

CHAPTER 6 - BIODIVERSITY



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6. Biodiversity

This chapter provides a summary of the potential impacts of the project on biodiversity, including terrestrial and aquatic ecology. The chapter describes the existing biodiversity environment; identifies potential impacts during construction, operation and decommissioning; and provides measures to avoid, mitigate, manage and offset the potential impacts identified.

The main potential for impacts on biodiversity would be during construction. The terrestrial biodiversity assessment, which has applied a precautionary approach, concludes that clearing vegetation within the project's disturbance footprint would have direct and potential indirect impacts on several terrestrial threatened ecological communities and various threatened species. The main operational impact on terrestrial biodiversity relates to the potential for connectivity impacts on some fauna species, which would be minimised and managed by the proposed mitigation measures.

With implementation of the proposed mitigation measures, potential impacts on aquatic ecology are expected to be minor, localised and temporary during construction, and negligible during operation and decommissioning. Consequently, no long-term impacts on key fish habitat or aquatic biota are anticipated.

Under the NSW Biodiversity Offsets Scheme, biodiversity offsets would be provided for residual impacts on native vegetation and threatened species habitat that cannot be avoided or mitigated.

Further information is provided in Technical Report 1 (Biodiversity development assessment report (BDAR)) and Technical Report 2 (Aquatic ecology).

6.1 Approach

6.1.1 Overview

The assessments of the potential impacts on biodiversity involved consideration of a range of legislation, statutory requirements, guidelines and policies.

The assessment of the potential impacts on terrestrial biodiversity has been undertaken in accordance with the *Biodiversity Conservation Act 2016* (BC Act) and the *Biodiversity Assessment Method* (DPIE, 2020b) (the BAM), as required by the SEARs. The BAM is a legislated assessment methodology established under section 6.7 of the BC Act. It provides a consistent and transparent framework for assessing the potential impacts of a project on biodiversity values, including threatened species, ecological communities, and their habitats. The BAM is a core component of the NSW Biodiversity Offsets Scheme (the BOS), which ensures that biodiversity impacts from development are appropriately offset and are secured and managed in the long term.

The assessment considered the potential direct and indirect impacts of the project, including clearing of native vegetation and potential disturbance to fauna habitat. The BAM Calculator was used to quantify the biodiversity credit obligations required to offset these impacts in accordance with the BOS. These credits include both ecosystem and species credits, depending on the biodiversity values affected.

The project has also been declared a controlled action under the EPBC Act. As such, Technical Report 1 (BDAR) includes an assessment of the potential impacts on relevant matters of national environmental significance, namely, listed threatened species and ecological communities protected under the EPBC Act. As described in section 4.2, this assessment has been undertaken in accordance with the EPBC Act Assessment Bilateral Agreement between the Australian and NSW governments (the Bilateral Agreement). This allows the NSW biodiversity assessment process (including the BDAR) to be accredited for the purposes of the EPBC Act. The supplementary SEARs issued for the project (see Appendix A (SEARs compliance table)) outline the EPBC Act matters to be assessed under the Bilateral Agreement, and these have been addressed by the assessment. The potential for significant impacts on matters listed by the EPBC Act was assessed in accordance with the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (Department of Environment (DoE), 2013)) (the Significant Impact Guidelines 1.1).

The SEARs also require an assessment of the potential impacts of the project on aquatic ecology and key fish habitat. This assessment has been undertaken in accordance with the *Fisheries Management Act 1994* (FM Act) and with reference to key guidelines, including the *Policy and guidelines for fish habitat conservation and management* (Department of Primary Industries, 2013) and *Why do fish need to cross the road?* (Fairfull and Witheridge, 2003). The aquatic ecology assessment was informed by the findings of the water assessments (see chapter 8 (Water)), ensuring that potential impacts on aquatic habitats and species were considered in the context of potential impacts on water quality, hydrology and watercourses.

Further information on the legislative and policy contexts for the terrestrial and aquatic biodiversity assessments is provided in section 1.8 of Technical Report 1 (BDAR) and section 2.2 of Technical Report 2 (Aquatic ecology). Further information on the assessment methodologies applied is provided in section 2 of Technical Report 1 and section 2.3 of Technical Report 2. An overview of the methodologies is provided below.

6.1.2 Methodology

Study areas

Terrestrial biodiversity

The BAM outlines that the assessment area for a BDAR includes the 'subject land' and, for a linear project, a 500 metre buffer surrounding the outside edge of the subject land. In accordance with the BAM, the subject land is the area where a proposed development is planned, where biodiversity values are assessed, and where any necessary biodiversity credits for offsetting impacts are determined. The assessment area is effectively the study area for the BDAR, which is the term used by other assessments undertaken for the EIS.

For this project and the EIS, the subject land (considered by the BDAR) is equivalent to the disturbance footprint. As described in section 3.1, the term 'disturbance footprint' refers to the area that would be subject to direct land disturbance and clearing to construct the project. It excludes areas approved for disturbance for the Narrabri Gas Project and the Hunter Gas Pipeline and areas where trenchless crossings are proposed. The disturbance footprint, which is a subset of the broader project site (described in section 2.2.2), has an area of about 212 hectares.

In this chapter the terms disturbance footprint and study area are used for consistency with the EIS as a whole. The disturbance footprint is shown in Appendix B (Map book). The study area for the BDAR (the assessment area) is shown on Figure 2 to 13 in Technical Report 1.

Aquatic ecology

The aquatic study area includes watercourses in the Namoi River catchment that would be intersected by the project site and an area of about two kilometres around the project site. The study area for the aquatic ecology assessment is shown on Figure 2.1 in Technical Report 2.

Key tasks

Terrestrial biodiversity

The methodology for the assessment included the following key tasks:

- defining the subject land and assessment area in accordance with the BAM
- reviewing the legislative and policy context
- undertaking a desktop review of existing ecological data, including vegetation mapping of plant community types (PCTs), threatened species records, and previous assessments from the Narrabri Gas Project
- assessing the site context, including landscape connectivity, proximity to protected areas, and presence of important habitat features

- conducting field surveys in accordance with the BAM and relevant NSW and Australian Government biodiversity survey guidelines across a range of seasons (between early 2023 and early 2025) to map vegetation, describe habitats, and confirm whether listed threatened flora, fauna or communities are present, including:
 - flora and fauna surveys
 - vegetation integrity assessments
 - habitat condition
 - targeted threatened species surveys
- assessing the potential direct and indirect impacts on biodiversity values, including native vegetation, habitats, threatened species, ecological communities, key threatening processes and matters of national environmental significance, including assessment of:
 - prescribed impacts (impacts that may affect biodiversity values in addition to, or instead of, impacts from clearing vegetation)
 - serious and irreversible impacts (SAIL) on threatened species, populations, or ecological communities
 - impacts on terrestrial groundwater dependant ecosystems
 - key threatening processes
 - cumulative impacts
- identifying mitigation and management measures to avoid and minimise impacts, consistent with the BOS hierarchy of avoid, minimise, offset
- calculating biodiversity credit obligations using the BAM Calculator, including:
 - ecosystem credits for impacted vegetation
 - species credits for threatened species habitat
- reviewing offset options under the BOS
- preparing a BDAR to describe the results of the assessment in accordance with section 6.12 of the BC Act, clause 6.8 of the Biodiversity Conservation Regulation 2017 (the BC Regulation) and the BAM.

Aquatic ecology

The methodology for the assessment included the following key tasks:

- defining and reviewing the study area, including watercourses intersected by the disturbance footprint
- reviewing the legislative and policy framework
- undertaking a desktop review of existing aquatic ecology data, including previous studies, water quality records, listed threatened species and communities' records, and mapped aquatic habitat values, including watercourses mapped as key fish habitat
- conducting aquatic habitat field surveys at 14 representative locations along watercourses crossed by the construction right of way to assess and ground truth aquatic habitat condition, riparian vegetation, and confirm the potential presence of key fish habitat
- integrating findings from the water assessments (described in chapter 8 (Water)) to inform the evaluation of potential impacts on aquatic ecosystems including groundwater dependent ecosystems.
- assessing potential impacts on aquatic habitats and species, with a focus on key fish habitat and listed threatened species and communities
- developing mitigation and management measures.

6.2 Existing environment

6.2.1 Landscape biodiversity features

Landscape features contribute to the overall biodiversity value of the study area. The key landscape features, as defined by the BAM, and how these relate to the biodiversity study area, are summarised in Table 6.1.

Table 6.1 Landscape features within the study area

Landscape feature	Study area
Areas of outstanding biodiversity value under the BC Act	None present.
NSW landscape regions (Mitchell landscapes)	<p>The study area is mainly located within the Coghill Alluvial Plains and Cubbo Uplands landscape regions, with smaller areas extending into the Baradine-Coghill Channels and Floodplains, Bugaldie Uplands and Liverpool Alluvial Plains.</p> <p>The Coghill Alluvial Plains are characterised by flat, fertile landscapes formed by the deposition of sediments from rivers and streams. These plains are typically well-drained and support a variety of agricultural activities due to their rich soil. The vegetation includes grasses, shrubs, and scattered trees.</p> <p>The Cubbo Uplands feature rolling hills, woodlands and diverse plant communities.</p> <p>There are no areas of geological significance within the study area.</p>
Interim Biographic Regionalisation for Australia (IBRA) bioregion and subregion	<p>The study area is located within the Brigalow Belt South Bioregion and the following subregions:</p> <ul style="list-style-type: none"> • Pilliga Outwash • Pilliga • Liverpool Plains.
Rivers and streams	<p>The project is located in the Namoi River catchment, which is part of the Murray-Darling Basin. The project site crosses 45 watercourses. Of these, six have a Strahler stream order of three or higher (including Bohena Creek, Bibblewindi Creek, Sandy Creek, Little Sandy Creek and Tulla Mullen Creek), with the rest lower order watercourses, most with a stream order of one. All watercourses are ephemeral. Further information about watercourses is provided in section 8.2.</p>
Important and local wetlands on, adjacent and downstream of the project site	None present.
Habitat connectivity features	<p>The north-western portion of the study area (within the Pilliga Outwash subregion) features extensive areas of dry sclerophyll forests and woodlands within the Pilliga East State Forest. This provides habitat connectivity for wildlife, although the Newell Highway and unsealed forestry tracks fragment some areas. The central portion of the study area through the Pilliga East and Bibblewindi State forests (within the Pilliga subregion) has good habitat connectivity, in particular along riparian corridors, despite the presence of a number of unsealed access tracks and existing easements for gas infrastructure. The eastern portion of the study area (within the Liverpool Plains subregion) has poor connectivity, affected by agricultural land uses, including fencing.</p>

6.2.2 Terrestrial flora

Vegetation communities/plant community types

As described in section 2.2.2, the project site traverses two distinct landscapes, characterised by the dominant land use of each. The western section (about 34.5 kilometres long) is located within State forests, and the eastern section (about 20.5 kilometres long) extends through agricultural/rural properties with small patches of scattered remnant vegetation.

Vegetation communities (PCTs) within the disturbance footprint are summarised in Table 6.2 and shown in Figure B.1.1 to Figure B.1.27 in Appendix B (Map Book).

A total of eight PCTs were identified. The most predominant PCTs within the disturbance footprint are:

- Narrow-leaved Ironbark – White Cypress Pine – Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion (PCT 398)
- Rough-barked Apple – Blakely's Red Gum – Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region (PCT 401).

Areas of native vegetation were assigned to one of three vegetation zones per PCT based on their condition (low, moderate or high). Vegetation was allocated into these condition classes based on factors such as vegetation health, fire history and land management.

A full list of the PCTs identified and further descriptive information is provided in section 4.2 of Technical Report 1 (BDAR). The results of the condition assessment are included in sections 4.4 and 4.5 of Technical Report 1.

As shown in Table 6.2 there is a total of about 168.34 hectares of native vegetation in the disturbance footprint (about 80 per cent of the disturbance footprint).

Table 6.2 Plant community types

PCT name	PCT ref	Condition	Total area in disturbance footprint (ha) ¹
Native vegetation			
Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion	PCT 88	Moderate	7.86
		Low	8
Poplar Box - Yellow Box - Western Grey Box grassy woodland on cracking clay soils mainly in the Liverpool Plains, Brigalow Belt South Bioregion	PCT 101	High	0.67
		Moderate	4.33
		Low	12.33
Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	PCT 141	High	1.56
Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion	PCT 398	High	13.75
		Moderate	46.16
		Low	14.92
Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland on sandy flats, mainly in the Pilliga Scrub region	PCT 401	Moderate	25.03
White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	PCT 405	High	12.09
Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on the Pilliga forests and surrounding region	PCT 408	Moderate	16.18

PCT name	PCT ref	Condition	Total area in disturbance footprint (ha) ¹
Narrow-leaved Ironbark - cypress pine - White Box shrubby open forest in the Brigalow Belt South Bioregion and Nandewar Bioregion.	PCT 592	Moderate	0.19
		Low	5.28
Total native vegetation			168.34
Disturbed areas and non-native vegetation			
Non-native vegetation (planted vegetation)	n/a	n/a	43.65
Total disturbed areas and non-native vegetation in the disturbance footprint			43.65

Note: 1. Totals may vary slightly due to rounding. All numbers have been rounded up.

Threatened ecological communities

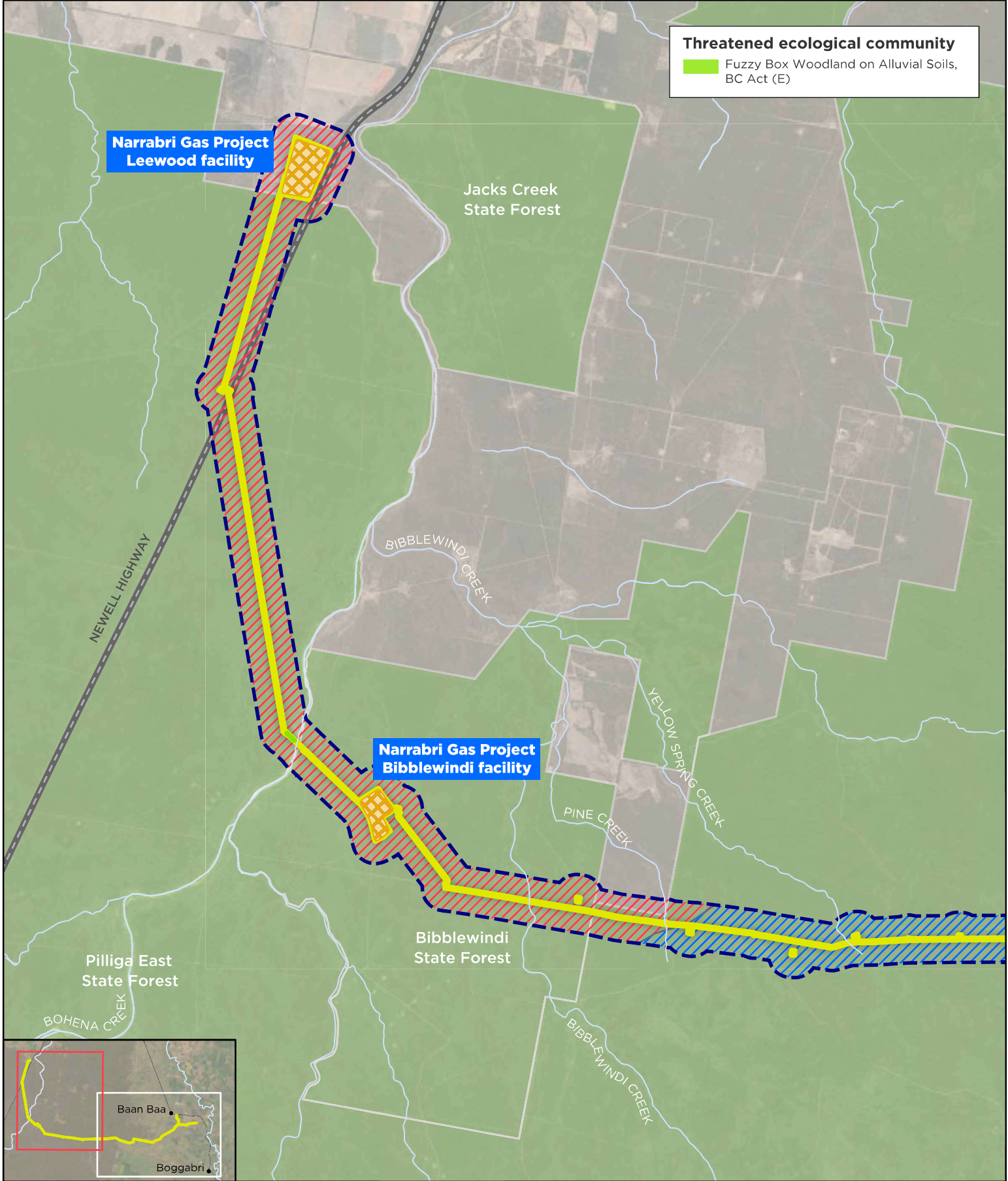
Three threatened ecological communities (TECs) were identified in the disturbance footprint after confirming the suite of PCTs present and reviewing primary literature sources on TECs, considering their spatial, floristic, structural, and landscape characteristics. The TECs are located in the eastern section of the disturbance footprint, within the Liverpool Plains IBRA subregion. TECs listed under the BC Act and EPBC Act located within the disturbance footprint are summarised in Table 6.3 and shown on Figure 6.1 and Figure 6.2.

It is noted that different condition thresholds apply to TECs under the BC Act and EPBC Act. Some vegetation does not meet the stricter condition thresholds for EPBC Act listing.

Table 6.3 Threatened ecological communities

TEC		PCT ref	Conservation status ¹	Area within the disturbance footprint subject to assessment under relevant Act (ha)	
BC Act listed name	EPBC Act listed name			BC Act	EPBC Act
Inland Grey Box Woodland in the Riverina, NSW South-Western Slopes, Cobar Penepplain, Nandewar and Brigalow Belt South Bioregions	Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	PCT 101	BC Act – E EPBC Act – E	4.92	4.69
n/a	Poplar Box Grassy Woodland on Alluvial Plains	PCT 101	EPBC Act - E	-	0.62
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland	PCT 101 PCT 401	BC Act – CE EPBC Act – CE	5.44	5.44
Total TECs in disturbance footprint				10.36	10.75

Note: 1. CE – critically endangered, E – endangered



Threatened ecological community
 Fuzzy Box Woodland on Alluvial Soils, BC Act (E)

**Narrabri Gas Project
 Leewood facility**

Jacks Creek
 State Forest

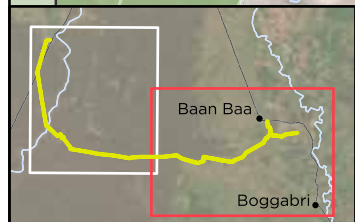
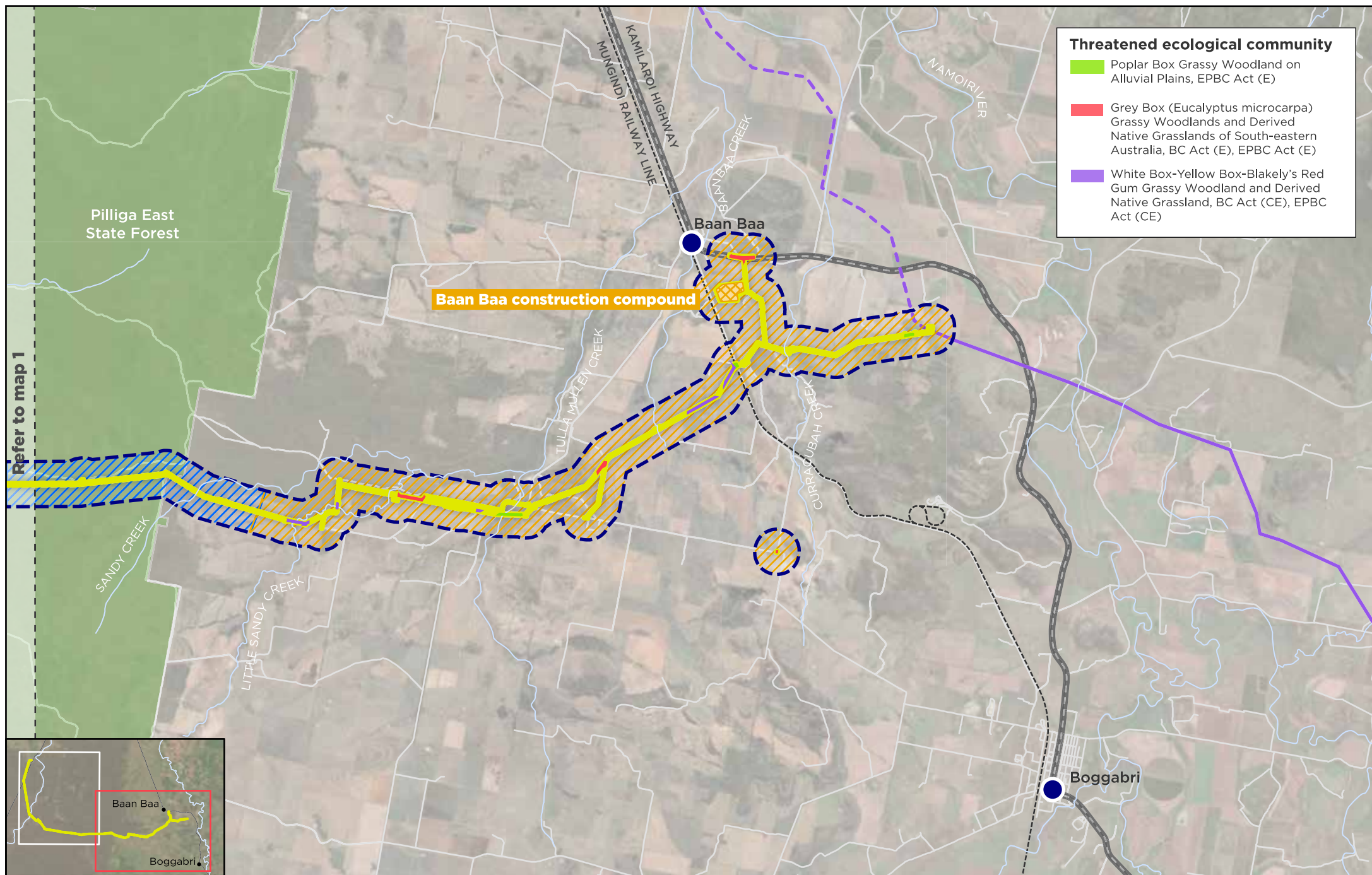
**Narrabri Gas Project
 Bibblewindi facility**

Bibblewindi
 State Forest

Pilliga East
 State Forest

Figure 6.1 Threatened ecological communities - map 1

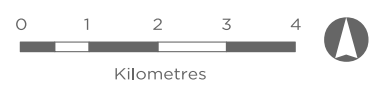
- Legend**
- Disturbance footprint
 - Construction facility
 - Pilliga
 - Pilliga Outwash
 - Assessment area
 - Highway
 - Watercourse



Legend

- Project infrastructure: Disturbance footprint, Construction facility
- IBRA Sub-Regions: Pilliga, Liverpool Plains
- Stage 2 Hunter Gas Pipeline - Indicative pipeline route, Stage 3 Hunter Gas Pipeline - Indicative pipeline route
- Assessment area, Town, Highway, Railway line, Watercourse

Figure 6.2 Threatened ecological communities - map 2



Threatened flora species

The results of the desktop review and preliminary calculations using the BAM Calculator indicated 19 potential candidate species-credit threatened flora species, all of which were retained for further assessment, i.e. targeted surveys as per the BAM.

Six threatened flora species were recorded within the disturbance footprint during the targeted surveys. An additional nine threatened flora species were assumed to be present for assessment purposes in suitable habitat located in areas where survey effort was incomplete at the time of preparation of the BDAR. Table 6.4 lists the threatened flora species recorded or assumed to be present that have been assessed for potential impacts and offsets, together with their conservation status as per their listing under the BC Act and/or EPBC Act.

A full list of flora species recorded is provided in Appendix C of Technical Report 1 (BDAR).

Table 6.4 Threatened flora species – recorded and assumed present

Species	Listing	
	BC Act ¹	EPBC Act ¹
Species recorded		
<i>Androcalva procumbens</i> (syn. <i>Commersonia procumbens</i>)	V	V
Pine Donkey Orchid (<i>Diuris tricolor</i>)	V	-
Winged Peppergrass (<i>Lepidium monoplacoides</i>)	E	E
Native Milkwort (<i>Polygala linariifolia</i>)	E	-
Greenhood Orchid (<i>Pterostylis cobarensis</i>)	V	-
<i>Tylophora linearis</i> (<i>Tylophora linearis</i>)	V	E
Species assumed present		
<i>Cyperus conicus</i>	E	-
Bluegrass (<i>Dichanthium setosum</i>)	V	V
Finger Panic Grass (<i>Digitaria porrecta</i>)	E	-
Belson's Panic (<i>Homopholis belsonii</i>)	E	V
Spiny Peppergrass (<i>Lepidium aschersonii</i>)	V	V
Large-leafed Monotaxis (<i>Monotaxis macrophylla</i>)	E	-
Scant Pomaderris (<i>Pomaderris queenslandica</i>)	E	-
Slender Darling Pea (<i>Swainsona murrayana</i>)	V	V
Austral Toadflax (<i>Thesium australe</i>)	V	V

Note: 1. V – vulnerable, E – endangered

Weeds

Weed species were found within the study area during surveys. These included five priority weed species, as identified by the *Biosecurity Act 2015*, 13 high threat weed species, and five weeds of national significance.

The General Biosecurity Duty under the *Biosecurity Act 2015* requires any person who deals with weeds to ensure that the biosecurity risk of the weed is prevented, eliminated or minimised, as far as reasonably practicable (further information is provided in section 11.3.3).

Weeds of national significance are weeds that have been prioritised by the Australian government based on their potential for spread, their invasiveness, and their social and economic impacts. Weeds of national significance found in the study area include African Boxthorn (*Lycium ferocissimum*), Tiger Pear (*Opuntia aurantiaca*) Prickly Pear (*Opuntia stricta*), Fireweed (*Senecio madagascariensis*), and Silver-leaved Nightshade (*Solanum elaeagnifolium*).

6.2.3 Terrestrial fauna

Terrestrial fauna habitats

Broad fauna habitat types found in the disturbance footprint include:

- native forest and shrublands within the Pilliga East and Bibblewindi State forests
- woodland patches in agricultural land
- grassland with scattered paddock trees
- watercourses and associated riparian vegetation
- farm dams
- rocky outcrops.

Habitat connectivity is provided by:

- Pilliga East and Bibblewindi state forests
- vegetated riparian corridors (e.g. Bohena Creek, Tulla Mullen Creek, Sandy Creek and Yellow Spring Creek)
- patches of isolated woodland and paddock trees in agricultural land
- vegetated road reserves.

A full description of the habitat types and threatened fauna species recorded or likely to occur in each habitat is provided in section 5 of Technical Report 1 (BDAR).

Habitat values are higher in the western section of the study area, where the State forests provide large contiguous habitats that support corridors for wildlife movement. Habitat values are lower in the eastern section of the study area, where the land has been extensively cleared for agriculture and property fencing presents barriers to fauna movement.

Threatened fauna species

The results of the desktop review and preliminary calculations using the BAM Calculator indicated 25 potential candidate species-credit threatened fauna species, of which 18 species were retained for further assessment (i.e. targeted surveys as per the BAM). A further 30 predicted (ecosystem credit fauna species) were known or predicted to occur in the disturbance footprint. Targeted surveys are not required to identify or confirm the presence of ecosystem credit species under the BAM because these species are assumed to be present based on habitat modelling. Offsets for ecosystem credit species are captured through offsets generated for associated PCTs.

A total of 18 threatened fauna species were recorded within the disturbance footprint during the targeted surveys.. Table 6.5 lists the fauna species recorded or assumed to be present, together with their conservation status under the BC Act and/or EPBC Act, and credit type under the BAM. These species include species credit species and dual credit species, which require species polygons for the purpose of calculating offset for direct impacts in accordance with the BAM.

Further information is provided in section 5 of Technical Report 1 (BDAR).

Table 6.5 Threatened fauna species – recorded and assumed present

Species	Listing		BAM credit type
	BC Act ¹	EPBC Act ¹	
Species recorded during surveys (candidate and predicted species)			
Dusky Woodswallow (<i>Artamus cyanopterus cyanopterus</i>)	V	-	Ecosystem
South-eastern Glossy Black-Cockatoo (<i>Calyptorhynchus lathami lathami</i>)	V	V	Species / ecosystem
Eastern Pygmy-possum (<i>Cercartetus nanus</i>)	V	-	Species
Brown Treecreeper (south eastern) (<i>Climacteris picumnus victoriae</i>)	V	V	Ecosystem
White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>) ²	V	-	Species / ecosystem
White-throated Needletail (<i>Hirundapus caudacutus</i>)	V	V	Ecosystem
Square-tailed Kite (<i>Lophoictinia isura</i>)	V	-	Species / ecosystem
Turquoise Parrot (<i>Neophema pulchella</i>)	V	-	Ecosystem
Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	V	V	Ecosystem
Little Lorikeet (<i>Parvipsitta pusilla</i>)	V	-	Ecosystem
Squirrel Glider (<i>Petaurus norfolcensis</i>)	V	-	Species
Scarlet Robin (<i>Petroica boodang</i>)	V	-	Ecosystem
Koala (<i>Phascolarctos cinereus</i>)	E	E	Species
Grey- crowned Babbler (Eastern subspecies) (<i>Pomatostomus temporalis temporalis</i>)	V	-	Ecosystem
Pilliga Mouse (<i>Pseudomys pilligaensis</i>)	V	V	Ecosystem
Speckled Warbler (<i>Pyrrholaemus sagittatus</i>)	V	-	Ecosystem
Diamond Firetail (<i>Stagonopleura guttata</i>)	V	V	Ecosystem
Eastern Grass Owl (<i>Tyto longimembris</i>)	V	-	Ecosystem
Candidate species credit species assumed present			
Pink-tailed Worm-lizard (<i>Aprasia parapulchella</i>)	V	V	Species
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	E	E	Species
Pale-headed snake (<i>Hoplocephalus bitorquatus</i>)	V	-	Species
Barking Owl (<i>Ninox connivens</i>)	V	-	Species / ecosystem
Grey-headed Flying-fox (foraging) (<i>Pteropus poliocephalus</i>) ²	V	V	Species / ecosystem
Masked Owl (<i>Tyto novaehollandiae</i>)	V	-	Species / ecosystem
Border Thick-tailed Gecko (<i>Uvidicolus sphyurus</i>)	V	V	Species
Eastern Cave Bat (<i>Vespadelus troughtoni</i>)	V	-	Species

Note: 1. V – vulnerable, E – endangered

2. No breeding or important habitat for this species is present within disturbance footprint; therefore, this species has been excluded from requiring further assessment and offsetting as a species credit species and is retained as an ecosystem credit species only.

6.2.4 Aquatic ecology

Aquatic habitats

The project site is located within the Namoi River catchment. Although DPI (2024) mapping indicates that several watercourses may provide key fish habitat, most surveyed sites were dry or contained only small, isolated pools unsuitable for sustaining fish populations. This is consistent with the nature of the aquatic study area, where all watercourses are ephemeral, flowing briefly after rainfall, and are predominantly first-order streams with limited permanent aquatic habitat for aquatic biota. Higher order watercourses within the aquatic study area have a more developed channel and riparian vegetation and occasional pools containing water depending on prevailing seasonal weather conditions.

Threatened aquatic species and populations

Threatened aquatic species and populations listed under the FM Act and EPBC Act are not likely to occur in the aquatic study area given the predominantly ephemeral flow regimes of the watercourses and absence of suitable permanent water habitat.

Bohena, Bibblewindi and Tulla Mullen creeks, and the unnamed tributaries of Sandy Creek, are within the mapped distribution of the Southern Purple Spotted Gudgeon. Recent research has indicated that there are no populations of this species in the Namoi River catchment (which includes the watercourses in the aquatic study area) (Lintermans, 2023). Bohena Creek is within the mapped distribution of the Eel-tailed Catfish. However, field surveys confirmed that the surveyed watercourses within the aquatic study area lacked suitable permanent habitat for the Southern Purple Spotted Gudgeon and Eel-tailed Catfish.

Murray Cod and Silver Perch are threatened fish species listed under the EPBC Act that have been identified as having the potential to occur within the aquatic study area. However, the likelihood of occurrence assessment concluded that the ephemeral watercourses in the study area do not provide preferred habitat for these species.

Threatened aquatic ecological communities

The watercourses in the aquatic study area are located in a catchment that is mapped as part of the Lowland Darling River endangered ecological community (EEC). Higher-order watercourses in the aquatic study area, such as Bohena Creek, may support the EEC during periods of flow, when conditions are suitable to sustain aquatic ecosystems. However, due to the predominantly ephemeral nature and generally lower stream order of the watercourses within the study area, their potential to support this aquatic EEC is considered limited.

6.2.5 Groundwater dependent ecosystems

Groundwater dependent ecosystems rely on a supply of groundwater to support the species composition, structure and function of the ecosystem. Groundwater dependency can range from total reliance to a proportional, opportunistic use of groundwater. The Groundwater Dependent Ecosystem Atlas maintained by the Bureau of Meteorology identifies groundwater dependent ecosystems reliant on surface and subsurface groundwater.

There are no known low or high potential aquatic groundwater dependent ecosystems mapped within the water study area, see Technical Report 4 (Water). Bohena Creek is mapped as a moderate potential aquatic groundwater dependent ecosystems.

There are areas of low, moderate and high potential terrestrial groundwater dependent ecosystems mapped within the water study area. High potential terrestrial groundwater dependent ecosystems comprise strips and fragmented patches of riparian vegetation associated with third to sixth order watercourses, such as Bohena Creek, Yellow Spring Creek, Sandy Creek and Tulla Mullen Creek, which intersect the project site. The project site also crosses areas mapped as low and moderate potential terrestrial groundwater dependent ecosystems, including woodland and grassland areas, primarily in the western portion of the water study area, see Technical Report 4 (Water).

Further information is provided in section 8.2.3.

6.2.6 Summary of matters of national environmental significance

Threatened ecological communities

As shown in Table 6.3, three TECs listed under the EPBC Act were identified within the disturbance footprint:

- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia (listed as endangered)
- Poplar Box Grassy Woodland on Alluvial Plains (listed as endangered)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (listed as critically endangered).

Threatened flora and fauna species

A total of 26 threatened fauna and flora species listed under the EPBC Act were recorded or assumed to be present within the disturbance footprint (see Table 6.6) and subject to further assessment. Further information is provided in Appendix I of Technical Report 1 (BDAR).

Table 6.6 Threatened species listed under EPBC Act – recorded, assumed present or considered likely to occur

Threatened species listed under the EPBC Act	EPBC Act status ¹	Likelihood of occurrence in the disturbance footprint
Flora		
<i>Androcalva procumbens</i> (syn. <i>Commersonia procumbens</i>)	V	Known
Bluegrass (<i>Dichanthium setosum</i>)	V	Possible (assumed present)
Belson's Panic (<i>Homopholis belsonii</i>)	V	Possible (assumed present)
Spiny Peppercress (<i>Lepidium aschersonii</i>)	V	Possible (assumed present)
Winged Peppercress (<i>Lepidium monoplocoides</i>)	E	Known
Slender Darling-pea (<i>Swainsona murrayana</i>)	V	Possible (assumed present)
Austral Toadflax (<i>Thesium australe</i>)	V	Possible (assumed present)
<i>Tylophora linearis</i>	E	Known
Fauna – birds		
Regent Honeyeater (<i>Anthochaera phrygia</i>)	CE	Possible (foraging habitat)
Southern Whiteface (<i>Aphelocephala leucopsis</i>)	V	Known
South-eastern Glossy Black Cockatoo (<i>Calyptorhynchus lathami lathami</i>)	V	Known
Brown Treecreeper (south-eastern) (<i>Climacteris picumnus victoriae</i>)	V	Known
Grey Falcon (<i>Falco hypoleucos</i>)	V	Unlikely ²
Painted Honeyeater (<i>Grantiella picta</i>)	V	Likely
White-throated Needletail (<i>Hirundapus caudacutus</i>)	V, M	Known ³
Swift Parrot (<i>Lathamus discolor</i>)	CE	Possible (foraging habitat)
South-eastern Hooded Robin (<i>Melanodryas cucullata cucullata</i>)	E	Likely
Diamond Firetail (<i>Stagonopleura guttata</i>)	V	Known

Threatened species listed under the EPBC Act	EPBC Act status ¹	Likelihood of occurrence in the disturbance footprint
Fauna – mammals		
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	E	Possible (assumed present)
Spotted-tailed Quoll (<i>Dasyurus maculatus maculatus</i>)	E	Likely
Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	V	Known
Koala (<i>Phascolarctos cinereus</i>)	E	Known
Pilliga Mouse (<i>Pseudomys pilligaensis</i>)	V	Known
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	V	Unlikely ²
Fauna – reptiles		
Pink-tailed Legless-lizard (<i>Aprasia parapulchella</i>)	V	Possible (assumed present)
Border Thick-tailed Gecko (<i>Uvidicolus sphyrurus</i>)	V	Possible (assumed present)

Notes: 1. V – vulnerable, E – endangered, CE – critically endangered, M – migratory
 2. Despite being unlikely to be present, further assessment was undertaken as the species was identified for further consideration by the Supplementary SEARs.
 3. No further assessment was undertaken as the species was assessed in the EPBC Act Referral and not identified for further consideration by the Supplementary SEARs.

Migratory species

The disturbance footprint includes potential habitat for migratory flycatchers that breed in eastern Australian forests and non-breeding migratory birds from Asia. Of these, one migratory species, the White-throated Needletail (*Hirundapus caudacutus*) was recorded during surveys. No mapped important habitat for migratory waders is located within, or near, the disturbance footprint.

6.3 Construction impacts

Potential impacts on biodiversity during construction include:

- direct impacts as a result of vegetation clearing and disturbance in the disturbance footprint
- indirect impacts on flora and fauna located outside the disturbance as a result of activities within the disturbance footprint.

A summary of the results of the impact assessment is provided in the following sections.

6.3.1 Terrestrial flora

Direct impacts on native vegetation

Vegetation clearing would be required to construct the project within the disturbance footprint. It is estimated that up to about 168.34 hectares of native vegetation within the disturbance footprint would be directly impacted (cleared), which would affect the native vegetation communities (PCTs) listed in Table 6.2. The most affected PCT would be 398 (Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion).

Threatened ecological communities

Table 6.7 provides a summary of the estimated direct impacts on the TECs listed under the BC Act and/or EPBC Act.

Table 6.7 Summary of direct impacts on threatened ecological communities

Threatened ecological community		Condition	Area of impact (ha)		Risk of SAI
BC Act listed name	EPBC Act listed name		BC Act	EPBC Act	
Inland Grey Box Woodland in the Riverina, NSW South-Western Slopes, Cobar Penneplain, Nandewar and Brigalow Belt South Bioregions	Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Moderate and low	4.92	4.69	No
n/a	Poplar Box Grassy Woodland on Alluvial Plains	Moderate	n/a	0.62	No
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions	White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland	High and low	5.44	5.44	Yes
Total impacts			10.36	10.75	-

Summary of impacts on TECs listed under the BC Act

The project would directly impact two TECs listed under the BC Act:

- Inland Grey Box Woodland in the Riverina, NSW South-Western Slopes, Cobar Penneplain, Nandewar and Brigalow Belt South Bioregions
- White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions ('Box Gum Woodland').

The amount of vegetation that would have the potential to be directly impacted in these communities is listed in Table 6.7.

An assessment of the potential for 'serious and irreversible impacts' on Box-Gum Woodland was determined to be required in consultation with NSW DCCEEW's Conservation Programs, Heritage, and Regulation Group (CPHR) and has been prepared (see section 9.1 of Technical Report 1).

The assessment found that Box-Gum Woodland in the disturbance footprint is already highly fragmented, surrounded by areas of agricultural land. The project would result in both the reduction of the total extent of the TEC and increased fragmentation of remnant patches. The project would involve clearing within five patches of Box-Gum Woodland, removing up to about 5.44 hectares (4.77 hectares of which is classified as low condition). This accounts for 0.00001 per cent of the total remaining area of the TEC.

After the pipeline is constructed, the cleared area would be rehabilitated in accordance with a rehabilitation strategy (see section 3.4.5). Grass and low shrubs would re-establish, but trees would not be replanted or permitted to regrow within the 20 metre wide operational corridor, reducing the TEC area to a lower condition with only ground cover and potentially disqualifying the area as a TEC.

During further design and construction planning, direct impacts on TECs would continue to be reviewed to avoid and/or minimise impacts as far as practicable in accordance with the mitigation measures in section 6.6. Biodiversity offsets would be provided for unavoidable impacts as described in section 6.6.3.

Summary of impacts on communities listed under the EPBC Act

The project would directly impact three TECs listed under the EPBC Act:

- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia
- Poplar Box Grassy Woodland on Alluvial Plains
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

The amount of vegetation that would have the potential to be directly impacted in these communities is listed in Table 6.7.

To address the Supplementary SEARs, assessments of significance of potential impacts on threatened flora species listed under the EPBC Act has been undertaken using the results of the targeted field surveys (see Appendix I of Technical Report 1 (BDAR)) in accordance with the Significant Impact Guidelines 1.1. Considering the limited scale of disturbance, the highly modified nature of the affected landscape, and the implementation of avoidance and mitigation measures, the project is unlikely to have a significant impact on the TECs listed under the EPBC Act.

During further design and construction planning, direct impacts on TECs would continue to be reviewed to avoid and/or minimise impacts as far as practicable in accordance with mitigation measures in section 6.6. Biodiversity offsets would be provided for unavoidable impacts as described in section 6.6.3.

Impacts on listed threatened flora species

Summary of impacts on species listed under the BC Act

The project has the potential to impact individuals and potential habitat for the six threatened candidate flora species listed under the BC Act that were recorded in the disturbance footprint, as well as potential habitat for nine candidate threatened flora species that were assumed to be present for the purposes of the assessment. Table 6.8 lists the estimated areas of habitat with the potential to be impacted for these species.

In accordance with the BC Regulation, species credits are required to offset impacts on these threatened flora species.

None of the threatened flora species that may be impacted by the project are considered 'serious and irreversible impacts' entities.

Potential impacts would be avoided, minimised, managed and offset as described in section 6.6.

Summary of impacts on threatened flora species listed under the EPBC Act (matters of national environmental significance)

The project has the potential to impact individuals and potential habitat for the three threatened flora species listed under the EPBC Act that were recorded in the disturbance footprint, as well as potential habitat for five species that were assumed to be present for the purposes of the assessment. Table 6.8 lists the estimated areas of habitat with the potential to be impacted for these species.

An assessment of significance of potential impacts on threatened flora species listed under the EPBC Act has been undertaken using the results of the targeted field surveys to address the Supplementary SEARs (see Appendix I of Technical Report 1 (BDAR)). Taking a precautionary and conservative approach, the project is considered to have the potential to significantly impact two flora species – *Tylophora linearis* and Winged Peppercress (*Lepidium monoplacoides*) – in accordance with the assessment criteria defined by the Significant Impact Guidelines 1.1. As the significant impact criteria assessment concluded that there is the potential for a significant impact, offsets are required under the EPBC Act Offset Policy. This offset requirement would be addressed through the retirement of biodiversity credits in accordance with the BOS.

Further information on the potential impacts and proposed mitigation measures, including biodiversity offset obligations, for matters of national environmental significance are provided in Appendix I of Technical Report 1 (BDAR).

Table 6.8 Threatened flora species – summary of potential impacts

Species	Listing		Area of potential habitat impact (ha)
	BC Act ¹	EPBC Act ¹	
Species recorded			
<i>Androcalva procumbens</i> (syn. <i>Commersonia procumbens</i>)	V	V	22.1
Pine Donkey Orchid (<i>Diuris tricolor</i>)	V	-	128.2
Winged Peppercress (<i>Lepidium monoplacoides</i>)	E	E	23.7
Native Milkwort (<i>Polygala linariifolia</i>)	E	-	13.3
Greenhood Orchid (<i>Pterostylis cobarensis</i>)	V	-	123
<i>Tylophora linearis</i> (<i>Tylophora linearis</i>)	V	E	61.5
Species assumed present			
<i>Cyperus conicus</i>	E	-	2.4
Bluegrass (<i>Dichanthium setosum</i>)	V	V	2.0
Finger Panic Grass (<i>Digitaria porrecta</i>)	E	-	2.0
Belson's Panic (<i>Homopholis belsonii</i>)	E	V	2.0
Spiny Peppercress (<i>Lepidium aschersonii</i>)	V	V	6.6
Large-leafed Monotaxis (<i>Monotaxis macrophylla</i>)	E	-	1.8
Scant Pomaderris (<i>Pomaderris queenslandica</i>)	E	-	1.8
Slender Darling Pea (<i>Swainsona murrayana</i>)	V	V	3.1
Austral Toadflax (<i>Thesium australe</i>)	V	V	2.1

Note: 1. V – vulnerable, E – endangered

6.3.2 Terrestrial fauna

Direct impacts

Potential direct impacts on threatened fauna and their habitats are summarised below.

Removal of habitat and habitat connectivity

The removal of the vegetation communities described above would have the potential to affect fauna, due to the removal of foraging, breeding and dispersal habitat of fauna species.

In the eastern portion of the disturbance footprint, impacts on habitat connectivity are anticipated to be lower due to the alignment traversing predominantly previously cleared agricultural land. In these areas the alignment has been located to avoid or minimise impact on remnant native vegetation, including roadside vegetation and hollow-bearing trees, as far as possible. In areas with sparse vegetation, less woody vegetation would be cleared, minimising connectivity impacts.

The alignment was moved to minimise impacts on landscape connectivity and fragmentation of important habitat areas outside forested areas in the Pilliga and Liverpool Plains subregions. Where complete avoidance was not possible, alignment refinements were implemented to reduce impacts on high-quality habitat, e.g. the use of horizontal directional drilling to retain riparian habitat and movement corridors at key locations.

Habitat connectivity impacts have the potential to be more pronounced where the alignment traverses forested areas. The Pilliga forests, although fragmented by forestry tracks and roads, provide extensive connected habitats. Construction of the project would create a cleared corridor approximately 55 kilometres long and generally 30 metres wide. Rehabilitation in accordance with the rehabilitation strategy (see section 3.4.5) would promote natural regeneration of native groundcover and shrubs (where previously present), improving connectivity, providing predator cover, and reinstating habitat values following construction.

Vegetation clearing would unevenly affect fauna. Many highly mobile species, such as birds and large mammals, are unlikely to experience connectivity issues, while others may avoid open areas or require an intact canopy to move, facing behavioural or physical barriers.

There is the potential for residual impacts on habitat connectivity for several threatened species, such as the Eastern Pygmy-possum, Pilliga Mouse, Corben's Long-eared Bat and the Squirrel Glider. However, these impacts are expected to lessen over time following construction as vegetation regeneration improves connectivity.

Mitigation measures would be implemented to minimise these impacts as far as practicable (see section 6.6). In addition, a connectivity strategy would be developed and implemented during and after construction to further avoid and minimise habitat fragmentation and connectivity impacts. This strategy, prepared in consultation with relevant experts and CPHR, will identify fauna connectivity measures to enhance connectivity for fauna species post-construction.

Removal of hollow-bearing trees

Hollows in living and dead trees (stags) and remnant paddock trees are important limiting resources in forest and woodland ecosystems, providing shelter and nesting habitat for frogs, reptiles, birds and mammals. It is estimated that about 184 hollow-bearing trees may need to be removed during construction.

Injury and mortality

Construction has the potential to result in the injury or mortality of some less mobile individuals during clearing. The potential injury or mortality of individuals is unlikely to affect an ecologically significant proportion of any local populations. More mobile native fauna, such as native birds, bats, terrestrial and arboreal mammals, that may be sheltering in vegetation within the disturbance footprint are likely to evade injury. Potential impacts would be managed by implementation of appropriate measures defined in the biodiversity management plan, which would form part of the CEMP.

Impacts on listed threatened fauna species

A total of 50 threatened fauna species listed under the BC Act, including predicted (ecosystem credit species) and candidate species (species credit species) in accordance with the NSW Biodiversity Assessment Method, have the potential to be impacted by the project. Of these, 26 species are also listed under the EPBC Act

Direct impacts on threatened fauna species are primarily associated with habitat loss as defined in accordance with the BAM. These direct impacts have been quantified based on the disturbance footprint and the presence of recorded or assumed habitat for each species.

As the project progresses through further design and construction planning, the assessment of direct impacts on threatened fauna species will be reviewed and refined to avoid and/or minimise impacts where practicable in accordance with mitigation measures in section 6.6.

Summary of impacts on species listed under the BC Act

lists the candidate fauna species credit species with the potential to be impacted, including the estimated area of habitat that would be affected. Species credits have been calculated in accordance with the BAM and would require retirement of like-for-like species credits in accordance with the BC Act, the BC Regulation and the Bilateral Agreement.

Table 6.9 Summary of potential direct impacts on threatened fauna species listed by the BC Act (candidate species credit species)

Species	Area of potential habitat impact (ha)
Candidate species credit species recorded	
South-eastern Glossy Black-Cockatoo (<i>Calyptorhynchus lathami lathami</i>)	40.9 (breeding habitat)
Eastern Pygmy-possum (<i>Cercartetus nanus</i>)	125.5
Square-tailed Kite (<i>Lophoictinia isura</i>)	8.7 (breeding habitat)
Squirrel Glider (<i>Petaurus norfolcensis</i>)	120.2
Koala (<i>Phascolarctos cinereus</i>)	128.1
Candidate species credit species assumed present	
Pink-tailed Worm-lizard (<i>Aprasia parapulchella</i>)	5.8
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	11.2
Pale-headed Snake (<i>Hoplocephalus bitorquatus</i>)	63.1
Barking Owl (<i>Ninox connivens</i>)	108.4 (breeding habitat)
Masked Owl (<i>Tyto novaehollandiae</i>)	108.4 (breeding habitat)
Border Thick-tailed Gecko (<i>Uvidicolus sphyurus</i>)	9.8
Eastern Cave Bat (<i>Vespadelus troughtoni</i>)	11.2

In accordance with the BAM, offsets for impacts on habitat for ecosystem credit fauna species will be addressed through the ecosystem credits calculated for the project’s impacts on native vegetation.

Potential impacts would be avoided, minimised, managed and offset as described in section 6.6.

Summary of impacts on fauna species listed under the EPBC Act

To address the Supplementary SEARs, assessments of significance of potential impacts on relevant threatened fauna species listed under the EPBC Act that have been recorded or assumed present in the disturbance footprint (see Table 6.5) have been undertaken using the results of the targeted field surveys (see Appendix I of Technical Report 1 (BDAR)).

Taking a precautionary and conservative approach, the project is considered to have the potential to significantly impact the following species in accordance with the assessment criteria defined by the Significant impact guidelines 1.1:

- South-eastern Glossy Black-Cockatoo (*Calyptorhynchus lathami lathami*)
- Brown Treecreeper (*Climacteris picumnus victoriae*)
- Corben's Long-eared Bat (*Nyctophilus corbeni*)
- Koala (*Phascolarctos cinereus*)
- Pilliga Mouse (*Pseudomys pilligaensis*).

Potential impacts would be avoided, minimised, managed and offset as described in section 6.6.

As the significant impact criteria assessment concluded that there is the potential for a significant impact, offsets are required under the EPBC Act Offset Policy. This offset requirement would be addressed through the retirement of biodiversity credits in accordance with the BOS.

Further information on the potential impacts and proposed mitigation measures, including biodiversity offset obligations, for matters of national environmental significance are provided in Appendix I of Technical Report 1 (BDAR).

Migratory species

The White throated Needletail (*Hirundapus caudacutus*) was the only migratory species recorded during field surveys. The disturbance footprint does not contain any important habitat for migratory species. The White throated Needletail is highly mobile and predominantly aerial. Given the linear nature of the project and low densities at which this species occur, no impacts on this species are expected.

6.3.3 Aquatic ecology

Potential impacts on aquatic ecology are predicted to be minor, localised, and temporary, primarily associated with trenching at watercourse crossings and associated disturbance to riparian areas. Watercourses in the study area are ephemeral, providing aquatic habitat only intermittently following rainfall. Sensitive aquatic habitats at Bohena Creek, Tulla Mullen Creek, and Little Sandy Creek would be protected through the use of horizontal directional drilling, avoiding the potential for direct disturbance.

At other crossings, standard trenching methods would be used, but these are unlikely to significantly affect aquatic species or habitat due to the dry conditions expected during construction. Instream habitat features such as woody debris will be temporarily relocated and reinstated post-construction. Small-scale removal of riparian vegetation will be managed through targeted rehabilitation measures.

No significant impacts are anticipated on threatened aquatic species or communities, including the Southern Purple Spotted Gudgeon, Eel-tailed Catfish, or the Lowland Darling River endangered ecological community, as suitable habitat is absent or limited.

With the implementation of the mitigation measures provided in section 6.6, together with those to minimise and manage the potential for impacts on water quality and watercourses in section 8.6, the project is unlikely to result in significant residual impacts on aquatic ecology. Accordingly, offsets under the FM Act and the *Policy and guidelines for fish habitat conservation and management* (Department of Primary Industries, 2013) are not required.

Further information about the potential for impacts on water quality and watercourses is provided in Chapter 8 (Water).

6.3.4 Indirect impacts

A summary of potential indirect impacts is provided in Table 6.10. Construction of the project is expected to result in minimal indirect impacts on terrestrial and aquatic ecology within the disturbance footprint and surrounding environment. Therefore, offsets under the BAM would not be required for these indirect impacts.

Table 6.10 Indirect impacts on biodiversity

Impact	Description
Edge effects and weed invasion	<p>'Edge effects' include increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna.</p> <p>While the area already contains established weeds, the introduction of new invasive flora species and degradation of native vegetation is possible, although infestations would be relatively easy to identify and control during the construction and operation phase. The effects would be local and limited to a small area within the disturbance footprint. In low-biomass forests like the dry sclerophyll woodlands of the Pilliga, edge effects on microclimate such as humidity, light, and temperature are minimal. As a result, edge effects from the project are expected to have a low impact on nearby habitats.</p>

Impact	Description
Invasion and spread of pests, pathogens and disease	Some pest species may benefit from disturbance caused by construction activities and the construction of cleared linear areas within the forest, resulting in increased competition with native species in the disturbance footprint. The potential for significant or new impacts associated with pathogens is relatively low, given the presence of existing development and extent of human visitation across large parts of the project site and surrounding environment.
Noise, vibration and light	Fauna in the disturbance footprint are currently exposed to varying levels of light, noise and vibration from agricultural and forestry activities and traffic. Fauna that occupies habitats adjacent to existing roads would be accustomed to existing lights and high noise and vibration levels. Individuals that nest or den in trees could abandon their nests and dens as a result of noise and vibration during construction. While there would be localised increases in light, noise and vibration during construction, these are unlikely to result in a significant impact due to the large area of adjacent habitat.
Dust	If not properly managed, dust generation could reduce habitat quality for flora and fauna by affecting plant functions such as photosynthesis, respiration, and transpiration, and by potentially impacting animal health. However, there is limited potential for dust-related impacts during construction as standard construction management measures will be implemented to suppress dust (see section 10.6).
Fire	Construction presents a potential fire risk, for example from storage of combustible fuels or ignition from works areas. A fire management plan will be prepared as part of the CEMP to manage potential risk of ignition and the risk of fires spreading to adjacent areas (see section 16.6.2).
Water quality	Construction may affect downstream water quality due to sediment runoff from erosion or disturbance of watercourse beds and banks, during trenching or after heavy rainfall. However, given the ephemeral nature of the watercourses, existing water quality and the short duration of works at each crossing location, in combination with the mitigation measures proposed in section 8.6, minimal potential for impacts on water quality impacts are expected.

6.3.5 Groundwater dependent ecosystems

Technical Report 4 (Water) concluded that impacts on groundwater dependent ecosystems are not anticipated. Further information is provided in section 8.3.2.

6.3.6 Key threatening processes

The BC Act, FM Act and EPBC Act list a series of key threatening processes. These are defined as a process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community. The project itself does not constitute a key threatening process. The project would have the potential exacerbate the following key threatening processes during construction:

- clearing of native vegetation (BC Act and EPBC Act)
- loss of hollow-bearing trees (BC Act)
- the degradation of native riparian vegetation along NSW water courses (FM Act)
- the removal of large woody debris from NSW rivers and streams (FM Act).

The approach to managing the potential impacts of the project, which would address the potential impacts of key threatening processes, are described in section 6.6.

6.3.7 Additional impacts that require consideration

In accordance with the BAM, an assessment of biodiversity values, in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat are required. For many of these impacts, the biodiversity values may be difficult to quantify, replace or offset, making avoiding and minimising impacts critical. Clause 6.1 of the BC Regulation requires the following prescribed impacts to be assessed under the NSW Biodiversity Offsets Scheme. These include, where they relate to the project:

- Karst, caves, crevices, cliffs, rocks and other geological features of significance – there are a few rocky outcrop areas which may provide habitat for reptiles that are likely to be impacted by the project.
- Human-made structures or non-native vegetation – no structures or non-native vegetation providing habitat for threatened fauna or flora occur in the disturbance footprint and therefore would not be affected by the project.
- Habitat connectivity – there is the potential for impacts on fauna connectivity, this is likely to occur in the Pilliga forests (see and section 8.3.2 in Technical Report 1 – BDAR).
- Water bodies, water quality and hydrological processes – given the ephemeral nature of watercourses in the project site, changes to hydrology are likely to be minimal in the context of impacts on riparian habitat relevant to threatened species.
- Vehicle strikes – impacts of vehicle strike during construction are unlikely to substantially impact threatened species in the local areas and region as a whole.

6.4 Operation impacts

The presence of the maintained operational pipeline corridor would provide a potential barrier to some fauna movement and connectivity and may result in fragmentation of populations of some species. This may affect species such as the Squirrel Glider, Pilliga Mouse and Eastern Pygmy-possum. Proposed measures to minimise the potential for fauna connectivity impacts, such as crossing aids and the rehabilitation of the construction right of way, would be identified in a fauna connectivity strategy and implemented to support fauna movement during operation as far as practicable (see section 6.6).

A routine operation and maintenance program would be implemented which would include monitoring from a remotely operated control room as well as ground and/or aerial patrols. Given the pipeline is located underground and the limited scale of maintenance activities, no impacts on biodiversity during operation are anticipated.

6.5 Decommissioning impacts

At project closure, the pipeline would be decommissioned as described in section 3.8.

Potential biodiversity impacts associated with decommissioning are expected to be negligible given the pipeline would remain in place and removal of surface infrastructure works would be confined to already disturbed areas. Decommissioning activities are expected to be minor, temporary and highly localised, typically lasting no more than a week at any given location. There would be limited vegetation removal, thereby minimising potential impacts on threatened species or ecological communities. If vegetation is removed during decommissioning, it would occur within areas previously disturbed by the project.

Decommissioning activities will be managed in accordance with the decommissioning environmental management plan, which will ensure that any disturbance is minimised and that activities are carried out in accordance with relevant ecological control measures.

Further information about the approach to environmental management during decommissioning is provided in section 20.4 of the EIS.

6.6 Mitigation and management

6.6.1 Approach to mitigation and management

The overall approach to managing impacts on biodiversity is, in order of importance, to:

- avoid impacts through the planning and design process
- minimise impacts through the planning and design process
- mitigate impacts using a range of mitigation measures
- offset any residual impact that could not be avoided, minimised or mitigated as required by relevant legislation.

Santos is committed to minimising the potential impacts of the project where these are unavoidable and is continually investigating opportunities to reduce the disturbance footprint, where practicable. This approach to design development includes a focus on firstly avoiding and then minimising potential impacts during key phases of the design process in accordance with the BAM. Direct impacts would be reduced as far as practicable. The exact amount of clearance (within the project site) would be refined during detailed design.

Avoidance of impacts was facilitated by incorporating the assessment of alternative pipeline routes into the survey methodology and feeding that information back into the project design process. Biodiversity surveys initially investigated an area several times wider than the disturbance footprint. This allowed for the identification of areas containing TECs and other important ecological values as well as areas with existing disturbance or marginal ecological value. Route design incorporated this information and sited the alignment to avoid or minimise impacts to ecological values as much as possible.

The following avoidance and minimisation measures were incorporated into the project design:

- co-location with existing and approved disturbance areas for other projects
- optimisation of route selection through cleared agricultural lands
- optimisation of route selection to minimise impacts on threatened flora populations
- trenchless construction to avoid TECs and riparian vegetation
- minimisation of fragmentation and connectivity impacts
- retention of significant habitat trees and hollow-bearing trees.

This approach ensures that the biodiversity impacts of the project are managed in a way that is consistent with NSW legislation and policy, and that long-term conservation outcomes are achieved.

Approach to managing the key potential impacts identified

The key potential impacts identified by the biodiversity assessment are:

- removal of native vegetation, including hollow-bearing trees
- direct impacts to TECs listed under the BC Act and EPBC Act
- direct impacts on flora and fauna species listed under the BC Act and EPBC Act
- impacts to fauna habitat and connectivity for species such as the Squirrel Glider during construction and operation.

Measures to mitigate impacts that cannot be avoided are provided in section 6.6.2. The potential for impacts during construction would be managed in accordance with a project-specific biodiversity management plan, which would be prepared and implemented as part of the CEMP. The plan would detail processes and responsibilities to minimise potential impacts on biodiversity during construction.

Measures to minimise potential impacts associated with noise, flooding, water quality, soil management, soil contamination, and air quality would assist in minimising potential indirect impacts on biodiversity. These mitigation measures are provided in chapters 7 (Soils), 8 (Water), 9 (Noise and vibration), and 10 (Air quality).

Fauna connectivity measures will be implemented as defined in a fauna connectivity strategy to support fauna movement across the permanent easement.

6.6.2 List of mitigation measures

Measures that will be implemented to address potential biodiversity impacts are listed in Table 6.11.

Table 6.11 Biodiversity mitigation measures

Impact/issue	Ref	Mitigation measures	Timing
Avoiding impacts on biodiversity	BD1	Santos will continue to identify opportunities to refine the design and construction methodology to further avoid or minimise impacts on native vegetation and fauna habitat as far as practicable. The design and construction planning of watercourse crossings will continue to be refined to further avoid or minimise impacts on riparian and instream vegetation as far as practicable.	Design, pre-construction
Avoid and minimise impacts on riparian vegetation	BD2	The width of clearing will be reduced to 20 m at crossings of Bibblewindi and Little Sandy creeks.	Design, pre-construction, construction
Fauna connectivity	BD3	A fauna connectivity strategy will be prepared prior to construction to support fauna movement across the permanent easement. The strategy will: <ul style="list-style-type: none"> • prioritise forested and vegetated areas • identify key movement corridors • recommend crossing aids (e.g. glider poles) • define ongoing monitoring requirements during operation • include consultation with relevant experts and NSW Department of Climate Change, Energy, the Environment and Water (Conservation Programs, Heritage and Regulation branch). 	Design, construction, operation
Offsetting impacts on native vegetation and threatened species	BD4	Biodiversity offsets will be finalised in accordance with the NSW Biodiversity Offsets Scheme and the NSW Assessment Bilateral Agreement under the EPBC Act.	Design
General biodiversity impacts and management	BD5	A biodiversity management plan will be prepared and implemented as part of the CEMP. The plan will: <ul style="list-style-type: none"> • identify biodiversity values within the project site, including native vegetation, fauna habitats and ecologically sensitive features • describe measures to avoid, minimise and manage impacts on biodiversity values, including site-specific controls, procedures and responsibilities • specify induction and training requirements for all personnel prior to commencing site works, ensuring awareness of biodiversity values, protection measures and responsibilities • define fauna management protocols, including pre-clearing surveys, and procedures for fauna handling and relocation (see mitigation measures BD6 and BD7) • identify consultation requirements with relevant stakeholders • include a biosecurity management procedure with measures to minimise the potential or biodiversity risks in accordance with the general biosecurity duty under the <i>Biosecurity Act 2015</i> (NSW) and regional weed management plans • include an unexpected finds procedure • outline fauna monitoring and adaptive management protocols (see mitigation measure BD9). 	Pre-construction, construction
	BD6	All clearing in forest and woodland areas (including remnant patches) would be supervised by a fauna spotter catcher trained to detect, remove and relocate fauna from clearing sites.	Construction

Impact/issue	Ref	Mitigation measures	Timing
	BD7	During pre-clearing surveys (mitigation measure BD6), trees in the disturbance footprint with hollows or other high habitat values located within two metres of the edge of the disturbance footprint will be marked and avoided where practicable. Tree hollows in hollow-bearing trees within areas to be cleared will be assessed by an ecologist for suitability for salvage and relocation.	Construction
	BD8	The rehabilitation strategy (mitigation measure LU8) will include measures to support the natural regeneration and revegetation of disturbed vegetated areas, and to reinstate habitat features where appropriate and practicable.	Pre-construction
Monitoring	BD9	A fauna monitoring program, including monitoring locations, methods and timing, will be developed and implemented as part of the CEMP using appropriate techniques to monitor the presence of fauna in the disturbance footprint and inform adaptive management for mitigation of potential impacts.	Construction
Aquatic ecology at watercourse crossings	BD10	Measures to manage potential impacts on instream habitat and fish passage will be included in the construction soil and water management plan (mitigation measure SC1) with reference to the <i>Policy and guidelines for fish habitat conservation and management</i> (Department of Primary Industries, 2013) and <i>Why do fish need to cross the road?</i> (Fairfull and Witheridge, 2003), including: <ul style="list-style-type: none"> any large woody debris (i.e. snags) that may be disturbed by watercourse crossings will be temporarily relocated and replaced as close as practicable to the original location and orientation relative to the bank measures for dewatering and fish salvage at watercourse crossings, if required. 	Pre-construction
Riparian vegetation	BD11	The rehabilitation strategy (mitigation measure LU8) will include measures to provide for the rehabilitation (including revegetation where appropriate) of watercourses and riparian areas disturbed during construction.	Pre-construction

6.6.3 Offsetting

Biodiversity offset requirements under the BC Act

The offsets required to compensate for the residual terrestrial biodiversity impacts under the BC Act have been determined using the BAM Calculator. In accordance with the offset rules established by the BC Regulation, offset obligations can be achieved by retiring appropriate biodiversity credits from an established Biodiversity Stewardship Site, monetary payment directly into the Biodiversity Conservation Fund, or funding an approved biodiversity action.

A total of up to 3,871 ecosystem credits are estimated to be required to offset the project’s impacts on native vegetation as shown in Table 6.12. This would also offset impacts on habitat for ecosystem-credit threatened fauna species.

Table 6.12 Ecosystem credits

PCT	Ecosystem credits
Pilliga Box - White Cypress Pine - Buloke shrubby woodland (PCT 88)	244
Poplar Box - Yellow Box - Western Grey Box grassy woodland on cracking clay soils (PCT 101)	397
Broombush - wattle very tall shrubland (PCT 141)	59
Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest (PCT 398)	1,713
Rough-barked Apple - Blakely's Red Gum - Black Cypress Pine woodland (PCT 401)	630
White Bloodwood - Red Ironbark - Black Cypress Pine shrubby sandstone woodland (PCT 405)	372
Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland (PCT 408)	367
Narrow-leaved Ironbark - cypress pine - White Box shrubby open forest (PCT 592)	82
Total	3,864

The disturbance footprint is known or assumed to support 27 species-credit species as detailed in with A total of up to 36,317 species credits are estimated to be required to offset the project's impacts on species credit species as shown in Table 6.13.

Table 6.13 Species credits

Species	Species credits
Flora	
<i>Androcalva procumbens</i> (syn. <i>Commersonia procumbens</i>)	814
<i>Cyperus conicus</i>	64
Bluegrass (<i>Dicanthium setosum</i>)	61
Finger Panic Grass (<i>Digitaria porrecta</i>)	61
Pine Donkey Orchid (<i>Diuris tricolor</i>)	2,751
Spiny Peppercress (<i>Lepidium aschersoni</i>)	100
Winged Peppercress (<i>Lepidium monoplocoides</i>)	425
Belson's Panic (<i>Homopholis belsonii</i>)	61
Large-leaved Monotaxis (<i>Monotaxis macrophylla</i>)	54
Native Milkwort (<i>Polygala linariifolia</i>)	487
Scant Pomaderris (<i>Pomaderris queenslandica</i>)	54
Greenhood Orchid (<i>Pterostylis cobarensis</i>)	4,303
Slender Darling Pea (<i>Swainsona murrayana</i>)	83
Austral Toadflax (<i>Thesium australe</i>)	46
<i>Tylophora linearis</i>	2,087

Species	Species credits
Fauna	
Pink-tailed Worm-lizard (<i>Aprasia parapulcella</i>)	176
South-eastern Glossy Black-Cockatoo (<i>Calyptorhynchus lathami</i>)	1,367
Eastern Pygmy Possum (<i>Cercartetus nanus</i>)	4,401
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	326
Pale-headed Snake (<i>Hoplocephalus bitorquatus</i>)	2,168
Square-tailed Kite (<i>Lophoictinia isura</i>)	109
Barking Owl (<i>Ninox connivens</i>)	3,532
Squirrel Glider (<i>Petaurus norfolcensis</i>)	4,190
Koala (<i>Phascolarctos cinereus</i>)	4,447
Masked Owl (<i>Tyto novaehollandiae</i>)	3,532
Border thick-tailed Gecko (<i>Uvidicolus sphyrurus</i>)	292
Eastern Cave Bat (<i>Vespadelus troughtoni</i>)	326
Total	36,317

Biodiversity offset obligations under the EPBC Act – offset for significant impacts

In accordance with the *EPBC Act Environmental Offsets Policy* (DSEWPaC, 2012), biodiversity offsets are required to compensate for significant residual impacts on matters of national environmental significance after all reasonable avoidance, minimisation, and mitigation measures have been applied. Where potential impacts on matters of national environmental significance can be reduced to below the threshold of significance, biodiversity offsets are not necessary.

Under the Bilateral Agreement the retirement of biodiversity credits in accordance with the BOS is considered an acceptable offsetting mechanism for potentially significant impacts on matters of national environmental significance. These offset requirements have been calculated using the BAM Calculator and will be delivered in line with the BOS and the BC Act, in accordance with the Bilateral Agreement.

Biodiversity offset strategy

The biodiversity offset strategy will adopt a mix of approaches including:

- purchase of biodiversity credits from existing biodiversity stewardship sites
- payment to the Biodiversity Conservation Fund corresponding to the number and type of credits required
- retirement of biodiversity credits created from a Biodiversity Stewardship Agreement on land with the required biodiversity values
- establishing offset sites
- funding of an approved biodiversity action.

The final strategy and proposed offset delivery approach would be confirmed as the design of the project is further refined and the final disturbance footprint is confirmed.