like-for-like offsets for EPBC Act offsets.

There is the potential for some proposal activities to have a cumulative, irreversible and/or permanent impact upon some ecological receptors, even after the implementation of all mitigation measures. In these cases, the compensation for the residual impact will need to occur. Compensation in the form of Biodiversity Credit retirements will be required as per the BC Act.

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