Tarrawonga Coal Project

Environmental Assessment

APPENDIX F

FLORA ASSESSMENT

Resource Strategies

Tarrawonga Coal Pty Ltd

Tarrawonga Coal Project – Flora Assessment

Prepared for Whitehaven Coal Pty Ltd

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1 SUMMARY AND CONCLUSIONS

Flora Communities and Species

1. A flora survey of the Tarrawonga Coal Project area was conducted over a total of 17 days: in November 2010 (6 days), January 2011 (5 days), May 2011 (1 day), July 2011 (3 days) and August 2011 (2 days).
2. The study area was found to support 5 native vegetation communities comprising: White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (4 forms); White Box - White Cypress Pine shrubby woodland (2 forms), White Box - White Cypress Pine grassy woodland (4 forms); Narrow-leaved Grey Box - Poplar Box - White Cypress Pine grassy open woodland (2 forms); and Bracteate Honeymyrtle low riparian forest.
3. The surveys employed quadrat plots, spot sampling sites, random meanders, shrub cover transects and line intercept intersects.
4. A total of 363 flora species were found on the study area, of which 269 (74.1%) are native and 94 (25.9%) are introduced.
5. The plant families with the highest numbers of species were the Grasses, Poaceae (66 species); Daisies, Asteraceae (56 species); Pea Flowers, subfamily Faboideae (19 species); the saltbushes and bluebushes, Chenopodiaceae (16 taxa); the Mallows and Sidas, Malvaceae (12 species) and the Eucalypts and related genera in the family Myrtaceae (12 species). In all, some 80 plant families or subfamilies were represented.
6. The highest proportions of introduced species and weeds were found in the disturbed riparian zone of Goonbri Creek and in the cleared and semi-cleared pasture areas. The least weeds were found in the less disturbed habitats of Leard State Forest.

Condition of the Vegetation

7. The condition of the native vegetation within the study area varied considerably. In general the most disturbed areas are the lower slopes and valley floor used historically for cropping and grazing and these are considered to be in poor condition. The semi-cleared and regenerating slopes and ridges on the Project-related property to the east of the current Tarrawonga Coal Mine are considered to be in moderate to good condition. The parts of the study area in Leard State Forest are the least disturbed, despite past logging, and are considered to be in good to excellent condition.

Threatened Flora Species and Populations

8. No flora species or populations listed in the schedules of the New South Wales (NSW) *Threatened Species Conservation Act, 1995* (TSC Act) or the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act), were found in the study area.

Threatened Vegetation Communities and Critical Habitat

9. One vegetation community dominated by White Box (*Eucalyptus albens*) is considered to belong to the White Box-Yellow Box-Blakely's Red Gum Woodland Endangered Ecological Community (EEC) listed under the TSC Act, or the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands Critically Endangered Ecological Community (CEEC) listed under the EPBC Act.
10. No Critical Habitat listed in the schedules of the TSC Act or EPBC Act was found in the study area or surrounds.

Assessment of Project Impacts on Native Flora

11. The Project is assessed as having the following potential impacts on native flora:

- A loss of 397 hectares (ha) of predominantly native vegetation, including derived native grasslands.
- A loss of 13 ha of White Box, Yellow Box, Blakely's Red Gum Woodland EEC listed under the TSC Act, which is equivalent to the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands CEEC listed under the EPBC Act.
- No significant increase in habitat fragmentation.
- A low potential for weed incursion into the high quality native bushland in Leard State Forest due to low soil fertility in the forest.
- A low likelihood of adversely affecting ground water dependent vegetation communities.
- Moderate potential for sporadic short term adverse effects of dust on native vegetation close to the working open cut.
- A low risk of increased bush fire frequency.
- The main potential cumulative long term impact of the Project is its contribution to the likely loss of most of the existing native vegetation on outcrop areas of the Permian Maules Creek Formation.
- A threatened flora assessment concluded that the Project has a low potential to adversely affect populations of *Diuris tricolor*, *Pomaderris queenslandica, Pultenaea setulosa* and *Thesium australe* that were assessed as having a moderate or high potential to occur in the study area.

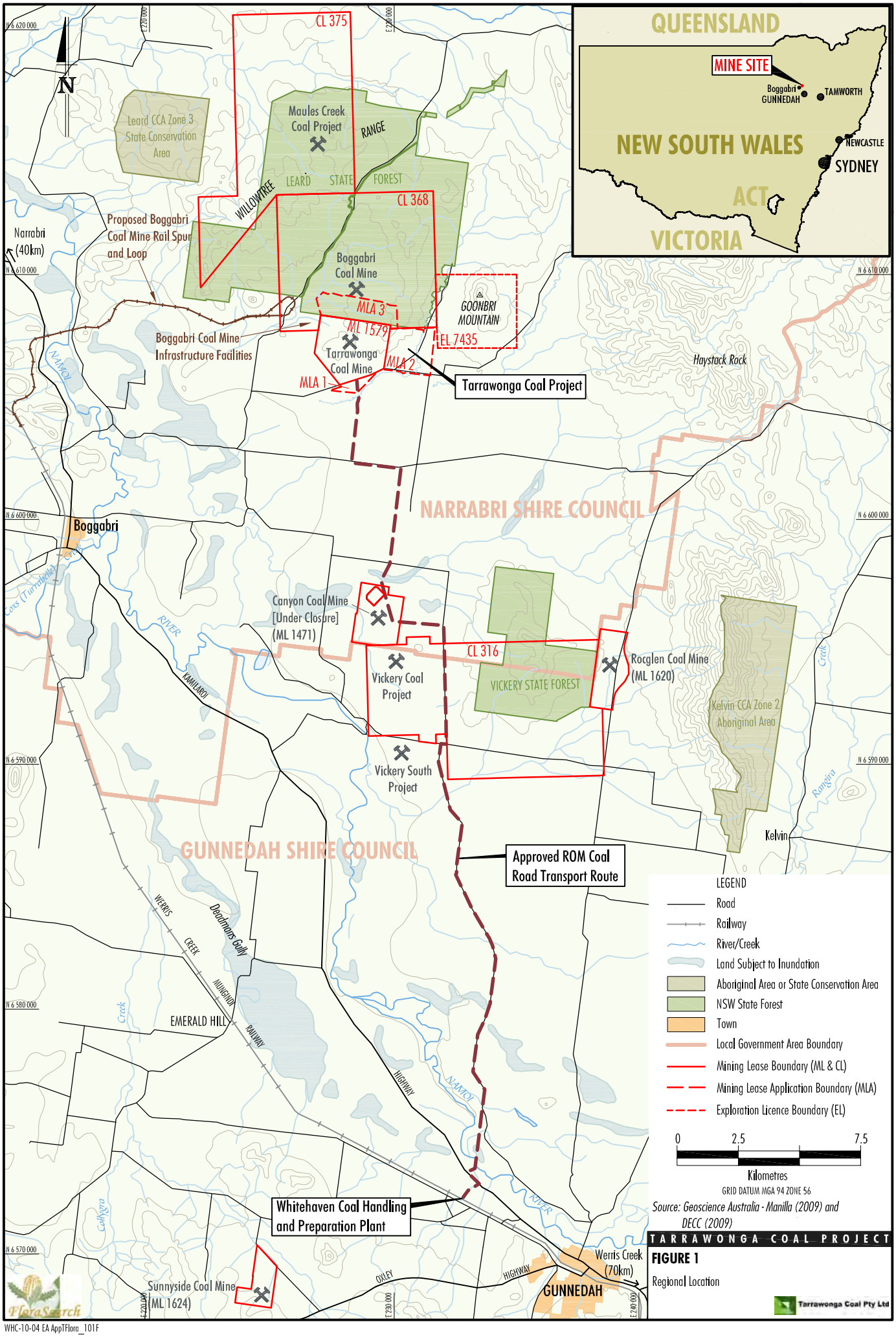
2 INTRODUCTION

FloraSearch was commissioned by Whitehaven Coal Pty Ltd (Whitehaven) to conduct a flora assessment for the Tarrawonga Coal Project (the Project), located approximately 15 kilometres (km) north-east of Boggabri and 42 km north-northwest of Gunnedah in the Gunnedah Basin, NSW (Figure 1).

The main activities associated with the development of the Project would include (Figure 2):

- continued development of mining operations in the Maules Creek Formation to facilitate a Project run-of-mine (ROM) coal production rate of up to 3 million tonnes per annum (Mtpa), including open cut extensions:
  - to the east within Mining Lease (ML) 1579 and Mining Lease Application (MLA) 2; and
  - to the north within Coal Lease 368 (MLA 3) which adjoins ML 1579;
- ongoing exploration activities;
- construction and use of a services corridor (including haul road link) directly from the Project open cut mining operation to the upgraded Boggabri Coal Mine Infrastructure Facilities[1];
- use of upgraded Boggabri Coal Mine Infrastructure Facilities for the handling and processing of Project coal and the loading of Project product coal to trains for transport on the Boggabri Coal Mine private rail spur to the Werris Creek Mungindi Railway[1];
- construction and use of a new mine facilities area including relocation of existing mine facilities infrastructure and service facilities;
- use of an existing on-site mobile crusher for coal crushing and screening of up to 150,000 tonnes (t) of domestic specification coal per annum for direct collection by customers at the mine site;
- use an existing on-site mobile crusher to produce up to approximately 90,000 cubic metres (m^3) of gravel materials per annum for direct collection by customers at the mine site;
- progressive backfilling of the mine void behind the advancing open cut mining operation with waste rock and minor quantities of coarse reject material;
- continued and expanded placement of waste rock in the Northern Emplacement (including integration with the Boggabri Coal Mine emplacement) and Southern Emplacement, as mining develops;
- progressive development of new haul roads and internal roads, as mining develops;
- realignment of sections of Goonbri Road and construction of new intersections;
- construction of an engineered low permeability barrier to the east and south-east of the open cut to reduce the potential for local drainage of alluvial groundwater into the open cut;
- removal of a section of Goonbri Creek within the Project open cut and the establishment of a permanent Goonbri Creek alignment and associated flood bund to the east and south-east of the open cut;
- progressive development of sediment basins and storage dams, pumps, pipelines and other water management equipment and structures;
- continued development of soil stockpiles, laydown areas and gravel/borrow areas;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

[1] Subject to approvals and upgrades being in place for the transfer of Project ROM coal to the Boggabri Coal Mine Infrastructure Facilities.



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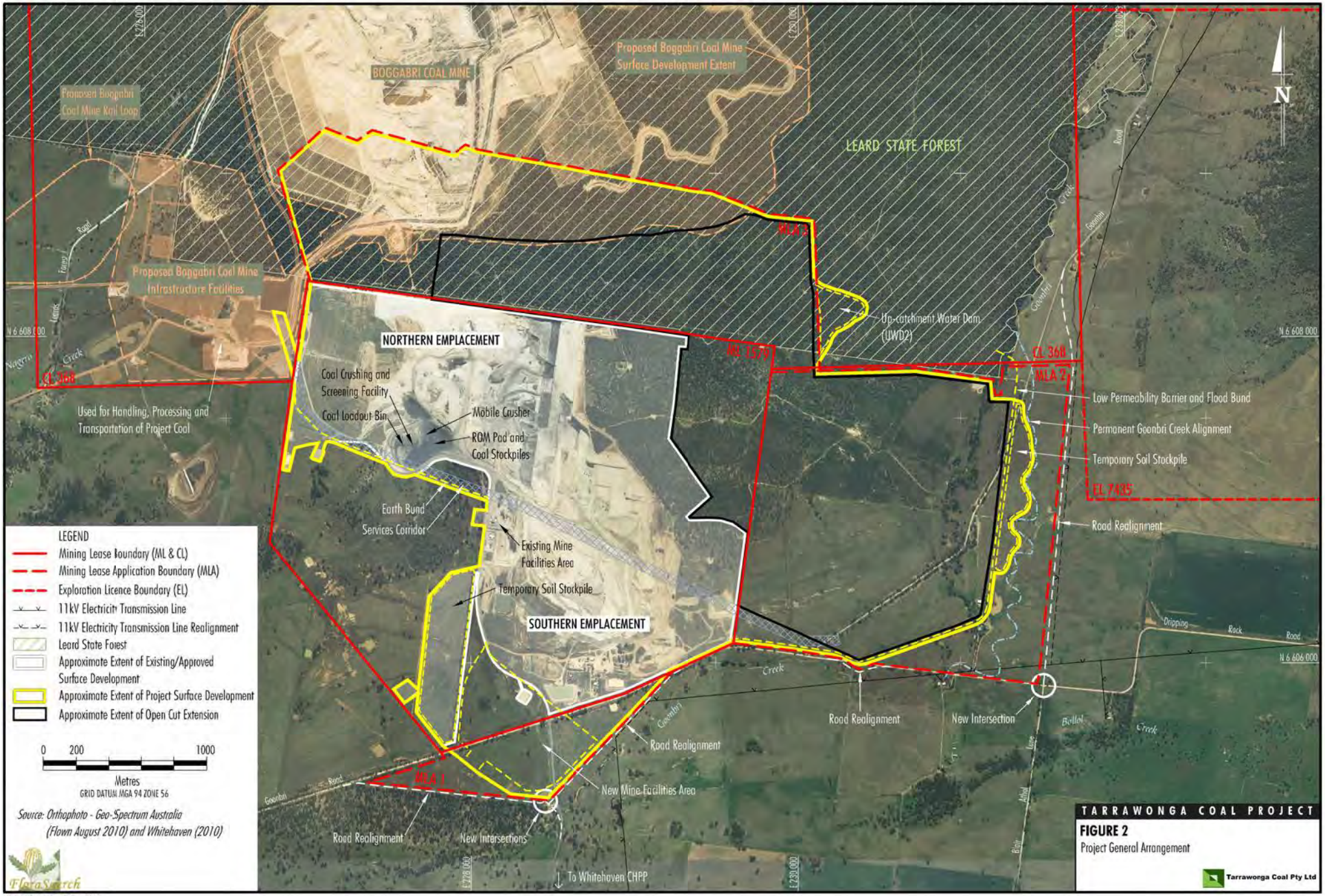

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The proposed life of the Project is 17 years, commencing 1 January 2013.

Further detail regarding the Project description is provided in Section 2 of the main text of the Environmental Assessment (EA).

2.1 SURVEY AND ASSESSMENT OBJECTIVES

The objectives of the survey were to:

- sample the vegetation within the study area using standard flora survey techniques;
- determine and map the vegetation communities present within the study area;
- compile a comprehensive plant species list for each vegetation community;
- develop a list of threatened plant species, populations, communities or critical habitat, listed in the schedules of the TSC Act and EPBC Act, considered to be Rare or Threatened Australian Plants (ROTAP) by Briggs and Leigh (1996), that could potentially occur in the study area;
- conduct targeted searches for potentially occurring threatened plant species, populations, communities and critical habitat, and map any occurrences;
- conduct a detailed analysis of the potential impacts of the proposed Project on flora and their habitats;
- discuss avoidance and mitigation measures to minimise impacts on threatened flora;
- assess the impact of the Project on threatened flora by consideration of the six factors of assessment in the NSW *Draft Guidelines for Threatened Species Assessment* (NSW Department of Environment and Conservation [DEC] and NSW Department of Primary Industries [DPI] 2005); and
- address the NSW Department of Planning and Infrastructure's (DP&I) Director-General's Requirements, where relevant, quoted below:
    - ***Biodiversity*** *– including:*
        - *accurate estimates of the proposed vegetation clearing;*
        - *a detailed assessment of the potential impacts of the project on any:*
            - *terrestrial or aquatic threatened species or populations or their habitats, endangered ecological communities or groundwater dependent ecosystems;*
            - *regionally significant remnant vegetation, or vegetation corridors; and*
            - *the matters outlined in Appendix B;* [i.e. comments on assessment requirements for Environmental Assessment of the Tarrawonga Coal Project, provided on the 11 April 2011 by the Department of Sustainability, Environment, Water, Population and Communities to the DoPI]
        - *a detailed description of the measures that would be implemented to avoid or mitigate impacts on biodiversity;*
        - *an offset strategy to address the residual impacts of the project, and ensure that the project would maintain or improve the biodiversity values of the region in the medium to long term;*

2.2 REGIONAL SETTING

The study area occurs within the Gunnedah Basin geological formation on the NSW North West Slopes and Plains. The Gunnedah Basin developed in a trough between the Lachlan Fold Belt to the west and the New England Fold Belt on the eastern side of the Mooki Thrust (Pratt 1998), approximately 6 km east of the study area. The Gunnedah Basin lies within the Namoi River catchment that is bounded by the Liverpool Range to the south, the Great Dividing Range to the east, the Nandewar Range to the north and the Pilliga Scrub to the west.

Most of the lower lying areas of the Namoi Valley comprise Quarternary alluviums from which the native vegetation has been almost completely cleared for agriculture. Within the Gunnedah Basin native vegetation persists on the steep terrain of small inselbergs, such as Mount Binalong and Goonbri Mountain that respectively comprise remnants of former Jurassic and Tertiary volcanic landscapes. Native vegetation also remains on the poorer soils of Early Permian sediments, such as the Maules Creek, Goonbri and Leard Formations of the Leard and Vickery State Forests.

In the areas north of Boggabri, significant naturally vegetated areas occur on rugged outcrops of the Early Permian Boggabri Volcanics that underly the sedimentary formations (e.g. Leard State Conservation Area). On the eastern side of the Mooki Thrust, rugged ranges comprising Carboniferous sediments and tuffs also support native vegetation (e.g. Kelvin State Forest).

2.3 DESCRIPTION OF THE STUDY AREA AND SURROUNDS

The study area for the flora survey in this report comprises lands to the north, east and south of the existing Tarrawonga Coal Mine (Figure 2). The study area includes part of Leard State Forest and parts of several previous agricultural properties (Figure 2). The study area is traversed by Goonbri and Dripping Rock Roads.

2.3.1 Topography and Drainage

The watercourses on the study area form an interrupted channel network (Speight 2009). Goonbri Creek drains the eastern side of the Willowtree Range in Leard State Forest, Middle Mountain and Goonbri Mountain. The lower reaches of Goonbri Creek traverse the study area as an incised channel owing to the existence of a low landscape gradient. However, it loses definition on the flat plain west of the study area. Bollol Creek enters the study area from the east as a low non-incised drainage line whose waters disperse onto the plain and are lost to the substrate (Figure 2).

Altitudes in the study area range from 260 metres (m) Australian Height Datum (AHD) on the alluvial flats in the south to 360 m AHD in Leard State Forest. The terrain on the agricultural properties in the south is flat, ranging from 260 to 280 m AHD over approximately 4 km. By contrast, the area within Leard State Forest has steeper, more dissected terrain ranging from 300 to 370 m AHD.

2.3.2 Geology and Soils

The study area is situated mainly on Early Permian age coal measures of the Maules Creek Formation, which, in addition to coal, largely comprise conglomerates, with lesser amounts of sandstone, siltstone and claystone (Pratt 1998). The southern parts of the study area on flatter terrain comprise quarternary alluvial sediments. Infilling of the Namoi Valley with alluvial deposits (Namoi Sediments) to form a broad flat valley floor is thought to have begun in the Pliocene (<5.3 million years ago [Ma]) and has continued to the present (*ibid.*). The low slope of the valley floor and the lack of topographical relief suggest the Namoi Valley may have been dammed intermittently during this period at Cox's Gap, 8 km north of Boggabri, forming a large lake (*ibid.*). The surface layer of the Namoi Sediments, known as the Curlewis Member or Narrabri Formation, is Pleistocene in age (<1.8 Ma), and comprises brown clays becoming darker near the surface, with limited channel sand and gravel deposits (*ibid.*).

2.3.3 Climate

The study area lies within the eastern subhumid region of Australia which has a hot summer and no dry season (NSW National Parks and Wildlife Service [NPWS] 2003). A detailed discussion of the climate of the study area and surrounds is provided by Gilbert and Associates (2011) (Appendix B of the Project EA).

2.3.4 Land Use

The study area was part of the tribal lands of the Kamilaroi Aboriginal people who inhabited the Liverpool Plains (NPWS 2003). The European settlement of the valley began in 1835 with the establishment of a sheep run called Namoi Hut at the confluence of the Namoi River and Cox's Creek (Heritage Management Consultants 2011 [Appendix L of the Project EA]).

The fertile soils of the Namoi Valley support a diverse range of agricultural industries including both winter and summer cropping, and cattle, sheep and pig production (Gunnedah Shire Council 2011). Wheat is the most widely grown cereal crop followed by sorghum, barley, maize and sunflowers. Cotton is a significant summer crop. Other important crops include oats, canola, soybeans, mung beans, chickpeas and safflower (*ibid.*). The total annual value of agricultural production is $120 million in the Gunnedah Shire (*ibid*.) and $439.5 million in the Narrabri Shire (Narrabri Shire Council 2011). On the study area, agricultural pursuits including cropping and grazing have been the dominant forms of land use since white settlement of the area. Logging of Ironbark and White Cypress Pine would also have occurred episodically in Leard State Forest and on privately owned land.

Open cut and underground coal mining, for both domestic and export markets, is also prominent on the Liverpool Plains. The Boggabri Coal Mine and proposed Maules Creek Project are to the north of the study area (Figure 1).

2.4 BOTANICAL/BIOGEOGRAPHIC REGIONS

The study area occurs in the southern part of the North West Slopes Botanical Division (Anderson 1968; Harden [Ed.] 1990-2002). It also lies in the Liverpool Plains subregion of the Brigalow Belt South Bioregion as defined originally by Thackway and Cresswell (1995). This bioregion extends from Dubbo in NSW to the central coast of Queensland and occupies 22.6 million ha, with 5.3 million ha in NSW. The study area lies close to the eastern boundary of the Brigalow Belt South Bioregion with the Nandewar Bioregion. Consequently the vegetation of the study area can be expected to have similarities with that of the nearby parts of the Nandewar Bioregion. The site also occurs within the Liverpool Plains (Part B) Catchment Management Authority (CMA) subregion of the Namoi CMA area.

3 PREVIOUS VEGETATION STUDIES

3.1 REGIONAL SURVEYS

The Brigalow Belt South and Nandewar Bioregions were the subjects of large survey efforts (the Western Regional Assessments) by the NSW Government between 1999 and 2004 to obtain a comprehensive understanding of the vegetation in order to inform conservation decisions that were formalised in the NSW *Brigalow and Nandewar Community Conservation Area Act, 2005*. The assessments also provided scientific information on which to base Forest Agreements, as well as providing information for use by other regional planning organisations such as Regional Vegetation Management Committees and Catchment Management Boards (Beckers and Binns 2000). These studies generated a large number of reports; the most relevant for this study are discussed below.

1. ***Brigalow Belt South - Stage 1. Vegetation Survey and Mapping (Beckers and Binns 2000).***

   This project collated and analysed existing survey data (790 plots) with that from 474 new survey plots for crown lands (State Forests, Nature Reserves and vacant crown land) in the area south of Narrabri. This included 9 plots in Leard State Forest close to the study area. Some 1,850 plant species, including 1,569 native species (85%) were recorded in a combined dataset of 2554 plots. The project identified 492 'unique vegetation mapping types' within 60 'broad overstorey types'. Nine vegetation mapping types were reported for Leard State Forest (Table 1).

Table 1
Vegetation Types in Leard State Forest

Vegetation Type	Scientific Names	Area (ha)
Ironbark - Western Box	*Eucalyptus crebra*[1] - *E. microcarpa*	1,589
Red Ironbark	*E. fibrosa*[1]	2,511
Untyped	-	59
Western Box	*E. macrocarpa*	376
White Box	*E. albens*	214
White Cypress Pine - Box	*Callitris glaucophylla* - *E. albens*[1]	1,171
White Cypress Pine - Narrow-leafed Ironbark	*Callitris glaucophylla* - *E. crebra*	2,482
White Cypress Pine - Red Gum	*Callitris glaucophylla* - *E. chloroclada*	63
White Cypress Pine - Western Ironbarks	*Callitris glaucophylla* - *E. melanophloia*[1]	182

Source: Beckers and Binns (2000).

[1] Scientific names in this table have been inferred from the common names provided by Beckers and Binns (2000). Some scientific names are uncertain owing to their use of broad common names such as Ironbark and Box. In these cases the most likely species has been selected. However, their use of broad names may reflect potential for the presence of more than one species in these groups.

2. ***Brigalow Belt South - Stage 2. Targeted Flora Survey and Mapping (NPWS 2002a).***

   This project focussed on the whole of the Brigalow Belt South Bioregion, including private land. It identified records for 2,458 vascular plant taxa within the Bioregion, of which 84% (2,075) are native species. Within the Liverpool Plains subregion, which includes the study area, 739 plant species were recorded. Of these, 24 each are listed as Vulnerable and Endangered under the TSC Act, while 23 and 10 are listed as Vulnerable and Endangered, respectively, under the EPBC Act. No site locations for any of the threatened taxa fell within Leard State Forest or the study area.

3. ***Brigalow Belt South - Stage 2. Joint Vegetation Mapping Project (NSW Department of Infrastructure, Planning and Natural Resources [DIPNR] 2004).***

   Multivariate statistical analysis of 3,139 flora plot sites identified 115 vegetation types within the Brigalow Belt South Bioregion. GIS modelling was used to construct predictive probability maps of the possible current and former distributions of each community. By including the full probability distribution for each community in the mapping, the maps tend to show much larger possible distributions for the vegetation types than is likely in reality, thus limiting their usefulness. For example, some 40 vegetation types are mapped as having some probability of occurring on or near the study area. Many of these have their typical areas and core distributions remote from the study area. In addition, none of the 40 communities is represented as having a high probability of occurring on the study area, suggesting strongly that the modelling is biased towards vegetation types from other parts of the Brigalow Belt South Bioregion. Consequently, this study has limited usefulness for the study area.

4. ***NSW Western Regional Assessments, Nandewar. Biodiversity Surrogates - Vegetation (Wall 2004).***

   The study area is close to the eastern margin of the Brigalow Belt South Bioregion, which adjoins the Nandewar Bioregion. Consequently, it is likely that similar vegetation may occur in the western parts of the Nandewar Bioregion to that on the study area (Wall 2004). Some 113 vegetation communities were derived from statistical analysis of floristic data from 2,908 flora plots. Over 1,600 native and 370 exotic taxa were recorded. White Box and White Cypress Pine were commonly recorded and '*are regarded as signature species for this region*' (Wall 2004). Distribution maps were produced of the predicted extant and historical distribution of vegetation communities across the region.

5. ***NSW Vegetation Types Database (NSW Department of Environment, Climate Change and Water [DECCW] 2008).***

   The NSW Vegetation Types Database was established for use with the NSW Biometric methodology (Gibbons *et al*. 2005) for the development of Property Vegetation Plans under the *NSW Native Vegetation Act 2003*. The database recognises 143 vegetation types in the Namoi CMA area, which includes the whole catchment of the Namoi River from the New England Tablelands in the east, the Liverpool Range in the south and the Nandewar Range in the north to its confluence with the Barwon River near Walgett. The catchment includes a wide range of climatic conditions from sub-alpine to semi-arid and landscapes from montane to inland plains. The Liverpool Plains and the study area lie near the centre of the catchment. The DECCW (2008) vegetation classification for the Namoi catchment was compiled from a number of sources including mainly Benson *et al*. (2006) for the western plains part of the area, Wall (2004) and NPWS (1999) for the higher eastern areas, and DIPNR (2004) and Wall (2004) for the central areas. The vegetation types in DECCW (2008) were derived by amalgamating similar units from the previous studies to form a set of broad, easily recognisable regional vegetation groups.

6. ***NSW Vegetation Classification and Assessment: Plant communities of the BBS, NAN & West New England Tablelands (NET) Bioregions (Benson et al. 2010.)***

   A comprehensive synthesis of all previous vegetation studies in the Brigalow Belt South and Nandewar Bioregions was recently published in the fourth paper in the NSW Vegetation Classification and Assessment (NSWVCA) series (Benson *et al*. 2010). This classification endeavours to identify, describe and assess the conservation status of vegetation communities at the 'plant association' level defined by Beadle and Costin (1952). By applying a common approach to vegetation classification across the whole state, the NSWVCA aims to develop a consistent, validated state-wide categorisation of communities. The NSWVCA recognises a total of 235 plant communities in the Brigalow Belt South Bioregion (Benson *et al.* 2010). Owing to its broad regional focus, the NSWVCA does not provide specific information on the study area and no vegetation mapping is provided. However, the detailed vegetation descriptions allow vegetation on the study area to be matched to the appropriate NSWVCA community. The NSWVCA also provides a detailed assessment of the vegetation types in the Brigalow Belt South Bioregion that are part of threatened ecological communities at the state and Commonwealth level.

3.2 LOCAL SURVEYS

Several vegetation surveys have been conducted on and near the study area for previous development applications for the Tarrawonga Coal Mine and Boggabri Coal Mine. The most relevant and comprehensive of these are discussed below.

1. ***Proposed East Boggabri Coal Mine – Flora Assessment of Proposed Mine Site (Geoff Cunningham Natural Resource Consultants 2005).***

Geoff Cunningham Natural Resource Consultants (GCNRC) (2005) identified and described eight vegetation communities on the original approved area of the Tarrawonga Coal Mine (Table 2). GCNRC (2005) recorded 146 native and 36 introduced flora species on 70 sample sites. No threatened plant species were recorded by GCNRC (2005) on their study area. However, GCNRC (2005) identified disturbed remnants of Narrow-leaf Ironbark-White Cypress Pine (GCNRC Community 2) as an EEC, listed as the White Box Yellow Box Blakely's Red Gum Woodland EEC under the TSC Act, and as the then Grassy White Box Woodlands EEC under the EPBC Act. GCNRC (2005) considered that communities dominated by White Box (*Eucalyptus albens*) on their study area, viz. the White Box - Pilliga Grey Box - Narrow-leaf Ironbark Community (GCNCR Community 7) and the Shrubby White Box Woodland Community (GCNCR Community 8), were not part of the listed threatened communities. No justification is provided for accepting GCNCR Community 2 as part of the EECs, or for rejecting GCNCR Communities 7 and 8 from the EECs.

Table 2
Vegetation Communities Previously Mapped Within the Study Area and Immediate Surrounds

Landscape Position	GCNRC (2005)		Eco Logical Australia (2010)		Parsons Brinkerhoff (2010)	
	Community Name	**Scientific Name**	**Community Name**	**Scientific Name**	**Community Name**	**Scientific Name**
Hills and ridges	Narrow-leaf Ironbark - White Cypress Pine	*Eucalyptus crebra - Callitris glaucophylla*	White Cypress Pine – Narrow-leaved Ironbark shrub/grass open forest (advanced growth)	*C. glaucophylla - E. crebra*	Narrow-leaved Ironbark - White cypress Pine shrubby open forest	*C. glaucophylla - E. crebra*
	Regenerating White Cypress Pine – Narrow leaf Ironbark - Wattle	*C. glaucophylla - E. crebra - Acacia* spp.				
Lower slopes	Shrubby White Box Woodland Community	*Eucalyptus albens*	White Box - White Cypress Pine shrubby open forest	*E. albens - C. glaucophylla*	White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	*E. albens - E. crebra - C. glaucophylla*
	-	-	-	-	White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest	*E. albens - E. crebra - C. glaucophylla*
	-	-	White Box grassy woodland	*E. albens*	White Box - White Cypress Pine grassy woodland	*E. albens - C. glaucophylla*
	White Box – Narrow-leaved Grey Box - Narrow-leaf Ironbark	*E. albens - Eucalyptus pilligaensis - E. crebra*	-	-	-	-
Valley floor	Box - White Cypress Pine - Bull Oak	*E. pilligaensis - Eucalyptus populnea* subsp. *bimbil - C. glaucophylla - Allocasuarina luehmannii*	Narrow-leaved Grey Box - Poplar Box - White Cypress Pine grassy open woodland	*E. pilligaensis – E.. populnea* subsp. *bimbil - C. glaucophylla*	Narrow-leaved Grey Box - Poplar Box - White Cypress Pine grassy open woodland	*E. pilligaensis - E. populnea* subsp. *bimbil - C. glaucophylla*
	White Box – Yellow Box - Blakely's Red Gum - White Cypress Pine	*E. albens - Eucalyptus melliodora - Eucalyptus blakelyi - C. glaucophylla*	-	-	-	-
	Belah	*Casuarina cristata*	-	-	-	-
Mainly lower slopes and valley floor	Cleared Lands	-	-	-	Derived native grassland	-
		-	-	-	Exotic grassland	-

2. *Tarrawonga Coal Mine Modification - Biobanking and Threatened Species Assessment Report (Eco Logical Australia 2010)*

Eco Logical Australia (2010) prepared a *Biobanking and Threatened Species Assessment* for the Tarrawonga Coal Mine Modification. This identified four Revised Biometric Vegetation Types (DECCW 2008) on ML 1579 on which the Tarrawonga Coal Mine is located:

- White Cypress Pine – Narrow-leaved Ironbark Shrub/Grass Open Forest of the Western Nandewar Bioregion;
- White Box Grassy Woodland of the Nandewar and Brigalow Belt South Bioregions;
- Narrow-leaved Grey Box - Poplar Box - White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone; and
- White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions.

Eco Logical Australia (2010) considered the occurrences of the *White Box Grassy Woodland of the Nandewar and Brigalow Belt South Bioregions* community in the modification area met the definition of the White Box-Yellow Box-Blakely's Red Gum Woodland EEC listed under the TSC Act. One small occurrence of this community (0.8 ha) was considered to meet the definition of the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC listed under the EPBC Act. Eco Logical Australia (2010) also concluded that no threatened flora species listed under the TSC Act or EPBC Act had been previously recorded in the modification area or were found by suitable targeted surveys.

3. *Continuation of Boggabri Coal Mine – Biodiversity Impact Assessment (Parsons Brinkerhoff 2010)*

Parsons Brinkerhoff (2010) conducted a *Biodiversity Impact Assessment* for proposed continuation of the Boggabri Coal Mine that adjoins the northern boundary of the Tarrawonga Coal Mine ML. The Parsons Brinkerhoff (2010) study area included the whole of Leard State Forest. A small part to the south east of the Parsons Brinkerhoff study area is also a part of the study area for this report. Much of the Parsons Brinkerhoff (2010) study area involves environments that do not occur on the study area for this report, in particular, the Boggabri rail corridor where it traverses alluvial landscapes, and the northern and western parts of Leard State Forest that have different geology and soils. Only those vegetation communities in the Parsons Brinkerhoff (2010) study area that occur close the study area in this report are given in Table 2.

Parsons Brinkerhoff (2010) identified a total of 16 vegetation communities on their study area, seven of which (Table 2) occur in close proximity to the study area of this report. Three communities listed as endangered under the TSC Act were identified by Parsons Brinkerhoff (2010), one of which, the White Box-Yellow Box-Blakely's Red Gum Woodland EEC (Box-Gum Woodland), has potential to occur on the study area for this report. The same community was also considered to conform to the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands CECC listed under the EPBC Act.

Parsons Brinkerhoff (2010) considered that two vegetation types in Leard State Forest conformed to the Box-Gum Woodland EEC/CEEC. These are:

- The White Box-Narrow-leaved Ironbark-White Cypress Pine grassy open forest community; and
- White Box-White Cypress Pine grassy woodland community.

Further discussion regarding some of the areas mapped by Parsons Brinkerhoff (2010) as these communities is provided in Section 6.6.

Parsons Brinkerhoff (2010) conducted 134 flora quadrat samples over their whole study area, which resulted in the recording of 427 flora species; 365 of which are native. One threatened flora species was recorded in their surveys; *Pultenaea setulosa*, which is listed as Vulnerable under the EPBC Act. In addition, they noted a record of *Pomaderris queenslandica* (Scant Pomaderris) that had been previously recorded in Leard State Forest (PlantNet Flora Online Spatial Search), and is listed as Endangered under the TSC Act.

4 THREATENED SPECIES, POPULATIONS, ECOLOGICAL COMMUNITIES AND CRITICAL HABITAT

4.1 BACKGROUND REVIEW

Lists of threatened species, populations, ecological communities and critical habitat that are known, or have potential, to occur in the study area were derived by consulting the following sources:

- DECCW Atlas of NSW Wildlife (DECCW 2010) using a search area of approximately 20 km x 20 km covering the study area.
- DECCW List of Threatened Species Known or Predicted to occur in Liverpool Plains (DECCW 2010).
- Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) Protected Matters Search using a search area of approximately 30 km x 30 km covering the study area (DEWHA 2010).
- Royal Botanic Gardens Sydney database using a search area of approximately 30 km x 30 km covering the study area (Royal Botanic Gardens Sydney 2010).
- *Leard State Conservation Area Draft Plan of Management* (Office of Environment and Heritage [OEH] 2011a).
- Previous flora studies on and near the study area:
  - *Brigalow Belt South – Stage 1. Vegetation Survey and Mapping* (Beckers and Binns 2000).
  - *Brigalow Belt South – Stage 2. Targeted Flora Survey and Mapping* (NPWS 2002a).
  - *Brigalow Belt South – Stage 2. Joint Vegetation Mapping Project* (DIPNR 2004).
  - *NSW Western Regional Assessments, Nandewar. Biodiversity Surrogates – Vegetation* (Wall 2004).
  - NSW Vegetation Types Database (DECCW 2008).
  - *NSW Vegetation Classification and Assessment: Plant Communities of the Brigalow Belt South, Nandewar and NET Bioregions* (Benson *et al*. 2010).
  - *Proposed East Boggabri Mine – Flora Assessment of Proposed Mine Site* (GCNRC 2005).
  - *Tarrawonga Coal Mine Modification – Biobanking and Threatened Species Assessment* (Eco Logical 2010).
  - *Continuation of Boggabri Coal Mine – Biodiversity Impact Assessment* (Parsons Brinkerhoff 2010).

Subsequent to the above, searches of approximately 100 km x 100 km (OEH Atlas of NSW Wildlife and Royal Botanic Gardens Sydney databases) surrounding the study area were undertaken. Results of these searches were used to inform discussions regarding local and regional distribution of threatened species.

Table 3
Threatened Plant Species that may Potentially Occur on the Study Area

Family Name	Scientific Name	Conservation Status		Habitat	Distribution	Likelihood of Occurrence
		TSC Act[1]	EPBC Act[2]			
Apocynaceae	*Tylophora linearis*	V	E	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla* and *Allocasuarina luehmannii* (DEC 2005a). On coarse-grained sediments.	Distributed to the west of the study area from the Pilliga Scrub to Peak Hill and Dubbo.	Low (Known communities and soils absent from study area)
Brassicaceae	*Lepidium aschersonii*	V	V	In NSW, the Spiny Peppercress is usually found on grey loam gilgai soils, on ridges between the gilgai depressions (Bower, unpublished; DEC 2005b). Around Narrabri it is found in open to dense Brigalow (*Acacia harpophylla*) communities with a sparse grassy understorey (*ibid.*). In Central Western NSW it occurs mainly in communities dominated by Belah (*Casuarina cristata*), but also in Bull Mallee (*Eucalyptus behriana*) woodland and Grey Box (*Eucalyptus microcarpa*)/Buloke (*Allocasuarina luehmannii*) woodland (Bower unpublished).	Distributed on the Central West Slopes in the Barmedman - West Wyalong - Lake Cowal area (Bower, unpubl.) and near Narrabri on the North West Plains (DEC 2005b). Recorded recently in the Leard State Conservation Area to the west of the study area (OEH 2011a).	Low (Habitat absent from study area)
Cyperaceae	*Cyperus conicus*	E	-	In NSW this species is known from open woodland on sandy soils where it grows with other dryland sedges (DEC 2005c).	It occurs in the Pilliga Scrub, North east of Narrabri and near the Queensland border in the eastern parts of the NSW North West Plains Botanical Division (NSW Flora Online 2011).	Low (Suitable habitat does not appear to occur on the study area)
Fabaceae	*Pultenaea setulosa*	-	V	This species (as *Pultenaea* sp. I) is reported to occur on volcanic soils (Weston 1991). Parsons Brinkerhoff (2010) recorded extensive populations in the centre and west of Leard State Forest. The habitat of *P. setulosa* in Leard State Forest is steep south-facing gullies which are more shaded and retain more moisture than the surrounding gentler terrain.	Occurs in the Nandewar Range (Mount Kaputar National Park) (Weston 1991) and the southern slopes of the Willowtree Range in Leard State Forest (Parsons Brinkerhoff 2010) (Attachment A). Scattered records occur in the wider region including a concentration near Nundle (Attachment A).	Medium (Lack of preferred soils and steep sheltered terrain, but proximity of other records suggests it may have potential to occur)
	Swainsona murrayana	V	V	Occurs on flat inland floodplains and depressions on clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams (DEC 2005d).	Occurs principally on the NSW South West Plains with a few records on the margins of the NSW North West Plains and NSW North West Slopes Botanical Divisions (NSW Flora Online 2011). There appear to be no records from the Liverpool Plains.	Low (Habitat absent from study area)
Orchidaceae	*Diuris tricolor*	V	-	It occurs in Box - Gum Woodlands and White Cypress Pine forests, generally on sandy soils derived from granite or sandstone. The understorey is usually grass dominated with a variety of native herbs (DEC 2005e).	Found sporadically on the western slopes and upper Hunter Valley of NSW from south of Narranderra to the Queensland border (DEC 2005e). A search of various databases in June 2011 (OEH Atlas of NSW Wildlife and Royal Botanic Gardens Sydney 2010) did not return any records for this species within 100 km of the study area.	Medium (A widespread species, but favours coarse-grained sandy soils which are absent from the study area)
	Prasophyllum sp. Wybong	-	CE	Occurs on generally fertile soils in native grasslands and grassy woodlands (Threatened Species Scientific Committee [TSSC] 2009a). Soils on the study area have generally low fertility, except on the valley floor, where farming practices would likely have eliminated the species.	Known from seven populations between Tenterfield and Yeoval. Study area is within the species' distribution.	Low (lack of suitable soils)

Table 3 (Continued)
Threatened Plant Species that may Potentially Occur on the Study Area

Family Name	Scientific Name	Conservation Status		Habitat	Distribution	Likelihood of Occurrence
		TSC Act[1]	EPBC Act[2]			
Orchidaceae	*Pterostylis cobarensis*	V	V	Habitats are eucalypt woodlands, open mallee or *Callitris* shrublands on low stony ridges and slopes in skeletal sandy-loam soils (DEC 2005f). Such habitats are absent from the study area.	Recorded mainly west of the study area, although there is a record from Narrabri (DEC 2005f).	Low (lack of suitable soils)
Poaceae	*Dichanthum setosum*	V	V	The main populations are on heavy black soils derived from basalt (DEC 2005g). It has also been recorded from stony red-brown hard-setting loams over a clay subsoil (TSSC 2008a). It is often found in disturbed areas including roadsides, cleared woodlands, grazing paddocks or highly disturbed sites. It is known to occur with White Box (*E. albens*), which occurs on the study area.	Principally known from the New England Tableland, but also occurs on the NSW North West Slopes, NSW North West Plains and NSW Central West Slopes (TSSC 2008a).	Low (lack of suitable soils)
	Digitaria porrecta	E	E	Soils are usually fertile, dark and fine textured with some degree of seasonal cracking (TSSC 2008b). Favours native grassland, woodlands or open forest with a grassy understorey (DEC 2005h). Suitable soils for this species are most likely derived from erosion of basalt and are absent from the study area.	On the North West Slopes and Plains from near Moree south to Tambar Springs and from Tamworth to Coonabarabran (DEC 2005h).	Low (lack of suitable soils)
	Homopholis belsonii	-	V	Occurs in a variety of landscape positions and soil types from rocky hills to alluvial flats (TSSC 2008c).	Occurs between Wee Waa, Goondiwindi and Glen Innes (TSSC 2008c), well outside the study area.	Low (lack of suitable soils)
Rhamnaceae	*Pomaderris queenslandica*	E	-	There is little information available on this species. According to DEC (2005i), it is found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Known from a few locations on the New England Tablelands and North West Slopes and several locations on the NSW north coast. It is reported by Royal Botanic Gardens Sydney and OEH to occur in Leard State Forest and Mount Kaputar National Park (Attachment A).	High
Rutaceae	*Philotheca ericifolia*	-	V	Occurs chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies (Weston and Porteners 1991 [as *Eriostemon ericifolius*]). Habitats include heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops (TSSC 2008d). Tends to occur on coarse-grained sediments, which are absent from the study area.	Occurs from the upper Hunter Valley and Pilliga to the Peak Hill, Dubbo and West Wyalong districts of NSW. The study area is east of its known range.	Low (lack of suitable soils and habitat)
Santalaceae	*Thesium australe*	V	V	Occurs in grassland or grassy woodland. Often found in damp sites in association with Kangaroo Grass (*Themeda australis*) (DEC 2005j). Can be found on a wide variety of soils derived from sedimentary, igneous and metamorphic rocks as well as recent alluvium (Department of Sustainability and Environment [DSE] 2003).	Occurs in small populations scattered across the western slopes, tablelands and coast of NSW (DEC 2005j) (Attachment A). In the wider region, there are concentrations in Kaputar National Park and around Inverell (Attachment A).	Medium (Main host plant is rare in the study area, but may once have been more abundant)
Surianaceae	*Cadellia pentastylis*	V	V	Grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities forming a closed or open canopy with eucalypt and cypress pine species (TSSC 2008e). Grows on low to medium nutrient soils of sandy clay or clayey consistencies, with a typical soil profile having a sandy loam surface layer, grading from a light clay to a medium clay with depth (DEC 2005k).	Western edge of the NSW north western slopes including the Gunnedah and Narrabri areas.	Low (There are no records for this obvious species close to the study area)

[1] Threatened species status under the NSW *Threatened Species Conservation Act, 1995* (current to 11 May 2011).

[2] Threatened species status under the Commonwealth *Environment Protection and Biodiversity Conservation Act*, *1999* (current to 11 May 2011).

CE - Critically Endangered; E - Endangered; V - Vulnerable.

4.2 THREATENED FLORA SPECIES

Table 3 shows 15 threatened plant species listed in the schedules of the TSC Act and/or the EPBC Act that were returned from the database searches as potentially occurring on the study area. Table 3 assesses the likelihood of suitable habitat for these species in the study area by analysing their distribution and habitat requirements from the available literature as well as records from previous studies on or near the study area. Prior to the surveys, eleven of the 15 species were considered to have a low probability of occurring on the study area, while four were considered to have either a medium (*Pultenaea setulosa, Thesium australe* and *Diuris tricolor*) or high (*Pomaderris queenslandica*) probability of occurring. These four species were the primary targets of threatened species searches during the surveys conducted for this study.

Of the four threatened species selected for targeted searches, two are shrubs and two are slender herbs (Table 3). The presence of the shrubs can be detected at any time of the year and in any seasonal conditions, although identification is usually easier when flowering or fruiting material is present. Detection of *D. tricolor* is possible only in spring when plants are flowering. *T. australe* is difficult to detect at all times as it is an inconspicuous plant with tiny flowers.

4.3 THREATENED POPULATIONS

Twenty-three endangered populations are currently (April 2011) listed in Schedule 1 of the TSC Act. None potentially occur in the study area.

4.4 THREATENED ECOLOGICAL COMMUNITIES

Prior to the surveys, six Threatened Ecological Communities (TEC) listed in the schedules of the TSC Act and/or EPBC Act, were considered possible occurrences in the study area (Table 4). The likelihood of each occurring on the study area is assessed (Table 4) by considering the known distributions and habitats of each, as well as the findings of previous studies on and near the study area (GCNRC 2005; Ecological Australia 2010; Parsons Brinkerhoff 2010). From this assessment, two communities were considered to have moderate to high potential to occur on the study area, *viz*:

1. Inland Grey Box Woodland (moderate potential to occur); and
2. Box-Gum Woodland (high potential to occur).

4.5 CRITICAL HABITAT

No Critical Habitat for flora has been declared on or near the study area under the TSC Act or the EPBC Act (OEH 2011).

Table 4
Potential Threatened Plant Communities on the Study Area

Community name		Conservation Status		Known Distribution	Potential Habitats	Likelihood of Occurrence
TSC Act[1]	EPBC Act[2]	TSC Act[1]	EPBC Act[2]			
Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South bioregions	-	E	-	Seven main locations on the North West Slopes in NSW, between Narrabri and the Queensland border, and also in Queensland (DEC 2005l).	Occurs on undulating terrain on a variety of soil types, between 300-450 m altitude (DEC 2005l). The southern limit is Black Jack Mountain, 7.5 km west south west of Gunnedah (Curran and Curran 2005).	Low (Not known on or near the study area despite numerous studies)
Fuzzy Box on alluvials of the South West Slopes, Darling Riverine Plains and the Brigalow Belt South Bioregions	-	E	-	Mainly in the Dubbo-Narromine-Parkes-Forbes area (DEC 2005m).	Occurs on brown loam or clay, alluvial or colluvial soils on prior streams and abandoned channels or slight depressions on undulating plains or flats of the western slopes, often upslope of frequently inundated River Red Gum communities. It also occurs on colluvial soils on lower slopes and valley flats (DEC 2005m).	Low (Not known on or near the study area despite numerous studies)
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (Inland Grey Box Woodland)	Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of Eastern Australia (equivalent to Inland Grey Box Woodland)	E	E	Lower western slopes and plains from the Victorian border to Queensland (DEC 2005n). At a Commonwealth level it also occurs in Victoria and South Australia (TSSC 2009b).	Inland Grey Box Woodland occurs on fertile soils of the western slopes and plains of NSW (DEC 2005n). It often occurs on productive soils derived from alluvial or colluvial materials but may occur on a range of other substrates (TSSC 2009b).	Moderate
Native vegetation on Cracking Clay Soils of the Liverpool Plains	Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland	E	CE	NSW community is located around Coonabarabran, Gunnedah, Murrurundi, Narrabri, Tamworth and Quirindi on the North West Slopes and Plains (DEC 2005o).	Occurs on the highly fertile cracking clay soils of the Liverpool Plains (DEC 2005o). Generally occurs on flat to low slopes, of no more than 5% (or less than 1 degree) inclination (TSSC 2009c).	Low (Suitable soils are absent or rare on the study area)
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray Darling Depression, Riverina and NSW South western Slopes Bioregions	Weeping Myall Woodlands	E	E	Scattered across the eastern parts of the alluvial plains of the Murray-Darling river system (DEC 2005p) on the NSW western slopes and plains.	Occurs on red-brown earths and heavy textured grey and brown alluvial soils (DEC 2005p) that become waterlogged in winter.	Low (The study area is upslope of landscapes suitable for this community)

Table 4 (Continued)
Potential Threatened Plant Communities on the Study Area

Community name		Conservation Status		Known Distribution	Potential Habitats	Likelihood of Occurrence
TSC Act[1]	EPBC Act[2]	TSC Act[1]	EPBC Act[2]			
White Box, Yellow Box, Blakely's Red Gum Woodland (Box-Gum Woodland)	White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (equivalent to Box-Gum Woodland)	E	CE	Occurs mainly on the tablelands and western slopes of NSW (DEC 2005q). This community has been identified on or near the study area by previous studies (GCNRC 2005; Ecological Australia 2010; Parsons Brinkerhoff 2010).	Generally occurs on fertile lower parts of the landscape where resources such as water and nutrients are abundant.	High

[1] Threatened Ecological Community status under NSW *Threatened Species Conservation Act, 1995* (current to 11 May 2011).

[2] Threatened Ecological Community status under Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (current to 11 May 2011).

E – Endangered; CE - Critically Endangered.

5 METHODS

The vegetation survey was carried out over 17 days in the periods 9, 10, 16-19 November 2010, 17-21 January 2011, 23 May 2011, 29-31 July and 3 and 5 August 2011. The survey encompassed all patches of native vegetation within the study area in order to sample and identify all communities present. All habitat types were surveyed to maximise the chances of finding populations of any threatened species. Complete coverage of the area was facilitated by recent aerial photography showing remnant vegetation. Four wheel drive access was available via fire trails and paddock tracks through most of the area. Areas inaccessible by vehicle were traversed on foot.

5.1 VEGETATION SAMPLING

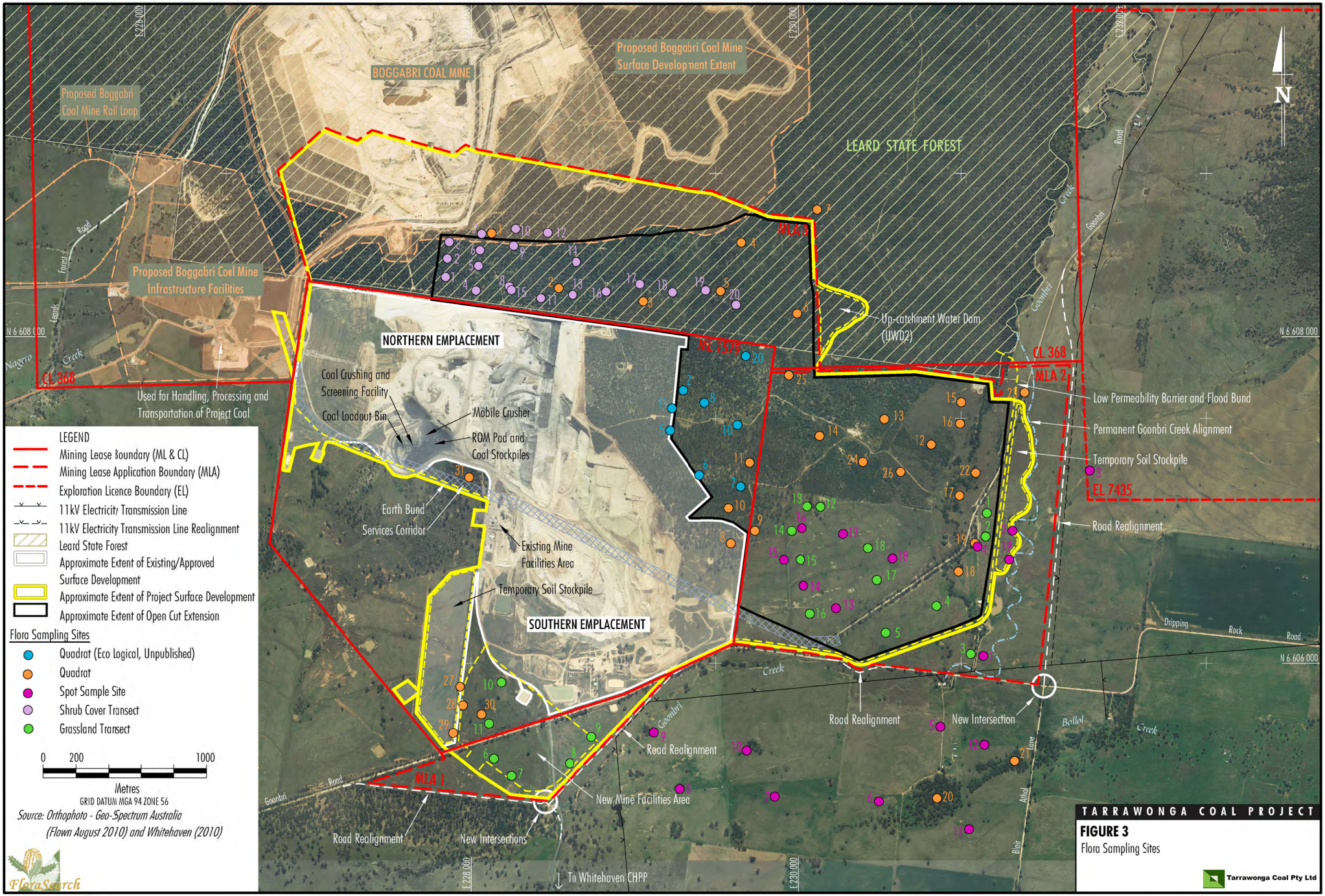
Four methods of documenting the vegetation were employed; quadrat sampling, spot sampling, random meanders, shrub cover transects and line intercept transects. These methods are detailed below. Figure 3 shows the locations of flora sample sites.

5.1.1 Quadrat Sampling

Thirty one quadrat sites were sampled over the study area (in accordance with DECC 2008). Within these, the dominant species in each vegetation stratum were recorded, with an estimate of the percentage of the ground surface covered by their canopies. A list of all vascular plant species present within the quadrat was also made with each being assigned a cover abundance rating using a modified Braun-Blanquet scale (Table 5). Details recorded for each site included its Global Positioning System (GPS) position, landform, physiography, soil characteristics, disturbance, vegetation structural formation and general comments. Results from previous quadrats within the study area were also reviewed as part of this study (i.e. quadrats from Eco Logical 2010). Quadrat plots were stratified across all predominantly native vegetation communities in proportion to their representation on the study area (Table 6). The location of quadrat sites is provided on Figure 3.

Table 5
Modified Braun-Blanquet Cover Abundance Rating Scale

Rating	Percent Ground Cover
1	<1 (and rare)
2	<1 (and common)
3	1 - 5
4	6 - 25
5	26 - 50
6	51 - 75
7	76 - 100



TARRAWONGA COAL PROJECT

FIGURE 3

Flora Sampling Sites

Tarrawonga Coal Pty Ltd

WHC-10-04 EA AppTFlora_103G

Table 6
Sampling Effort Stratified by Vegetation Communities

Community Number	Community Name	Quadrat Numbers		Spot Sample Numbers	Transect Numbers	
		FloraSearch (this report)	Eco Logical Australia, (unpublished)		Crown Cover	Line Intercept
1	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (mature community)	3, 4, 6, 7, 11	2, 5, 6, 7, 8, 20	-	-	-
1a	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (regeneration - mainly White Cypress Pine)	12, 13, 14, 24, 25, 26, 30	-	-	-	-
1b	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (semi-cleared and regenerating)	10	-	-	-	-
1c	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (derived grasslands)	15, 16	10, 11	-	-	-
2	White Box - White Cypress Pine shrubby woodland	1, 2, 5	-	-	1-20	-
2b	White Box - White Cypress Pine shrubby woodland (semi-cleared and regenerating)	8, 9	-	-	-	-
3	White Box - White Cypress Pine grassy woodland (mature community)	27, 29, 31	-	-	-	-
3a	White Box - White Cypress Pine grassy woodland (regeneration - mainly White Cypress Pine)	-	-	-	-	-
3b	White Box - White Cypress Pine grassy woodland (cleared and regenerating)	28	-	-	-	-
3c	White Box - White Cypress Pine grassy woodland (derived grassland)	-	-	-	-	11
4	Narrow-leaved Grey Box - Poplar Box - White cypress Pine grassy open woodland	19, 23	-	-	-	-
4c	Narrow-leaved Grey Box - Poplar Box - White cypress Pine grassy open woodland (derived grasslands)	17	-	-	-	-
5	Bracteate Honeymyrtle low riparian forest	18, 20, 21, 22	-	-	-	-
6	Cleared farmland	-	-	BC1 to BC5, CP1 to CP6, TM1 to TM8	-	1-10, 12-18

[1] BC = 'Bollol Creek Station'; CP = contour paddock on MLA 1; TM = 'Templemore'.

5.1.2 Spot Sampling

Spot samples were used as a rapid means of documenting highly disturbed sites on cleared farmland that support only anthropogenic (secondary) grasslands from which most of the original native species have disappeared. Some 19 spot samples were conducted in grazing and cropping paddocks on 'Bollol Creek Station', 'Templemore' and other areas (Figure 3, Table 6). Spot samples listed all ground cover vascular plants within an approximate 15 m radius of the central point at which a GPS reading was taken. The dominant tree and shrub species, if present, were also noted. Brief notes were taken on site characteristics, the condition of the vegetation and any disturbance. Samples were spread relatively evenly across the cleared farmlands (Figure 3).

5.1.3 Random Meanders

Random meanders were used to search for threatened flora species (in accordance with DEC 2004). 'Random meander' describes the nature of the search which is a randomly directed walk through habitat considered likely to support populations of the targeted species. The random meanders in this survey were targeted to the known habitats described in fact sheets and profiles of threatened species published on the websites of the OEH and DSEWPaC, as well as on the website of the Royal Botanic Gardens Sydney. The species targeted are given in Table 3. Random meanders were conducted by one person walking through the larger blocks of bushland. Meanders extended from 30 minutes duration to 90 minutes. For some meanders, lists of all observed flora species were compiled to provide further data on community composition and the flora diversity of the study area. In all meanders, any species not previously seen were recorded.

5.1.4 Shrub Cover Transects

Shrub cover transects were conducted in areas dominated by White Box (*Eucalyptus albens*) in Leard State Forest to provide accurate measures of shrub canopy cover. This data was used to assess whether White Box woodland in Leard State Forest is predominantly shrubby or grassy, which in turn was used to assist in determining whether it belongs to the NSW Box-Gum Woodland EEC or the Commonwealth Box – Gum Grassy Woodland and Derived Grassland CEEC.

The method used was adapted for shrub canopy cover from Figure 7 in Hnatiuk *et al.* (2009). The length of canopy cover by individual shrubs or groups of shrubs was measured along a straight fifty meter measuring tape. The sum of the canopy cover intervals in meters was divided by 50 to obtain the proportion of the transect covered by shrub canopies. To minimise parallax error in the measurement of tall shrubs (1 m or more in height) a straight stake was held against the canopy edge perpendicular to the transect tape on one side of the shrub. The person holding the stake also held the end of a retractable measuring tape, while a second person measured the distance to the other side of the canopy. Sampling was based on a pre-determined grid derived from previous mapping of the extent of White Box in Leard State Forest. The GPS coordinates of the starting point of each transect on the grid were taken from a GIS program in the office, without knowledge of the shrubbiness or otherwise of each site. Transects were run due west on a compass bearing from each grid point. Twenty such transects were conducted and are shown on Figure 3 as "Shrub Cover Transects".

5.1.5 Line Intercept Transects

Line intercept transects as per the Biometric (Gibbons *et al.* 2005) and Biobanking (DECC 2008) methodologies were conducted on every quadrat site, all Shrub Cover Transects and at 18 sites in cleared farmland. Line intercept transects were used to provide estimates of ground cover by four classes of vegetation; native grasses, low native shrubs (<1 m high), other native ground covers (forbs, ferns etc.) and exotic species. The class(es) of vegetation intercepting a 50 m measuring tape at one meter intervals (50 points) was recorded and the percentage cover of each class was calculated. The additional locations of these transects (i.e. in additional to those conducted at a quadrat location) are shown on Figure 3 as "Grassland Transects".

5.2 VEGETATION MAPPING

The approximate distribution of each vegetation community was mapped onto high resolution colour aerial photos of the study area at the commencement of the field work. A day was spent traversing the study area by a four-wheel drive vehicle to record the locations and extent of each community. This information was refined on subsequent visits to each part of the study area for vegetation sampling. The field mapping was later refined by air photo interpretation in the office.

Some communities, for example the White Box - White Cypress Pine shrubby woodland, could not be reliably mapped by the above approaches. Patches of this vegetation type were mapped by walking the perimeter of the community and recording the track taken in a hand held GPS unit, resulting in a precise map of community boundaries.

5.3 SPECIES LISTING

All observed plant species were recorded, whether identified on formal sample sites or not. Some less common plants were only observed on one occasion whilst moving between sample sites or on random meanders. Where plants could not be quickly identified in the field, a sample was taken for later examination. Samples were preserved in a plant press and identified later using a binocular microscope and flora keys. The principal reference was the Flora of New South Wales (Harden [Ed.] 1990-2002) and it is used as the basis for nomenclature in this report along with any updates on the PlantNet web site of the Royal Botanic Gardens Sydney Trust. Any specimens that could not be conclusively identified were sent to the Royal Botanic Gardens Sydney for specialist diagnosis.

5.4 VEGETATION CONDITION ASSESSMENT

The field methods developed were used to assess the condition of patches of native vegetation on the study area. Native vegetation condition varies widely across the study area according to the history of land use. The measures made on the 20 × 50 m quadrats are summarised below from DECC (2008).

- Native plant species diversity: the number of native plant species in the 20 × 20 m subplot.
- Native overstorey cover: mean percent cover of ground by the foliage of the uppermost vegetation layer; trees or tall shrubs (>1 m) at 10 points along a 50 m transect along the long axis of the plot.
- Native midstorey cover: mean percent cover of ground by the foliage of the middle vegetation layer; tall shrubs (>1 m), low trees and regeneration at 10 points along a 50 m transect along the long axis of the plot.

- Native groundcover – grasses: presence or absence of native grasses at 50 points 1 m apart on a 50 m transect along the long axis of the plot.
- Native groundcover – shrubs: mean percent cover of ground by the foliage of low shrubs (>1 m) and regeneration at 10 points along a 50 m transect along the long axis of the plot.
- Native groundcover – other: presence or absence of native herbs, ferns, and other non-woody groundcover species at 50 points 1 m apart on a 50 m transect along the long axis of the plot.
- Exotic plant cover: presence or absence of exotic grasses at 50 points 1 m apart on a 50 m transect along the long axis of the plot.
- Number of trees with hollows: all living and dead standing trees with their centres in the 50 × 20 quadrat were examined for hollows capable of harbouring wildlife. Hollows are defined as tree holes > 5 centimetres (cm) diameter, having depth, and > 1 m above the ground.
- Regeneration: the proportion of overstorey trees species that are regenerating on the 50 × 20 m quadrat and in similar vegetation in the surrounds.
- Total length of fallen logs: the length of fallen logs > 10 cm diameter and > 0.5 m long was totalled for the whole 50 × 20 m quadrat.

6 RESULTS AND DISCUSSION

6.1 VEGETATION COMMUNITIES

The survey revealed the presence on the study area of five native vegetation communities and one anthropogenic vegetation community (cleared farmland) (Table 6). The distribution of each community is shown on Figure 4. Table 6 shows the nearest equivalent communities in the most recently developed regional classification for the Namoi CMA area (DECCW 2008) and for the Brigalow Belt South Bioregion (Benson *et al*. 2010). It should be noted that the NSWVCA (Benson *et al*. 2010) does not have directly equivalent vegetation types to Communities 1 and 5 in this report that have also been recognised in other local studies (Section 3, Table 2). Community 5 in this report has no direct equivalent in the Biometric Vegetation Type database (DECCW 2008) or in the NSWVCA (Benson *et al*. 2010) (Table 6).

Variants are recognised within several communities (Table 6) and represent condition classes reflecting past disturbance and the nature of the regeneration currently present (Figure 4). These condition classes may be widespread on the study area, and are designated by the letters a, b and c after the community number, as follows:

a. This vegetation condition class comprises dense monocultural regeneration of White Cypress Pine. Most patches comprise trees of relatively uniform age suggesting large patches underwent uniform regeneration following single clearing events.

b. This condition class comprises regeneration of diverse components of the original community following clearing or semi-clearing, such that, in time, full recovery of the original diversity can be expected.

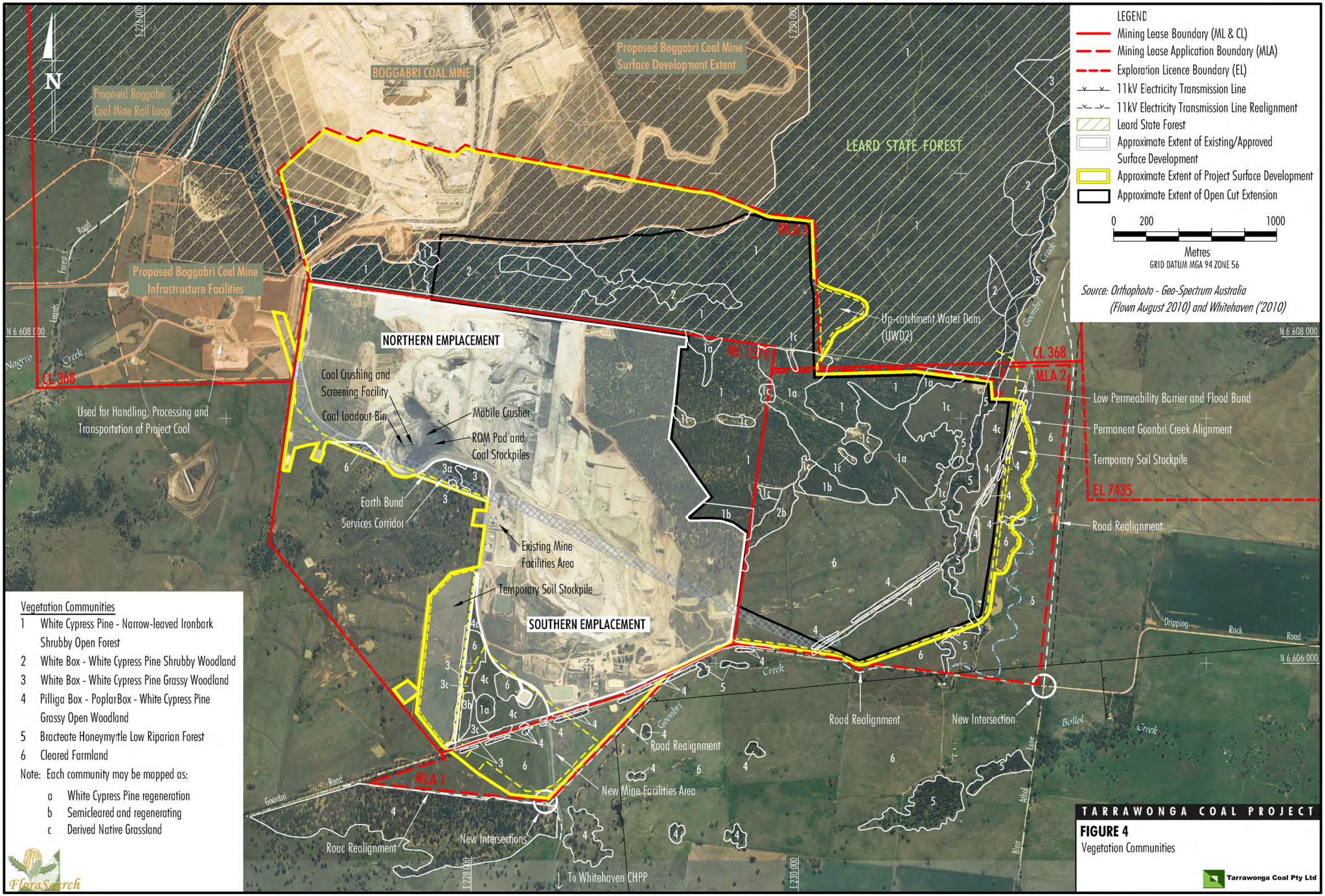
c. Vegetation condition class ‘c’ comprises derived native grasslands that have resulted from clearing of the original community and long term suppression of regeneration by trees and shrubs by grazing or management.

Vegetation patches considered in good condition with high native plant diversity and high resilience are shown in Figure 4 without a letter suffix.

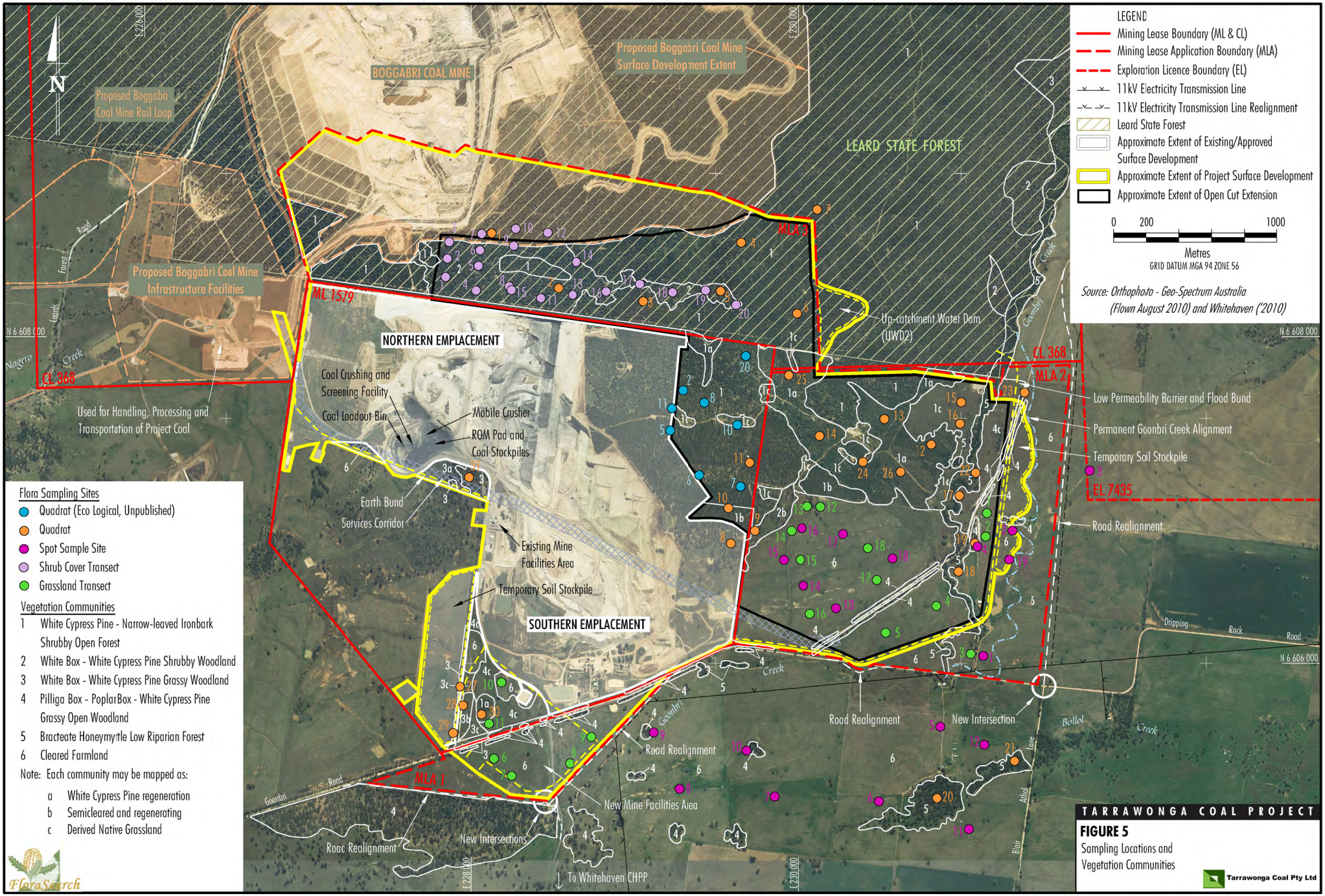
Tables 8 to 13 provide descriptions of each plant community specific to the study area using sample data collected in this survey. Plates 1 to 17 provide indicative photos of the vegetation communities. Figure 5 provides the location of quadrats within each of the vegetation communities and therefore also the photo locations referred to in Plates 1 to 17.

Grassland Classification

Grassland formations present on the study area are classified as ‘derived native grasslands’ (vegetation condition class c above) or ‘cleared farmland’. The Biobanking (DECC 2008) criterion for ‘cleared farmland’ was used to categorize the grasslands; i.e. cleared farmland is defined as having greater than 50 percent of ground cover by exotic species. Conversely, derived native grassland has 50 percent or more ground cover by native species, predominantly native grasses. To ensure grasslands on the study area were correctly classified, eighteen 50 m line intercept transects were conducted in grassland areas containing mixes of native and introduced species, comprising mainly former grazing and cropping paddocks. The results are given in Table 7.



WHC-10-04 EA AppTFlora_104L



WHC-10-04 EA AppTFlora_105F

The results in Table 7 show quite high levels of exotic plant cover on most transects, with 50 percent cover or more on all but two transects (numbers 2 and 16). Conversely, native grass cover was below 50 percent on all but transect 11, which is classified as derived native grassland.

The total of the cover estimates for the four categories on each transect may exceed 100 percent because more than one category of vegetation may occur at each transect point. Consequently, the data does not easily allow total native cover to be compared with total exotic cover. When the three native cover categories are summed (row 4 of the data), the totals may overestimate native cover because of double counting at some transect points. Even so, exotic cover exceeded total native cover on all but six transects (numbers 2, 3, 4, 5, 12 and 16). In at least some cases where the two cover measures are close (e.g., transect numbers 2, 4 and 5), the true native cover is likely to be less than the exotic cover. These observations indicate that the biobanking approach requires modification for the purpose of classifying grasslands as predominantly native or exotic. In any event, it is clear that exotic plants dominate the cleared farmland parts of the study area.

Table 7
Vegetation Communities Recognised within the Study Area

Community Number	Community Name			Vegetation Formation	Comment
	FloraSearch (this report)	Nearest Equivalent Biometric Vegetation Type (DECCW 2008)	Nearest Equivalent NSWVCA Community (Benson *et al*. 2010)		
1 1a, 1b, 1c	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest	White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion (Namoi CMA community NA228)	Narrow-leaved Ironbark - Cypress Pine - White Box shrubby open forest in the Brigalow Belt South and Nandewar Bioregions (NSWVCA community 592)	Dry Sclerophyll Forests (Shrubby subformation)	NSWVCA community 592 of Benson *et al*. (2010) includes White Box, which is absent from Community 1 of this report. The NSWVCA does not have a directly comparable vegetation type to Community 1, which is widespread in Leard State Forest.
2 2b	White Box - White Cypress Pine shrubby woodland	White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (Namoi CMA community NA225)	White Box - White Cypress Pine shrubby hills open forest mainly in the Nandewar Bioregion (NSWVCA community 588)	Dry Sclerophyll Forests (Shrub/grass subformation)	
3 3a, 3b, 3c	White Box - White Cypress Pine grassy woodland	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions (Namoi CMA community NA226)	White Box - White Cypress Pine shrub grass hills woodland in the Brigalow Belt South and Nandewar Bioregions (NSWVCA community 435).	Grassy Woodlands	The occurrence of this community is small and highly disturbed. The remnant appears most similar to NSWVCA community 435, although there are differences.
4 4c	Narrow-leaved Grey Box - Poplar Box - White Cypress Pine grassy open woodland	Narrow-leaved Grey Box – Poplar Box – White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Namoi CMA community NA179)	Narrow-leaved Grey Box – White Cypress Pine – Buloke shrubby woodland in the Brigalow Belt South Bioregion (NSWVCA community 88)	Dry Sclerophyll Forests (Shrub/grass subformation)	-
5	Bracteate Honeymyrtle low riparian forest	Bracteate Honey Myrtle riparian low forest/shrubland of rich soil depressions in the Brigalow Belt South Bioregion (Border Rivers/Gwydir CMA community 22).	Bracteate Honey Myrtle riparian low forest/shrubland of rich soil depressions in the Brigalow Belt South Bioregion (NSWVCA community 112)	Forested Wetlands	No vegetation type equivalent to Community 5 in this report is documented in the Namoi CMA area by DECCW (2008), although a similar community is documented for the Border Rivers/Gwydir CMA area (Border Rivers/Gwydir CMA community 22 [DECCW 2008]). Similarly, the nearest equivalent NSWVCA community Black Tea-tree – River Oak – Wilga riparian low forest/shrubland wetland of rich soil depressions in Brigalow Belt South Bioregion, NSWVCA community 112 [Benson *et al*. 2010]), it differs significantly from that on the study area.
6	Cleared farmland	Cleared farmland	No equivalent	No equivalent	-

a Dense White Cypress Pine regeneration

b Semicleared historically and regenerating

c Derived native grassland

Table 8
Community 1. White Cypress Pine - Narrow-leaved Ironbark Shrubby Open Forest

No. of quadrats: 15

Landscape position: Upper slopes and hill tops of the Willowtree Range.

Dominant species

Trees: Narrow-leaved Ironbark (*Eucalyptus crebra*) and White Cypress Pine (*Callitris glaucophylla*) with occasional White Box (*Eucalyptus albens*) and White Bloodwood (*Corymbia trachyphloia* subsp. *amphistomatica*).

Low Trees: Scattered Motherumbah (*Acacia cheelii*), Wilga (*Geijera parviflora*), Quinine Bush (*Alstonia constricta*) and Weeping Pittosporum (*Pittosporum angustifolium*).

Shrubs: Shrubs are common and varied including Cough Bush (*Cassinia laevis*), Yellow-berry Bush (*Maytenus cunninghamii*), *Chenopodium auricomiforme,* Hoary Guinea Flower (*Hibbertia obtusifolia*), Pinkwood (*Beyeria viscosa*), Large Tick-trefoil (*Desmodium brachypodum*), Western Silver Wattle (*Acacia decora*), Velvet Mock Olive (*Notelaea microcarpa* subsp. *microcarpa*), Hopbushes (*Dodonaea sinuolata* subsp. *sinuolata*, *D. viscosa* subsp. *angustissima*), Shiny-leaved Canthium (*Psydrax odorata*) and Poison Pimelea (*Pimelea neo-anglica*).

Vines: Occasional Gargaloo (*Parsonsia eucalyptophylla*), Wonga Wonga Vine (*Pandorea pandorana*) and Native Jasmine (*Jasminum suavissimum*).

Creepers: Creepers include Slender Tick-trefoil (*Desmodium varians*) and Twining Glycines (*Glycine clandestina* and *G. tabacina*), Leafy Templetonia (*Templetonia stenophylla*), Hill Hibiscus (*Hibiscus sturtii*), Amulla (*Eremophila debilis*) and Tarvine (*Boerhavia dominii*).

Ground covers: This community is characterised by a sparse, but varied ground cover of forbs and rushes including Bristly Cloak Fern (*Cheilanthes distans*), Poison Rock Fern (*Cheilanthes sieberi* subsp. *sieberi*), Blue Trumpet (*Brunoniella australis*), Pink Tongues (*Rostellularia adscendens* var. *adscendens*), Native Carrot (*Daucus glochidiatus* form F), Purple Burr-daisy (*Calotis cuneifolia*), Yellow Burr-daisy (*Calotis lappulacea*), Common Everlasting (*Chrysocephalum apiculatum*), Yellow Buttons (*Chrysocephalum semipapposum*), Cudweed (*Euchiton sphaericus*), Cobbler's Tack (*Glossocardia bidens*), Common Sunray (*Triptilodiscus pygmaeus*), a Fuzzweed (*Vittadinia sulcata*), Golden Everlasting (*Xerochrysum bracteatum*), various native Bluebell species (*Wahlenbergia communis, W. gracilenta, W. gracilis, and W. stricta* subsp. *alterna*), Annual Chalkwort (*Gypsophila tubulosa*), Knotweed Goosefoot (*Einadia polygonoides*), Kidney Weed (*Dichondra repens*), *Evolvulus alsinoides* var. *decumbens*, Caustic Weed (*Chamaesyce drummondii*), Smooth Darling Pea (*Swainsona galegifolia*), Spike Centaury (*Schenkia spicata*), Native Geranium (*Geranium solanderi* var. *solanderi*), Forest Goodenia (*Goodenia hederacea*), Rough Raspwort (*Haloragis heterophylla*), *Oncinocalyx betchei*, Dwarf Skullcap (*Scutellaria humilis*), Corrugated Sida (*Sida corrugata*), *Oxalis perennans*, Swamp Dock (*Rumex brownii*), Rough Bedstraw (*Galium gaudichaudii*), *Solanum parvifolium*, Western Stackhousia (*Stackhousia muricata*), Nodding Chocolate Lily (*Dichopogon fimbriatus*), Slender Flat-sedge (*Cyperus gracilis*), Common Fringe- sedge(*Fimbristylis dichotoma*), Finger Rush (*Juncus subsecundus*), Wattle Mat-rush (*Lomandra filiformis* subsp. *filiformis*) and Many-flowered Mat-rush (*Lomandra multiflora*). The commoner grasses include Purple Wire-grass (*Aristida personata*), a Wallaby Grass (*Austrodanthonia racemosa* var. *obtusata*), Speargrass (*Austrostipa scabra* subsp. *scabra*), Barbwire Grass (*Cymbopogon refractus*), Slender Bottle-washers (*Enneapogon gracilis*), Two-colour Panic (*Panicum simile)* and Knottybutt Grass (*Paspalidium constrictum*).

Introduced species: Introduced species are less common in this community than others. The main exotics include Flax-leaf Fleabane (*Conyza bonariensis*), Smooth Catsear (*Hypochaeris glabra*), Common Sowthistle (*Sonchus oleraceus*), Common Prickly Pear (*Opuntia stricta*), Proliferous Pink (*Petrorhagia nanteuillii*), Four-leaved Allseed (*Polycarpon tetraphyllum*), Small-flower Catchfly (*Silene gallica*), various clovers and medics (principally *Trifolium arvense, T. campestre* and *T. glomeratum),* Scarlet Pimpernel (*Anagallis arvensis*) and Lesser Snapdragon (*Misopates orontium*).

Nearest Equivalent Biometric Vegetation Type (DECCW 2008): White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion (Namoi CMA Community 132).

Nearest Equivalent NSWVCA Community (Benson *et al*. 2010): Narrow-leaved Ironbark - Cypress Pine - White Box shrubby open forest in the Brigalow Belt South and Nandewar Bioregions (NSWVCA community 592).

Threatened Ecological Communities (TEC): This community is not part of a State or Commonwealth TEC.

Variants: Three variants of Community 1 are recognised in this report reflecting different states of recovery from past clearing.

Community 1a: White Cypress regeneration. Patchy large areas of footslopes and hills within the proposed open cut area have dense, even-aged stands of monospecific White Cypress Pine regeneration. These stands tend to have similar shrub and ground cover layers to the original community, but native species diversity and cover levels are lower due to competition from the pines, and the numbers of introduced species are higher (Table 15).

Community 1b: Narrow-leaved Ironbark/White Cypress Pine regeneration. This vegetation type represents areas on the hilly parts of the proposed open cut that have been semi-cleared in the past and are regenerating both Narrow-leaved Ironbark and White Cypress Pine. The shrub and ground cover layers in this type are more similar to Community 1 than to Community 1a.

Community 1c: This derived grassland variant of Community 1 is dominated by native grasses, particularly Barbwire Grass (*Cymbopogon refractus*), Hairy Panic (*Panicum effusum*) and Red Grass (*Bothriochloa decipiens*), and an array of native herbs characteristic of Community 1. It also has a higher representation of introduced species than Communities 1, 1a and 1b.

Plate 1. Community 1 (Quadrat 7)

Plate 2. Community 1a (Quadrat 24)

Plate 3. Community 1a (Quadrat 25)

Plate 4. Community 1a (Quadrat 26)

Plate 5. Community 1b (Quadrat 10)

Plate 6. Community 1b (Quadrat 10)

Table 9
Community 2. White Box - White Cypress Pine Shrubby Woodland

No. of quadrats: 5

Landscape position: Mid slopes and drainage lines of the Willowtree Range.

Dominant species

Trees: This community is dominated by White Cypress Pine *(Callitris glaucophylla)* and White Box *(Eucalyptus albens).*

Low Trees: Scattered Wilga *(Geijera parviflora).*

Shrubs: Sparse to dense cover of a Cassia *(Senna* form taxon *'zygophylla'),* Sticky Hop-bush *(Dodonaea viscosa* subsp. *spatulata*), Western Silver Wattle *(Acacia decora)* and Poison Pimelea *(Pimelea neo-anglica).*

Creepers: The most common creepers are Slender Tick-trefoil *(Desmodium varians),* Amulla *(Eremophila debilis)* and Tarvine *(Boerhavia dominii).*

Ground covers: The most frequent ground covers include a variety of ferns, forbs, rushes and grasses; Bristly Cloak Fern *(Cheilanthes distans),* Poison Rock Fern *(Cheilanthes sieberi* subsp. *sieberi),* Blue Trumpet *(Brunoniella australis),* Pink Tongues *(Rostellularia adscendens* var. *adscendens),* Native Carrot (*Daucus glochidiatus* form F*),* Purple Burr-daisy *(Calotis cuneifolia),* Yellow Burr-daisy *(Calotis lappulacea),* Cudweed *(Euchiton sphaericus),* Cobbler's Tack *(Glossocardia bidens),* a Vittadinia *(Vittadinia sulcata),* Tufted Bluebell *(Wahlenbergia communis),* Kidney Weed *(Dichondra repens),* Large Tick-trefoil *(Desmodium brachypodum),* Smooth Darling-pea *(Swainsona galegifolia),* Forest Goodenia *(Goodenia hederacea),* Western Stackhousia *(Stackhousia muricata),* Finger Rush *(Juncus subsecundus),* Wattle Mat-rush (*Lomandra filiformis* subsp*. filiformis),* Many-flowered Mat-rush *(Lomandra multiflora),* Wallaby Grass *(Austrodanthonia fulva),* Wallaby Grass *(Austrodanthonia racemosa* var. *obtusata),* Speargrass *(Austrostipa scabra* subsp. *scabra),* Barbwire Grass *(Cymbopogon refractus)* and Slender Bottle-washers *(Enneapogon gracilis).*

Introduced species: No introduced species were abundant in this community, although Common Sowthistle *(Sonchus oleraceus)* and Common Prickly Pear *(Opuntia stricta)* were widespread.

Nearest Equivalent Biometric Vegetation Type (DECCW 2008): White Box **-** White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (Namoi CMA Community 129).

Nearest Equivalent NSWVCA Community (Benson *et al*. 2010): White Box - White Cypress Pine shrubby hills open forest mainly in the Nandewar Bioregion (NSWVCA community 588)

Threatened Ecological Communities (TEC): This community is not part of a State or Commonwealth TEC.

Variants: One

Community 2b: Community 2b is a disturbed variant of Community 2 that occurs on semi-cleared former farmland to the south of Leard State Forest. Clearing and grazing have thinned the tree and shrub canopies, resulting in somewhat higher ground cover levels than in the less disturbed examples of Community 2 in Leard State Forest. The floristic composition of the two variants is very similar.

Plate 7. Community 2 - Leard State Forest (Quadrat 2)

Plate 8. Community 2 - Leard State Forest (Quadrat 5)

Table 10
Community 3. White Box - White Cypress Pine Grassy Woodland

No. of quadrats: 4

Landscape position: Gently undulating hills on soils of the Maules Creek Formation.

Dominant species

Trees: This community is dominated by White Box *(Eucalyptus albens)* and White Cypress Pine *(Callitris glaucophylla)* with occasional Poplar Box (*Eucalyptus populnea*).

Low Trees: Occasional Rosewood (*Alectryon oleifolius*).

Shrubs: Scattered Water Bush (*Myoporum montanum*), juvenile White Cypress Pine (*Callitris glaucophylla*), Small-leaf Bluebush (*Maireana microphylla*) and African Boxthorn (*Lycium ferocissimum*).

Creepers: Creepers included a Glycine (*Glycine tabacina*), Amulla (*Eremophila debilis*) and a Bindweed (*Convolvulus graminetinus*).

Ground covers: The ground layer of this community is heavily dominated by various native grass and lower numbers of ferns, spindly shrubs and forbs. The main grasses included; Purple Wire-grass (*Aristida personata*), A Wallaby Grass (*Austrodanthonia fulva*), Slender Bamboo Grass (*Austrostipa verticillata*) Knottybutt Grass (*Paspalidium constrictum*), Tall Chloris *(Chloris ventricosa*), Speargrass *(Austrostipa scabra* subsp. *scabra),* Curly Windmill Grass *(Enteropogon ramosus),*Granite Lovegrass (*Eragrostis alveiformis*), Snowgrass (*Poa sieberiana* var. *sieberiana*), and Queensland Bluegrass (*Dichanthium sericeum*). Other ground covers comprised mainly a Sida (*Sida spinosa*), Corrugated Sida (*Sida corrugata*), Spiked Sida (*Sida subspicata*), Variable Daisy (*Brachyscome ciliaris* var. *subintegrifolia*), Hogweed (*Zaleya galericulata*), Cudweed (*Euchiton sphaericus*), a Fuzzweed (*Vittadinia pustulata*), Galvanised Burr (*Sclerolaena birchii*), Blue Trumpet *(Brunoniella australis),*Berry Saltbush (*Einadia hastata*), Native Carrot (*Daucus glochidiatus* form F*),* Kidney Weed (*Dichondra repens,* Large Tick-trefoil (*Desmodium brachypodum*), Slender Tick-trefoil (*Desmodium varians*), Amulla (*Eremophila debilis*)Many-flowered Mat-rush *(Lomandra multiflora),*Oncinocalyx betchei*,* Hairy Joyweed (*Alternanthera nana*), Yellow Buttons (*Chrysocephalum apiculatum*), Caustic Weed (*Chamaesyce drummondii*) and Slender Flat-sedge (*Cyperus gracilis*).

Introduced species: Introduced species were common in the remnant of this community which comprises a narrow strip of trees and associated flora within former cultivation paddocks in the proposed new mine facilities area. The main weeds included the noxious weed African Boxthorn (*Lycium ferocissimum*), Saffron Thistle (*Carthamus lanatus*), Flaxleaf Fleabane (*Conyza bonariensis*), Mayne's Pest (*Glandularia aristigera*), Dwarf Marigold (*Schkuhria pinnata* var. *abrotanoides*) a Peppercress (*Lepidium africanum*), Proliferous Pink (*Petrorhagia nanteuillii*) and Lesser Snapdragon (*Misopates orontium*).

Nearest Equivalent Biometric Vegetation Type (DECCW 2008): White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions. (Namoi CMA Community 130).

Nearest Equivalent NSWVCA Community (Benson *et al*. 2010): White Box - White Cypress Pine shrub grass hills woodland in the Brigalow Belt South and Nandewar Bioregions (NSWVCA community 435).

Threatened Ecological Communities: Community 3 is part of the NSW *White Box, Yellow Box, Blakely's Red Gum Woodland* EEC and the Commonwealth *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands* CEEC, respectively.

Variants: Three

***Community 3a*:** This variant comprises dense regeneration of White Cypress Pine on cleared areas of this community.

***Community 3b*:** Historically cleared areas of Community 3 with regenerating White Box and White Cypress Pine are designated as Community 3b.

***Community 3c*:** Areas of grassland dominated by native grass species and considered to have been occupied by Community 3 prior to clearing are designated as Community 3c.

Plate 9. Community 3 (Quadrat 27)

Plate 10. Community 3b (Quadrat 28)

Table 11
Community 4. Narrow-leaved Grey Box - Poplar Box - White Cypress Pine Grassy Open Woodland

No. of quadrats: 3
Landscape position: Stagnant alluvial plains in the lower lying parts of the study area.
Dominant species ***Trees:*** The dominant trees on the quadrats were Poplar Box *(Eucalyptus populnea)* and White Cypress Pine *(Callitris glaucophylla).* Narrow-leaved Grey Box (*Eucalyptus pilligarensis*) occurs sporadically in this community along Goonbri Road. ***Low Trees:*** Dense stands of Wilga *(Geijera parviflora)* occur in this community along Goonbri Road, but are more sporadic in remnants on farmland. ***Shrubs:*** Low shrubs are not abundant, but include Small-leaf Bluebush *(Maireana microphylla),* Galvanized Burr *(Sclerolaena birchii),* Black Rolypoly *(Sclerolaena muricata* var. *villosa)* and a Sida *(Sida spinosa).* ***Creepers:*** Amulla *(Eremophila debilis)* and Tarvine *(Boerhavia dominii)* are common on otherwise bare ground and a Glycine (*Glycine tabacina*) twines over low vegetation and fallen branches. ***Ground covers:*** Ground cover is generally sparse where Wilgas and Cypress Pines dominant the upper canopy. However, in open areas and on farmland remnants the following herbs and grasses dominate; Yellow Burr-daisy *(Calotis lappulacea),* Golden Everlasting *(Xerochrysum bracteatum),* Fishweed *(Einadia trigonos* subsp. *leiocarpa),* Kidney Weed *(Dichondra repens),* Corrugated Sida *(Sida corrugata),* Slender Flat-sedge *(Cyperus gracilis),* Purple Wire-grass *(Aristida personata),* Wallaby Grass *(Austrodanthonia bipartita),* Speargrass *(Austrostipa scabra* subsp. *scabra),* Slender Bamboo Grass *(Austrostipa verticillata),* Queensland Bluegrass *(Dichanthium sericeum)* and *Eragrostis alveiformis.* ***Introduced species:*** The main introduced species were Prickly Lettuce *(Lactuca serriola),* Common Sowthistle *(Sonchus oleraceus),* A Peppercress *(Lepidium africanum)* and Prairie Grass *(Bromus catharticus).*
Nearest Equivalent Biometric Vegetation Type (DECCW 2008): Narrow-leaved Grey Box - Poplar Box – White Cypress Pine grassy open woodland on alluvial loams mainly of the temperate (hot summer) climate zone (Namoi CMA Community 83). **Nearest Equivalent NSWVCA Community (Benson *et al*. 2010):** Narrow-leaved Grey Box – White Cypress Pine – Buloke shrubby woodland in the Brigalow Belt South Bioregion (NSWVCA community 88).
Threatened Ecological Communities (TEC): This community is not part of a State or Commonwealth TEC.
Variants: One ***Community 4c:*** Grasslands derived from Community 4 occur above the riparian zone in the area east of Goonbri Creek and west of Goonbri Road. The dominant grasses are Red Grass (*Bothriochloa decipiens*), Slender Bamboo Grass (*Austrostipa verticillata*) and Purple Wire-grass (*Aristida personata*). The community includes a range of native herbs and sedges, as well as many introduced weeds.

Plate 11. Community 4 (Quadrat 19)

Plate 12. Community 4 (Quadrat 19)

Table 12
Community 5. Bracteate Honeymyrtle Low Riparian Forest

No. of quadrats: 4
Landscape position: In active alluvial zones along Goonbri and Bollol Creeks and wet depressions in paddocks.
Dominant species ***Trees:*** Emergent Blakely's Red Gum *(Eucalyptus blakelyi)* and Rough-barked Apple (*Angophora floribunda*) dominate along creeks. Also, Yellow Box (*Eucalyptus melliodora*), Poplar Box *(Eucalyptus populnea)* and Belah (*Casuarina cristata*) may be common in paddock depressions. ***Low Trees:*** A dense lower canopy of Bracteate Honeymyrtle (*Melaleuca bracteata*), Wilga *(Geijera parviflora)* and Velvet Mock Olive *(Notelaea microcarpa* var*. macrocarpa)* is usually present. ***Shrubs:*** Few low shrubs are present and may include Small-leaf Bluebush *(Maireana microphylla)* and a Sida (*Sida spinosa*). ***Creepers:*** The only creeper observed was a Glycine (*Glycine tabacina*). ***Ground covers:*** Due to heavy shading from the dense sub-canopy, ground covers are sparse except in openings and cleared areas. These commonly include Lesser Joyweed *(Alternanthera denticulata),* Fishweed *(Einadia trigonos* subsp. *leiocarpa),* Kidney Weed *(Dichondra repens),* Native Geranium *(Geranium solanderi* subsp*. solanderi),* Swamp Dock *(Rumex brownii),* Stinging Nettle *(Urtica incisa),* Tall Sedge *(Carex appressa),* Knob Sedge *(Carex inversa),* Slender Bamboo Grass *(Austrostipa verticillata),* Early Spring Grass *(Eriochloa pseudoacrotricha),* Weeping Grass *(Microlaena stipoides)* and Knottybutt Grass *(Paspalidium constrictum).* ***Introduced species:*** The moist fertile alluvial soils of this community are favourable to a wide range of introduced species including predominantly Khaki Weed *(Alternanthera pungens),* Redroot Amaranth *(Amaranthus retroflexus),* Pepper Tree *(Schinus areira),* Slender Celery *(Cyclospermum leptophyllum),* Cobblers Pegs *(Bidens pilosa),* Greater Beggar's Ticks *(Bidens subalternans),* Flaxleaf Fleabane *(Conyza bonariensis),* Prickly Lettuce *(Lactuca serriola),* Buchan Weed *(Hirschfeldia incana),* Four-leaved Allseed *(Polycarpon tetraphyllum),* Small-flowered Mallow *(Malva parviflora),* Paddy's Lucerne *(Sida rhombifolia),* Inkweed *(Phytolacca octandra),* Green Cestrum *(Cestrum parqui), Verbena caracasana* and Prairie Grass *(Bromus catharticus).*
Nearest Equivalent Biometric Vegetation Type (DECCW 2008): No equivalent in Namoi CMA region, refer to Table 7. **Nearest Equivalent NSWCA Community (Benson et al. 2010):** No equivalent in Namoi CMA region, refer to Table 7.
Threatened Ecological Communities (TEC): This community is not part of a State or Commonwealth TEC.
Variants: Creek and paddock variants can be distinguished on the basis of the dominant trees, as above.

Plate 13. Community 5 - Goonbri Creek (Quadrat 18)

Plate 14. Community 5 - Paddock depression, 'Templemore' (Quadrat 20)

Table 13
Community 6. Cleared Farmland

No. of quadrats: 19 spot samples

Landscape position: Cleared, cropped and grazed farming paddocks on mainly stagnant alluvial soils on the valley floor.

Dominant species

Trees: Where present, Poplar Box *(Eucalyptus populnea)* is the main remnant eucalypt scattered in the farming paddocks. Other occasional native trees include Narrow-leaved Grey Box (*E. pilligaensis*), Silver-leaved Ironbark (*E. melanophloia*), Beyer's Ironbark (*E. beyeriana*), White Box (*E. albens*) and Rough-barked Apple (*Angophora floribunda*).

Shrubs: Tall shrubs are almost entirely absent from the cleared farmland. The native subshrubs, Spiked Sida *(Sida subspicata)* and *Sida spinosa*, possess weedy characteristics and may be common in fallowed cultivation paddocks. Along fencelines and in rare remnant woodland patches Small-leaf Bluebush *(Maireana microphylla)* and Galvanized Burr *(Sclerolaena birchii)* occur sporadically.

Creepers: No native creepers occur commonly in the farmlands.

Ground covers: Native ground cover species tend to be rare in the paddocks except along some fencelines and in some remnant woodlots mapped as Community 4 (Figures 4 and 5). These include Yellow Burr-daisy *(Calotis lappulacea),* Fishweed *(Einadia trigonos* subsp*. leiocarpa),* Swamp Dock *(Rumex brownii),* Windmill Grass *(Chloris truncata),* Barbwire Grass *(Cymbopogon refractus),* Queensland Bluegrass *(Dichanthium sericeum),* Early Spring Grass *(Eriochloa pseudoacrotricha),* Hairy Panic *(Panicum effusum), Paspalidium distans,* Slender Rat's Tail Grass *(Sporobolus creber),* Speargrass *(Austrostipa scabra* subsp*. scabra),* Slender Bamboo Grass *(Austrostipa verticillata),* and Wallaby Grass *(Austrodanthonia fulva).* Native species commonly found in cultivated and grazed paddocks include Cudweed *(Euchiton sphaericus),* Fuzzweed *(Vittadinia cuneata var. cuneata),* Windmill Grass *(Chloris truncata),* Couch *(Cynodon dactylon),* Queensland Bluegrass *(Dichanthium sericeum),* Umbrella Grass *(Digitaria divaricatissima),* Awnless Barnyard Grass *(Echinochloa colona), Eragrostis alveiformis,* Early Spring Grass *(Eriochloa pseudoacrotricha),* Hairy Panic *(Panicum effusum), Paspalidium distans* and Slender Rat's Tail Grass *(Sporobolus creber).*

Introduced species: Introduced species are common and dominate the farming paddocks in terms of biomass. The most dominant species are Flaxleaf Fleabane *(Conyza bonariensis),* Dwarf Marigold *(Schkuhria pinnata* var. *abrotanoides),* Saffron Thistle *(Carthamus lanatus),* Slender Celery *(Cyclospermum leptophyllum) and* Skeleton Weed *(Chondrilla juncea).* Other common species include Khaki Weed *(Alternanthera pungens),* Redroot Amaranth *(Amaranthus retroflexus),* Gomphrena Weed *(Gomphrena celosioides),* Cobblers Pegs *(Bidens pilosa),* Bathurst Burr *(Xanthium spinosum),* Paterson's Curse *(Echium plantagineum),* Blue Heliotrope *(Heliotropium amplexicaule),* A Peppercress *(Lepidium africanum),* Hairy Brassica *(Lepidium bonariense),* Camel Melon *(Citrullus lanatus),* Lucerne *(Medicago sativa),* Common Centaury *(Centaurium erythraea),* Stagger Weed *(Stachys arvensis),* Wireweed *(Polygonum aviculare),* Twiggy Mullein *(Verbascum virgatum)* and Stinkgrass *(Eragrostis cilianensis).*

Nearest Equivalent Biometric Vegetation Type (DECCW 2008): No equivalent, refer to Table 7.

Nearest Equivalent NSWVCA Community (Benson *et al*. 2010): No equivalent, refer to Table 7.

Threatened Ecological Communities (TEC): This community is not part of a State or Commonwealth TEC.

Variants: None

Plate 15. Community 6 - Former cropping paddock infested with exotic Flaxleaf Fleabane

Table 14
Percentage Cover of Native and Exotic Groundcover Species in Grasslands on the Study Area

	Grassland Transect Number																		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Mean**
Native grasses	30	46	36	28	50	24	20	48	40	46	58	48	28	42	34	28	30	26	36.8
Native shrubs	2	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4
Native other	12	10	36	42	16	18	6	6	2	10	6	12	6	6	10	32	10	22	14.6
Total native	**44**	**56**	**72**	**74**	**66**	**42**	**26**	**54**	**42**	**56**	**64**	**60**	**34**	**48**	**44**	**60**	**40**	**48**	**51.7**
Exotic plants	66	48	58	68	54	68	84	54	50	72	68	52	62	54	58	42	58	70	60.3

6.2 FLORA SPECIES

A complete flora species list for the study area is provided in Attachment B. A total of 363 plant species were identified by the quadrat plots, spot samples, random meanders and in general movement around the study area. Of these, 269 (74.1%) are native to the natural communities of the study area and 94 (25.9%) are introduced. The sampling intensity varied among communities, consequently it is difficult to validly compare the numbers of species between communities (Table 15). The largest number of species was found in Community 1 with 201 species from 15 samples. High numbers were also found in Community 2, 152 species from 5 samples and Community 3, 157 species from 4 samples. Communities 1 and 2 dominate the parts of the study area in Leard State Forest. The relatively high species counts from Communities 1 and 2 reflect the high diversity of native species in the forest and its comparatively undisturbed condition.

The plant families with the highest numbers of species (Attachment B) were the Grasses, Poaceae (66 species); Daisies, Asteraceae (56 species); Pea Flowers, subfamily Faboideae (19 species); the saltbushes and bluebushes, Chenopodiaceae (16 taxa); the Mallows and Sidas, Malvaceae (12 species) and the Eucalypts and related genera in the family Myrtaceae (12 species). In all, some 80 plant families or subfamilies were represented.

Table 15
Numbers and Percentages of Native and Introduced Vascular Plant Species Identified in the Vegetation Communities within the Study Area

Community	No. Samples (Table 6)	Total Flora Species	Native Species		Introduced Species	
			Number	Percent	Number	Percent
1	15	201	161	80.1	40	19.9
2	5	152	132	86.8	20	13.2
3	4	157	121	77.1	36	22.9
4	3	75	59	78.7	16	21.3
5	4	118	70	59.3	48	40.7
6	19	131	79	60.3	52	39.7
Total	**60**	**363**	**269**	**74.1**	**94**	**25.9**

6.3 INTRODUCED SPECIES AND WEEDS

Table 15 shows the numbers and percentages of introduced species found by the survey. Overall, just over a quarter (25.9%) of the flora species are introduced. The highest proportions of introduced species, 40.7 and 39.7%, were found in the disturbed riparian zone of Goonbri Creek (Community 5) and in cleared farmlands in grazing paddocks (Community 6), respectively. However, all these areas nevertheless retained higher proportions of native than introduced species.

Introduced species were least abundant in the less disturbed habitats of Leard State Forest. Community 1 and Community 2 had the least introduced species, 19.9% and 13.2%, respectively, owing to the relatively poor soils on which they occur. The regenerating, historically cleared areas of Community 1 (Communities 1a and 1b) and Community 3 had higher proportions of introduced species, 24.8%, 19%, and 22.9%, respectively, than the less disturbed Communities 1 and 2. Comparable levels of introduced species occur in Community 4 (21.3%), which is present along disturbed roadsides and as small woodlots in farm paddocks where it would be regularly grazed.

Nine introduced species recorded in this survey are regarded as noxious weeds in the Narrabri Shire Council area (Table 16) under the NSW *Noxious Weeds Act 1993*. None were abundant anywhere within the study area, although Prickly Pear is widespread (Attachment B). Bathurst Burr, Blue Heliotrope and Galvanised Burr were relatively common in cleared farmland.

Table 16
Noxious Weeds Recorded on the Study Area

Common Name	Scientific Name	Noxious Weed Class	Communities in which Present
African Boxthorn[1]	*Lycium ferocissimum*	4	3, 5, 6
Bathurst Burr[1]	*Xanthium spinosum*	4	4, 5, 6
Blue Heliotrope[1]	*Heliotropium amplexicaule*	4	5, 6
Galvanised Burr[2]	*Sclerolaena birchii*	4	2, 3, 4, 5 6
Golden Dodder[1]	*Cuscuta campestris*	4	5, 6
Johnson Grass[1]	*Sorghum halepense*	4	5
Mexican Poppy[3]	*Argemone ochroleuca* subsp. *Ochroleuca*	5	6
Prickly Pear[4]	*Opuntia stricta*	4	1, 1a, 1b, 2, 3, 4, 5, 6
Spiny Burrgrass[4]	*Cenchrus spinifex* (syn. *C. incertus*)	4	6

Legal requirements (NSW Department of Primary Industries 2011)

1 The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

2 The plant must be controlled where it impacts on normal agricultural practices including cropping and pasture management.

3 The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

4 The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed.

6.4 THREATENED FLORA SPECIES

No flora species listed in the schedules of the TSC Act or EPBC Act, were found in the targeted searches or other sampling conducted over the study area.

6.5 ROTAP SPECIES

No flora species listed in the ROTAP (Briggs and Leigh 1996) classification were found in the targeted searches or other sampling conducted over the study area.

6.6 THREATENED ECOLOGICAL COMMUNITIES

The database searches returned two threatened ecological communities that were considered to have potential to occur on the study area; the Inland Grey Box Woodland EEC (moderate potential to occur) and the Box-Gum Woodland EEC/CEEC (high potential to occur) (Table 4). No Inland Grey Box (*Eucalyptus microcarpa*), or its derived grasslands, were found on or near the study area by this or previous surveys (GCNRC 2005; Eco Logical Australia 2010; Parsons Brinkerhoff 2010). Therefore, it is concluded that the Inland Grey Box Woodland EEC is absent from the study area.

Previous surveys (GCNRC 2005; Eco Logical Australia 2010; Parsons Brinkerhoff 2010) have recorded the Box-Gum Woodland EEC (TSC Act)/Box – Gum Grassy Woodland and Derived Grassland CEEC (EPBC Act). In broad agreement with GCNRC (2005) and Eco Logical Australia (2010) this EEC/CEEC was identified on the western side of the study area on and near the proposed infrastructure site and on part of the proposed services corridor (Community 3 – Figure 4). These occurrences have high grass cover levels and low shrub cover in the understorey, and meet all other criteria.

By contrast, occurrences of White Box in Leard State Forest (Community 2 - Figure 4) and to its south are not considered to conform to either the NSW Box-Gum Woodland EEC or the Commonwealth Box – Gum Grassy Woodland and Derived Grassland CEEC. This vegetation was observed to be generally shrubby rather than grassy, which rules it out as part of either the State EEC or the Commonwealth CEEC. However, this view contrasts with that of Parsons Brinkerhoff (2010) who considered that the same area of White Box dominated vegetation in Leard State Forest belongs to both the State EEC and the Commonwealth CEEC. In order to clarify this issue, 20 shrub cover transects (see section 5.1.4) were conducted in Leard State Forest to obtain accurate unbiased estimates of shrub cover throughout the White Box occurrence. At the same time measures of cover by native grasses, other native ground covers and leaf litter were also made.

The following sections present data on the structure and floristic composition of shrubby woodland patches dominated by White Box on the study area. This data is then discussed in relation to the NSW and Commonwealth guidelines for identification of the threatened communities.

White Box – White Cypress Pine Shrubby Woodland in the Project Area

The community occurs in the following two patches:

1. The major occurrence is in the southern part of Leard State Forest where it occurs on drainage lines and forms ecotones with a White Cypress Pine – Narrow-leaved Ironbark community on the adjoining slopes. Despite past logging, the community is in good condition. This occurrence is mapped as Community 2 on Figure 4.

2. A second smaller patch occurs on the margins of cleared land immediately east of ML1579. This patch also merges with a White Cypress Pine – Narrow-leaved Ironbark community upslope. It has been semi-cleared and grazed historically, such that the trees and shrubs are generally more widely spaced than in Leard State Forest. However, the two patches are very similar floristically. This occurrence is mapped as Community 2b on Figure 4.

Review of Box - Gum Woodland Characteristics

Before presenting and discussing the data, it is important to review the relevant State and Commonwealth guidelines for identification of the EEC/CEEC as follows.

The key documents for defining Box-Gum Woodlands are the *Final Determination* of the NSW Scientific Committee established under the TSC Act (NSW Scientific Committee 2002) and the *Listing Advice* of the Threatened Species Scientific Committee set up under the EPBC Act (DEH 2006a).

New South Wales

There are five main features in the Final Determination that govern whether the EEC exists at a site (NPWS 2002b):

1. *Whether the site is within the area defined in the Determination.*
2. *Whether the characteristic trees of the site are (or are likely to have been) White Box, Yellow Box or Blakely's Red Gum.*
3. *Whether the site is mainly grassy.*
4. *Whether any of the listed characteristic species occur (including as part of the seedbank in the soil).*
5. *If the site is degraded, whether there is potential for assisted natural regeneration of the overstorey or understorey.*

The Final Determination indicates Box-Gum Woodland includes vegetation where '*grass and herbaceous species generally characterise the ground layer…. Shrubs are generally sparse or absent, though they may be locally common.*' 'Locally common' is not defined in the Final Determination. However, the Identification Guidelines suggest that the intent of the Final Determination '*is that shrubs may be dominant over parts of an EEC site*' (NPWS 2002b). However, the Identification Guidelines note that:

> *…. shrubby woodlands, which generally occur in upper or midslope situations on shallower soils, are not part of the EEC. Such woodlands are more prevalent on hillsides of the North Western slopes (Nandewar and Brigalow Belt South bioregions). Where shrubby woodlands dominated by White Box, Yellow Box or Blakely's Red Gum intergrades (sic) with the Box-Gum Woodland the more shrub-free sections of the community should be regarded as Box-Gum Woodland.*

The NSW guidelines are general, avoid nominating quantitative criteria and are consequently open to interpretation, which can make them difficult to use (Bower 2011).

Commonwealth

The Commonwealth guidelines also exclude shrubby woodlands from the CEEC, and define them as having '*a continuous shrub layer of more than 30 percent cover*' (DEH 2006b).

The Commonwealth Listing Advice recognises that there can be difficulty in distinguishing grassy and shrubby box woodlands and offers the following explanation:

> *Shrubs can occur naturally in grassy woodlands, and can form an important part of the Box-Gum Grassy Woodland and Derived Grassland ecological community, however, on poorer soils throughout its range, this ecological community grades into shrubby woodlands (Prober and Thiele 1993). This can lead to confusion in recognising the listed ecological community, and the following can be used to determine if a remnant is included in the listed ecological community or if it is a shrubby woodland. Shrub cover in this ecological community is naturally patchy, and shrubs may be dominant only over a very localised area. A remnant with a significant ground layer of tussock grasses, and where the distribution of shrubs is scattered or patchy, is part of the ecological community. In shrubby woodlands, the dominance of native tussock grasses in the ground layer of the vegetation is lost. Therefore, a remnant with a continuous shrub layer, in which the shrub cover is greater than 30 percent, is considered to be a shrubby woodland and so is not part of the listed ecological community*

DEH (2006a) includes a flowchart to assist in determining whether a remnant constitutes part of the CEEC. The flowchart includes a number of quantitative measures for identifying areas that meet CEEC requirements including:

1. *Patches must have at least 5 trees no more than 75m apart, or are areas with a predominantly native ground cover. Patches are to be assessed at a minimum of 0.1ha or 50 × 20m.*
2. *Whether the patch has a predominantly native understorey: This is defined as 'at least 50 percent of the perennial vegetation cover in the ground layer'.*
3. *A minimum patch size of 0.1ha is specified for the whole patch.*
4. *There must be 12 or more non-grass native understorey species present, at least one of which is an 'important' species. A list of native species found in Box–Gum Woodlands is available from the DSEWPaC website with the 'important' species annotated.*
5. *Even if patches do not meet the preceding understorey requirement, they can be accepted as CEEC if the patch is more than 2 ha in size and either averages more than 20 trees per ha, or has natural regeneration of the overstorey eucalypts.*

Other Characteristics of Box-Gum Woodlands

Apart from the floristic and structural features listed above, the literature on Box-Gum Woodlands describes a range of correlated characteristics of the vegetation including:

1. It occurs on soils that are '*relatively fertile'* (NSW Scientific Committee 2002), '*moderately to highly fertile*' (NPWS 2002b), '*the fertile lower parts of the landscape where resources such as water and nutrients are abundant*' (NPWS 2002c) and '*on moderate to highly fertile soils*' (DEH 2006a).

2. Associated tree species may include White Cypress Pine, *Callitris glaucophylla*, and Narrow-leaved Ironbark, *Eucalyptus crebra* that occur with it on the study area (Scientific Committee 2002), although only White Cypress Pine is mentioned in the Commonwealth Listing Advice (DEH 2006a).

3. The Commonwealth Listing Advice stresses the rarity of good examples of Box-Gum Woodlands; '*less than 0.1 percent of Grassy White Box Woodlands (a component of the Box-Gum Grassy Woodland and Derived Grasslands) remain in near-intact condition*' (DEH 2006b). Also, '*there are only a small number of areas remaining that retain a highly diverse understorey dominated by native perennial tussock grasses. These areas are extremely rare, and usually quite small in size (Prober and Thiele 1995)*' and are typically '*cemeteries, road verges, some town commons, or travelling stock routes or reserves (Prober and Thiele in press)* (*ibid.*). However, '*the ecological community has been less severely impacted in parts of the western fall of northern NSW due to the use of native pastures rather than improved pastures, and less cropping. However, the extensive grazing in the north has still resulted in an overall decline in the condition of the ecological community, particularly the understorey' (ibid.).*

White Box Woodland Structure in Leard State Forest

The transect data obtained in this study show that shrub cover varies continuously from low (2.7 percent) to moderately high (45.8 percent) (Table 17, Figure 6), with a mean of 23.9 percent across the White Box occurrence. In essence, shrub cover showed considerable spatial variation with low and high shrub areas forming a complex mosaic in the landscape. It was observed that higher shrub densities tend to occur along creek lines and on gentle slopes, while flat areas tend to have fewer shrubs. However, there is no inverse correlation between shrubbiness and grassiness, i.e. there is no tendency for low shrub areas to exhibit increased grass cover (Figure 6), although there is some suggestion of higher levels of 'other native groundcovers' on some low shrub sites (Figure 6). In general, grass cover is sparse in the White Box woodland of Leard State Forest; the maximum cover recorded was 40 percent and most transects were below 30 percent (Table 17, Figure 6). Mean grass cover is only 21 percent, which is slightly lower than the mean shrub cover (23.9 percent) (Table 17). Such low grass cover levels are not consistent with the structure expected in grassy woodlands. It was also noted that leaf litter cover was high on most transects, up to 95% and mostly in excess of 50% with a mean of 64% (Table 17, Figure 6). These data are more consistent with shrubby than grassy woodlands.

Table 17
Shrub and Ground Cover Percentages on 20 Transects in White Box Woodland in Leard State Forest

Transect Number	Native Shrubs	Native Grasses	Native Other	Leaf Litter[1]
1	10.4	20	40	50
2	22.4	32	4	80
3	34.8	32	10	90
4	5.2	6	18	-
5	7.9	24	26	50
6	40.7	18	10	30
7	45.8	24	14	50
8	22.8	10	10	90
9	15.3	40	10	20
10	42.1	16	10	40
11	42.4	30	10	70
12	19.3	12	4	30
13	13.9	6	22	90
14	9.8	22	8	80
15	30.4	30	6	70
16	3.2	20	8	60
17	43.6	14	6	80
18	24.2	24	8	70
19	40.6	26	2	70
20	2.7	14	6	95
Mean	23.9	21.0	11.6	63.9

[1] Leaf litter cover is by visual estimate only, it was not measured on the biobanking transects.

The relatively high shrub levels and low grass cover in the Leard State Forest White Box woodland exclude it from the NSW Box-Gum Woodland EEC. The status of this area in relation to the EPBC Act guidelines is discussed below.

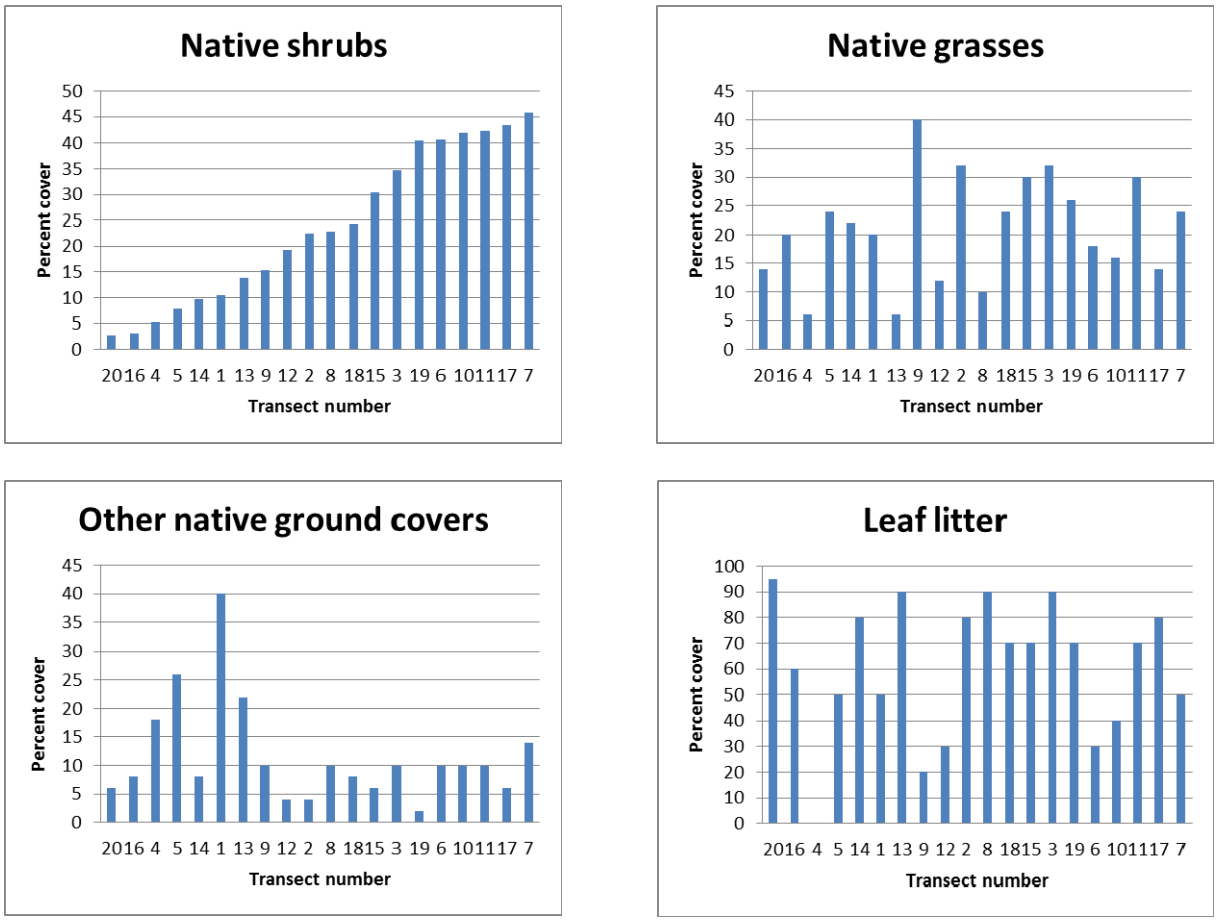


Figure 6. Ground Cover by Native Shrubs, Grasses, Other Ground Cover Species and Leaf Litter (Transects are presented in the same order in each chart from lowest to highest shrub cover).

Floristics

Nine 20 × 50 m Biometric flora quadrats were conducted in the White Box patches: three in Leard State Forest; two in the proposed open pit (MLA 2); three in the proposed infrastructure area; and one in the proposed service corridor (Figure 5).

Results from these quadrats are summarised in Table 18. In all patches, White Box is co-dominant with White Cypress Pine indicating they represent similar ecological communities. However, the quadrats in Leard State Forest are characterised by relatively high shrub levels with covers averaging 25%. By contrast, those on the proposed pit, infrastructure area and services corridor had low shrub covers averaging 3.5, 11.7 and less than 1%, respectively. The dominant shrubs in Leard State Forest are long-lived perennial species characteristic of poor soils, particularly *Beyeria viscosa*, *Dodonaea viscosa* subsp. *spatulata*, *Dodonaea sinuolata* subsp. *sinuolata*, *Senna* form taxon *filifolia*, *Maytenus cunninghamii* and *Acacia excelsa*. These shrubs extend upslope into the adjoining Narrow-leaved Ironbark/White Cypress Pine community and are absent from the other White Box patches. The most common shrub on the pit area of MLA 2 is *Acacia decora*, while *Myoporum montanum* and *Maireana microphylla* are most common on the infrastructure area. Shrubs are virtually absent from the services corridor site. The ground cover is sparse in Leard State Forest, intermediate in the pit area and services corridor site, and high on the infrastructure area, with mean covers of 36.7, 55.0, 60.0, and 93.3%, respectively.

Table 18
Results of Nine Flora Quadrats Conducted in the White Box - White Cypress Pine Association on the Study Area

Quadrat No.	1	2	5	8	9	27	28	29	31
Location	Leard State Forest	Leard State Forest	Leard State Forest	Pit Area (MLA 2)	Pit Area (MLA 2)	Infrastructure Area	Infrastructure Area	Infrastructure Area	Services Corridor
Dominant trees/low trees (> 2m)	*Eucalyptus albens* (3)[1] *Callitris glaucophylla* (3)	*E. albens* (4) *C. glaucophylla* (2) *Geijera parviflora* (3)	*E. albens* (4) *C. glaucophylla* (2) *G. parviflora* (2)	*E. albens* (5) *C. glaucophylla* (2) *G. parviflora* (3)	*E. albens* (5) *C. glaucophylla* (3)	*E. albens* (3) *C. glaucophylla* (3) *Alectryon oleifolius* (2)	Nil	*E. albens* (3) *E. populnea* (3) *C. glaucophylla* (3)	*E. albens* (5) *E. blakelyi* (4) *C. glaucophylla* (6) *G. parviflora* (2)
Dominant shrubs (< 2m)	*Senna* form taxon *zygophylla* (2) *Dodonaea viscosa* subsp. *angustifolia* (2) *Cassinia laevis* (2) *Acacia decora* (2) *Acacia leiocalyx* (2)	*Dodonaea viscosa* subsp. *angustifolia* (3) *Acacia decora* (3) *Senna* form taxon *zygophylla* (2)	*Acacia decora* (2) *Beyeria viscosa* (2)	*Senna* form taxon *zygophylla* (1) *Acacia decora* (1)	*Acacia decora* (2)	*Myoporum montanum* (2)	*E. albens* (3) *C. glaucophylla* (3) *Maireana microphylla* (2)	*M. montanum* (2) *C. glaucophylla* (2) *Lycium ferocissimum* (2) *M. microphylla* (2)	*Pimelea neoanglica* (1) *Acacia decora* (1)
Dominant ground covers	*Dichondra repens* (4) *Desmodium brachypodum* (4) *Cymbopogon refractus* (3) *Austrostipa scabra* subsp. *scabra* (3)	*D. repens* (3) *D. brachypodum* (4) *A. scabra* subsp. *scabra* (3) *Eremophila debilis* (2)	*Desmodium brachypodum* (4) *A. scabra* subsp. *scabra* (3) *Cyperus gracilis* (2) *Lomandra multiflora*(2) *Cymbopogon refractus* (2)	*D. repens* (5) *Aristida* sp. (4) *Desmodium brachypodum* (3) *E. debilis* (3) *A. scabra* subsp. *scabra* (3)	*A. scabra* subsp. *scabra* (3) *Poa* sp. (3) *Aristida* sp. (3) *Cyperus gracilis* (3) *D. repens* (3) *Calotis lappulacea* (2) *E. debilis* (2)	*Paspalidium constrictum* (5) *Chloris ventricosa* (4) *A. scabra* subsp. *scabra* (3)	*A. scabra* subsp. *scabra* (4) *Eragrostis alveiformis* (3) *Chloris ventricosa* (3) *Enteropogon ramosus* (3) *Sida spinosa* (2)	*Chloris ventricosa* (3) *A. scabra* subsp. *scabra* (3) *E. ramosus* (3) *Dichanthium sericeum* (3) *Brachyscome ciliaris* (2)	*Aristida personata* (6) *Lomandra filiformis* var. *filiformis* (4)
Tree canopy cover (%)	20	50	40	70	60	30	0	20	50
Shrub canopy cover (%)	25	35	15	2	5	5	20	10	<1
Native ground cover (%)	40	40	30	60	50	100	80	100	60
No. of native non-grass understorey species	34	30	25	38	41	15	17	19	18
No. of 'important' species	12	8	7	13	15	2	1	6	8
Geology[2]	Maules Creek Formation	Maules Creek Formation	Maules Creek Formation	Maules Creek Formation	Maules Creek Formation	Maules Creek Formation	Maules Creek Formation	Maules Creek Formation	Boggabri Volcanics

[1] Cover ratings: 1=<1%; 2=1-5%; 3=6-25%; 4=26-50%; 5=51-75%; 6=76-100%

[2] Department of Primary Industries (2009).

Soils

All but one patch are on relatively infertile soils derived from the early Permian sedimentary Maules Creek Formation. The small patch in the proposed services corridor is on soil derived from the Boggabri Volcanics. Pits for soil analysis were dug in the two eastern White Box patches by McKenzie Soil Management Pty. Ltd.; three in Leard State Forest and two on MLA 1 (David McKenzie, personal communication). The results showed that, although variable, the soils are similar on both sites. In general, the soils have low availability of some key nutrients for plant growth; phosphorus, nitrogen, zinc and copper. The soils are also prone to waterlogging, particularly in the subsoil and there are patchy occurrences of high subsoil salinity. The main positive aspects of the soils are generally favourable pH profiles, although patches of strongly acidic topsoils occur, and low stone content, indicating better water holding capacity than soils upslope in the ironbark areas.

TSC ACT: Status of the White Box patch in the pit area of MLA 2

The results in Table 18 show that the White Box dominated patch on the pit area of MLA 2 has moderate levels of native grass cover and generally low shrub cover. Accordingly, it potentially conforms to the NSW Box-Gum Woodland EEC criteria. However, as indicated above, the White Box woodland areas of Leard State Forest do not conform to the NSW Box-Gum Woodland EEC criteria, owing to their low grass cover and generally high shrub cover, and therefore are not part of the NSW Box-Gum Woodland EEC. The disturbed White Box dominated vegetation south of Leard State Forest is considered to be derived from the same community as in the forest due to similarities in floristics, soils and landscape position, despite having medium grass cover and low shrub cover owing to historical clearing and grazing. Accordingly, it is not considered to be part of the NSW Box-Gum Woodland EEC.

The White Box association in Leard State Forest and the pit area of MLA 2 conforms structurally and floristically to the Namoi CMA Biometric Vegetation Type, *White Box – White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions* (DECCW 2008). This association is not considered to be part of the NSW Box-Gum Woodland EEC in DECCW (2008).

EPBC ACT: Status of White Box dominated patches in Leard State Forest and the pit area of MLA 2 in relation to Commonwealth CEEC criteria

Application of the Commonwealth CEEC criteria (DEH 2006b) to the data in Tables 17 and 18 suggests that all White Box dominated patches on the study area conform to the CEEC. This is a paradoxical result given that the Leard State Forest patch does not meet the less stringent NSW EEC guidelines. The key difference is due to the shrub levels falling below the Commonwealth threshold of 30% canopy cover. In Leard State Forest the mean shrub cover for 20 transects was 23.9% (Table 17), while the mean estimated cover on three quadrats was 25% (Table 18). However, shrub cover in Leard State Forest is highly variable; from 2.7 to 45.8% in a complex mosaic of lower and higher shrub cover. This raises the question of whether the White Box occurrence in Leard State Forest should be classified as part of the Commonwealth CEEC.

A number of factors independent of the Commonwealth CEEC criteria suggest that the White Box/ White Cypress Pine vegetation in Leard State Forest does not belong in the Commonwealth CEEC. These are:

1. ***Groundcover.*** The native ground cover is sparse, averaging 21.0% on the transects (Table 17) and 36.7% on the quadrats (Table 18). Grassy woodlands tend to have considerably higher grass/forb cover levels.

2. ***Shrub species*.** The shrubs associated with White Box in Leard State Forest are characteristic of vegetation found on poor, often stony soils in hilly terrain. In particular, the dominant shrubs, *Beyeria viscosa*, *Dodonaea viscosa* subsp. *spatulata*, *Dodonaea sinuolata* subsp. *sinuolata*, *Maytenus cunninghamii* and *Acacia excelsa*, are rarely found in grassy box woodlands.

3. ***Soils*.** The soils in Leard State Forest are relatively infertile (David McKenzie, pers. comm.) being derived from early Permian sediments of the Maules Creek Formation. Grassy Box Woodlands occur on moderately to highly fertile soils. In the Brigalow Belt South and Nandewar Bioregions, Box-Gum Woodlands tend to be found on Quarternary or Tertiary alluvial soils, or soils derived from volcanics or fine-grained sediments (NPWS 2002b, Wall 2004, Benson *et al*. 2010).

4. ***Landscape position*.** The White Box distribution in Leard State Forest is in hilly terrain, where it is confined to drainage lines. Box-Gum Woodlands characteristically occur in the lower parts of the landscape in the Brigalow Belt South and Nandewar Bioregions where soils are moister and deeper. Grassy White Box woodlands occur in other parts of Leard State Forest on generally flat terrain, usually in low positions in the landscape (C Bower, personal observations).

5. ***General appearance.*** The appearance of the White Box communities in Leard State Forest is very different from that of typical Box-Gum Woodlands. Shrubs are frequent, often dense and much more obvious than in typical Box-Gum Woodland habitats. In addition, the ground cover is sparse without the generally uniform cover of tussock grasses found in typical Box-Gum Woodlands. The Leard State Forest White Box vegetation on the study area has shrub levels that may fall below the threshold in the Commonwealth guidelines, even though the community overall is clearly more shrubby than typical grassy White Box woodland. Grassy White Box woodlands may merge gradually into shrubby box woodlands as one goes upslope in hilly terrain (DEH 2006a). However, no such transition is obvious in Leard State Forest on the study area. Rather, densely shrubby patches form complex small scale mosaics with less shrubby areas.

The above considerations strongly suggest that the White Box – White Cypress Pine vegetation in Leard State Forest does not belong to the Commonwealth CEEC, despite the average shrub cover levels being below the 30% threshold. This is supported by the fact that Benson *et al*. (2010) do not consider this vegetation type (NSWVCA community 588) belongs to the Commonwealth CEEC.

CONCLUSIONS

It is concluded that:

1. The White Box dominated patches on the infrastructure and service corridor areas (Community 3 – Figure 4) conform to both the NSW Box – Gum Woodland EEC and the Commonwealth Box – Gum Grassy Woodland and Derived Grassland CEEC.

2. The White Box - White Cypress Pine shrubby woodland in Leard State Forest and the area of the proposed open cut pit (Community 2 – Figure 4) are not considered to be part of either the NSW Box-Gum Woodland EEC or the Commonwealth Box – Gum Grassy Woodland and Derived Grassland CEEC.

3. However, it should be noted that sufficient equivalent vegetation to offset both Communities 2 and 3 occurs in the offset area (Appendix C).

6.7 SEPP 44 – POTENTIAL KOALA HABITAT

Narrabri Shire is listed in Schedule 1 of NSW State Environmental Planning Policy (SEPP) No. 44 – Koala Habitat Protection as land to which the policy applies. Narrabri Shire is therefore considered to have potential koala habitat, which is defined as the presence of any of the koala food trees listed in Schedule 2 of the Policy. These tree species must constitute 15% of more of the total number of trees in the upper or lower strata of the tree component.

Two eucalypt species listed in Schedule 2 of SEPP 44 occur on the study area; White Box, *Eucalyptus albens* and Poplar Box, *Eucalyptus populnea.* White Box is a dominant in Communities 2 and 3, including the variants 2, 2b, 3 and 3b (Figure 4). Poplar Box is dominant in Community 4 (Figure 4). These communities and their variants listed here constitute potential koala habitat in the meaning of SEPP 44.

6.8 CONDITION OF THE VEGETATION

The study area encompasses varied geology, soils and topography that have strongly influenced past land use and, consequently, the condition of the native vegetation. Historic disturbance factors on the study area have included clearing of native vegetation, generally on areas of gentler topography and better soil types; logging; grazing by livestock and introduced feral herbivores such as rabbits; the construction of tracks and fire trails, and mining.

The most alienated parts of the study area are the flat valley floor of the Liverpool Plains and the gentler lower slopes of the Willowtree Range. This cleared land has been used for cropping and grazing historically. However, the prolonged drought of much of the last decade and acquisition of the land by Whitehaven has resulted in a reduction in farming intensity, such that much of the flatter parts of the study area are now cleared farmland, albeit with a high representation of vagile native grass species. It also supports a variety of mainly introduced herbs, with native herbs almost entirely absent. These areas lack the capacity to regenerate native tree and shrub cover in the short term since the soil seed bank is fully depleted. Long term unassisted recovery would depend on slow recolonisation of the area from adjacent remnant woodlots and bushland, although a proportion of the original species are likely to have been lost completely. The biodiversity value and resilience of the cleared farmlands is considered to be low.

Adjacent to the lowlands the eastern parts of the study area comprise steeper partially cleared land on the slopes and ridges of the Willowtree Range that dominates the adjacent Leard State Forest. Much of the existing tree cover appears to be regeneration from possibly multiple episodes of past clearing. This area has a low number and biomass of introduced species and a high diversity of the original flora. It retains its ecological resilience with a high capacity for regeneration and is assessed to be in moderate to good condition.

The proposed site for the new mine facilities area is on undulating terrain from which most of the original tree and shrub cover has been removed. While there is evidence of past cultivation and pasture improvement, the site retains a high proportion of native species, including herbs, rushes, sedges and grasses that are absent from the more highly disturbed sites on quarternary alluvium. Parts of the area also have regenerating White Cypress Pine and White Box, with sections conforming to the State and Commonwealth Box - Gum woodland EEC and CEEC, respectively.

The north of the study area within Leard State Forest is in close to its original condition, despite past logging. There is a low representation of introduced flora species and no reason to believe that native flora diversity has declined significantly since white settlement. Provided that threats such as introduced herbivores, particularly goats, could be controlled, recovery of the vegetation to close to its former structure and composition is possible. Consequently, the parts of the study area in Leard State Forest are considered to be in good to excellent condition.

7 POTENTIAL IMPACTS OF THE PROJECT ON TERRESTRIAL FLORA AND THEIR HABITATS

7.1 VEGETATION CLEARANCE

Clearing of native vegetation is listed as a key threatening process under both the TSC Act and EPBC Act. The total disturbance area for the Project is approximately 557 ha, including approximately 397 ha of native vegetation (Table 19). The majority of the native vegetation loss is associated with the open cut and mine waste rock emplacement areas (Figure 2) and is consequently unavoidable. The affected native vegetation lies within the southern parts of Leard State Forest and on the adjoining Project-related property. The southern parts of the proposed open cut are on cleared farmland supporting exotic grasslands and scattered remnant native trees. The remaining areas to be cleared are associated with the new mine facilities area and the services corridor, in the west of the study area, and ancillary infrastructure. The majority of the new mine facilities area overlies derived native grassland and exotic grassland with a small area of woodland along Goonbri Road (Figure 4). Other minor clearing would be required for ancillary infrastructure, including water management structures (north of the open cut), realignment of sections of Goonbri and Dripping Rock Roads and the establishment of the Goonbri Creek permanent alignment (east of the open cut).

Table 19
Potential Loss of Each Native Vegetation Community within the Study Area

No.	Community	Area (ha)	Area (ha)
1	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (mature community)	189	278
1a	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (regeneration - mainly White Cypress Pine)	55	
1b	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (semi-cleared and regenerating)	9	
1c	White Cypress Pine - Narrow-leaved Ironbark shrubby open forest (derived grassland)	25	
2	White Box - White Cypress Pine shrubby woodland	41	46
2b	White Box - White Cypress Pine shrubby woodland (semi-cleared and regenerating)	5	
3	White Box - White Cypress Pine grassy woodland	5	13
3a	White Box - White Cypress Pine grassy woodland (regeneration - mainly White Cypress Pine)	3	
3b	White Box - White Cypress Pine grassy woodland (semi-cleared and regenerating)	2	
3c	White Box - White Cypress Pine grassy woodland (derived grassland)	3	
4	Narrow-leaved Grey Box - Poplar Box - White cypress Pine grassy open woodland	12	45
4c	Narrow-leaved Grey Box - Poplar Box - White cypress Pine grassy open woodland (derived grassland)	33	
5	Bracteate Honeymyrtle low riparian forest	15	15
Total		397	397

7.2 HABITAT FRAGMENTATION

The study area is situated on the southern edge of a large remnant of native vegetation, of the order of 8,648 ha (excluding areas approved [i.e. Boggabri Coal Mine] to be cleared by other mining operations), which includes Leard State Forest and Leard State Conservation Area (*Brigalow and Nandewar Community Conservation Area Act, 2005*). This remnant is surrounded by cleared agricultural lands which effectively isolate it from other large remnants to the west (Pilliga Scrub), the north (Mt. Kaputar and the Nandewar Range) and the east (southern extensions of the Nandewar Range). There are no significant or continuous vegetated corridors linking the study area to the west, south or east. Consequently, although the Project would result in a relatively small diminution in native vegetation cover in the large Leard State Forest/State Conservation Area remnant, it would not lead to a reduction in habitat connectivity in the region.

7.3 WEEDS

Soil disturbance related to vegetation clearance is likely to create opportunities for weed establishment around the margins of the open cut, increasing the potential for weed incursion into the native habitats of Leard State Forest. Some 94 introduced flora species occur on the study area (Table 15), nine of which are listed as Noxious in Narrabri Shire (Table 16). Most of the weeds are associated with previously disturbed areas, especially cleared farmland, derived native grasslands and riparian habitats (Table 15). The potential for weed establishment and spread in Leard State Forest and on the adjoining Project-related property is considered to be low due to the predominantly poor soils that are unfavourable for most weed species in these areas.

Whitehaven undertakes weed control programs to ensure noxious weeds are kept in check on all of its properties (Section 8.3). With the continued implementation of these measures, it is considered that the Project is unlikely to significantly increase weed incursion into Leard State Forest.

7.4 HYDROLOGY

The Project has the potential to affect the hydrology of the study area surrounds by altering surface and groundwater flows. However, these effects are likely to be small and localised because:

- Establishment of the permanent Goonbri Creek re-alignment around the open cut would divert water from a small length of the existing creek. The alignment would remain after Project completion. The open cut area and new mine facilities area have been sited to minimise disturbance to Goonbri Creek which would continue to flow around the bottom of the open cut and the new mine facilities area (Figure 2).
- Community 5 (Bracteate Honeymyrtle low riparian forest) is potentially groundwater dependent, both along Goonbri Creek and in the paddock depressions along the diffuse course of Bollol Creek. However, the permanent Goonbri Creek alignment has been designed to ensure minimal changes/disruption to the sub-surface flow along the retained sections of Goonbri Creek and would not reduce flows along Bollol Creek. In particular, a low permeability barrier would be constructed to prevent sub-surface drainage of water from the alluvium along Goonbri Creek (and the wider floodplain) into the proposed pit. This is expected to provide complete protection of ground-water dependent vegetation.

- The other vegetation types on the study area are either vadophytic, depending primarily on water held in the soil profile that is replenished by infiltration of rainfall from the surface, or utilise shallow perched water tables sitting on impermeable clay layers that are not connected to the deeper aquifers (Parsons Brinkerhoff 2010).

7.5 DUST

Project activities such as blasting, materials handling and vehicle movements, may result in the generation and dispersion of atmospheric dust. Excessive dust generation can impact on the health and viability of surrounding vegetation by inhibiting physiological processes such as photosynthesis, respiration and transpiration, and may allow penetration of phytotoxic gaseous pollutants (e.g. Eller 1977; Farmer 1993, 2002). In dry periods when there is limited rainfall to wash dust from leaf surfaces, plants close to working areas of the open cut, up to several hundred meters away, may receive significant loads of dust on plant surfaces. This can cause physiological damage resulting in reduced growth and reproduction (Eller 1977; Farmer 1993, 2002), which may in turn result in changes to the composition of plant communities (reviewed by Farmer 2002).

Dust effects would be mitigated by a rigorous suppression regime through regular watering of roads and the implementation of other techniques within the study area (Section 8.6). However, drift of dust into surrounding bushland in very dry conditions and following blasting is difficult to mitigate and may result in residual deleterious effects to vegetation adjacent to the study area boundary. It is concluded that sporadic physiological damage to native plants may occur in areas adjacent to the working open cut.

7.6 INCREASED FREQUENCY OF BUSHFIRES

Project activities, including exploration, construction and environmental management and monitoring, may increase the risk of fire ignition (e.g. via increased vehicle traffic through dry vegetation). High frequency fire is listed as a key threatening process in the TSC Act (NPWS 2000). Whitehaven would implement strategies to minimise fire risk including the use of diesel vehicles, prohibition of smoking in fire prone areas and rapid response to any outbreak of fire (Section 8.5). The overall risk of increased bush fire frequency due to the Project is likely to be very low.

7.7 CUMULATIVE IMPACTS

Loss of Native Vegetation

The clearance of native flora for this Project would continue an historical, albeit fluctuating, trend towards reduction in the area of native vegetation in the region. The most fertile arable land in the lower lying flat to undulating parts of the Liverpool Plains is highly productive agricultural land that has been farmed intensively for a century and a half. The surrounding steeper slopes, hills and ranges have been subject to episodes of logging, clearing and sometimes natural regeneration throughout this period. The larger tracts of very steep and/or highly infertile areas have retained their natural vegetation cover and variously been dedicated as State Forests for timber extraction or conservation reserves. The Western Regional Assessments from the late 1990s to 2004 resulted in conversion of large areas of State Forests to conservation reserves in the region. This included the dedication of several new reserves close to the study area, for example, the Leard and Vickery State Conservation Areas and the enlargement of Pilliga Nature Reserve and Mt. Kaputar National Park.

A consequence of the history of land clearing in the Namoi Valley is that native vegetation types characteristic of the fertile soils of the Liverpool Plains have been all but eliminated from the region with only small fragmented remnants remaining, usually on private land. These communities comprise the bulk of the EECs listed for the region. By contrast, most vegetation types on steeper slopes, and skeletal and infertile soils, are well represented in the conservation reserve system.

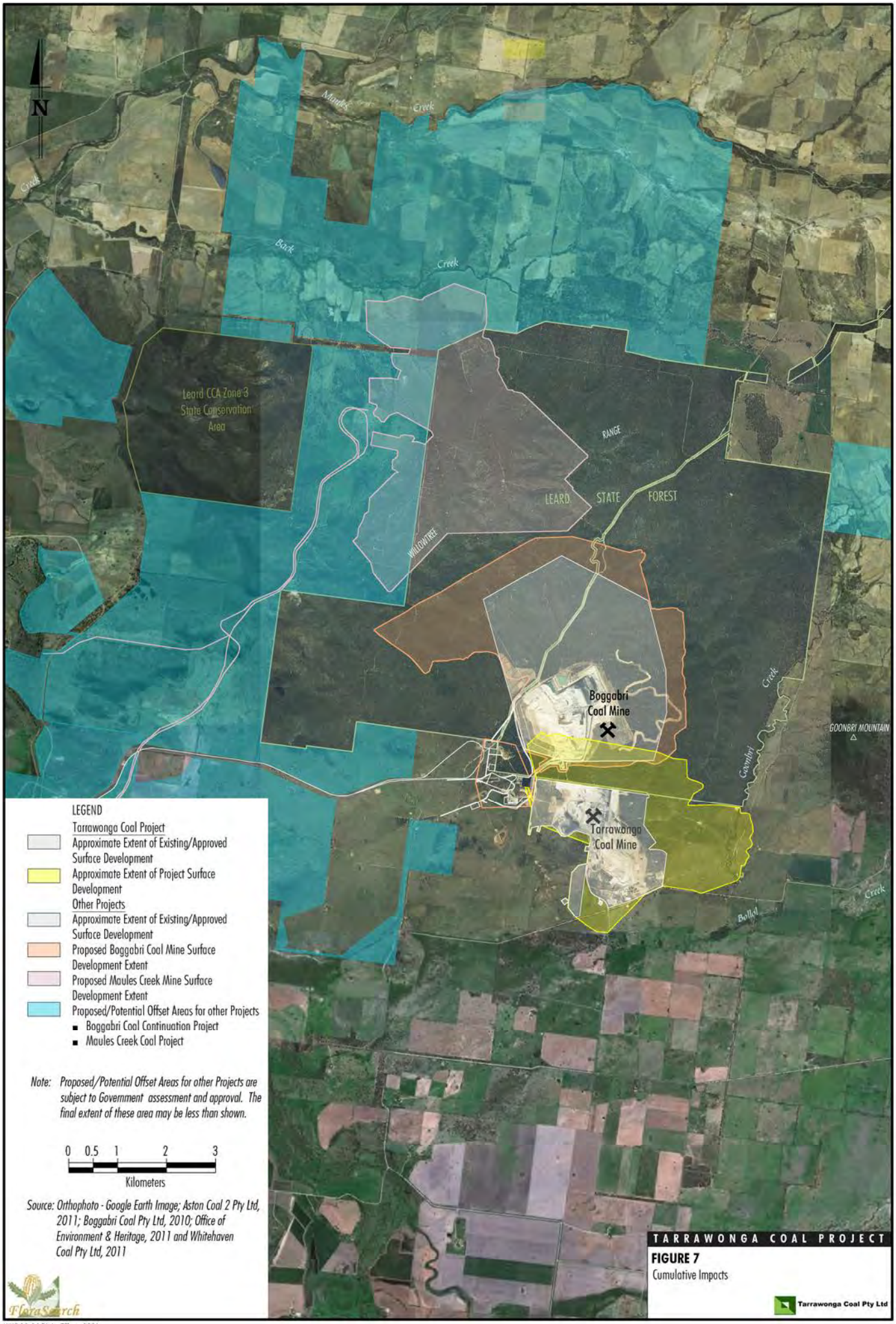
Most of the fertile soils in the vicinity of the Project is on Quarternary undifferentiated sediments, consequently the native vegetation of quarternary sedimentary substrates is very poorly represented in the conservation reserve system. Most of the reserves are on infertile substrates such as Jurassic Pilliga Sandstone (Pilliga Nature Reserve) or skeletal soils on the Boggabri Volcanics (parts of Leard State Conservation Area), or lithosols of the Nandewar Volcanic Complex (Mt. Kaputar National Park) (see Gunnedah Coalfield Regional Geology North Map [Pratt 1998]). Vickery State Conservation Area is on steep terrain between the Mooki and Playgan Thrusts on Late Carboniferous Currabubula Formation rocks of the New England Orogen. By contrast the naturally vegetated parts of the study area are on the Maules Creek Formation of the Early Permian Bellata Group.

The Permian rocks of the Gunnedah Basin contain the coal measures on which the local coal extraction industry and the Project are based. The Leard State Conservation Area contains areas of Permian sediments and appears to be the only reserve in the region with Permian geology. However, the zoning of the reserve allows for forestry, recreation and mineral extraction and consequently it is not protected from future disturbance.

Existing and foreshadowed coal mines on the Maules Creek Formation include the Boggabri Coal Mine (approved with an expansion proposed), Maules Creek Project and Tarrawonga Coal Mine. It is estimated that these mines/projects may collectively clear some 2,939 ha within Leard State Forest and that some 4,533 ha would remain with two large patches making up the majority of the remaining area (i.e. eastern path – 3,081 ha; western patch – 1,318 ha) (Figure 7). Consequently, the existing and foreshadowed mining proposals would clear 39% of Leard State Forest, a considerable reduction in biodiversity within the region. Although the loss of vegetation associated with the Tarrawonga Coal Project would be compensated for by the valuable 'Willeroi' offset (Attachment C), it nevertheless represents a significant net loss of biodiversity in the immediate region. However, in the context of the broader region, substantial areas of similar vegetation to that on the study area remain, particularly to the north and east (Nandewar Ranges).

Offset Strategy

The offset strategy for the Project is described in Attachment C.



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Threatened Flora

The study area has no threatened flora species, populations or critical habitat listed under either the TSC or EPBC Acts and no cumulative impact is expected to occur on such entities. However, approximately 13 ha of the NSW White Box Yellow Box Blakely's Red Gum EEC and Commonwealth Box – Gum Grassy Woodland and Derived Grassland CEEC would be removed for the Project. This is in addition to 1,168 ha of the same EEC that is approved or proposed to be removed for the Continuation of the Boggabri Coal Mine Project and the Maules Creek Coal Project. Relative to the potential losses of this community from adjoining development areas, the additional expected loss from the Project is small. Further discussion is provided in Section 9.1.

8 FLORA MANAGEMENT

A number of impact avoidance and mitigation measures applicable to flora have been developed for the existing Tarrawonga Coal Mine. These management measures are outlined in the following management plans for the Tarrawonga Coal Mine:

- Bushfire Management Plan (BMP) (Whitehaven Coal Pty Ltd 2011a);
- Site Water Management Plan (SWMP) (Whitehaven Coal Pty Ltd 2011b);
- Air Quality and Greenhouse Gas Management Plan (AQGGMP) (Whitehaven Coal Pty Ltd 2011c); and
- Mining Operations Plan (MOP) Amendment 2010 (Whitehaven Coal Pty Ltd 2010).

A Biodiversity Offset Strategy and Biodiversity Management Plan are also required under conditions 32 and 34 of DA 88-4-2005 MOD1, respectively.

These management plans would be reviewed and revised and/or prepared for the Project and would include additional flora management measures described in Sections 8.1 to 8.5.

8.1 VEGETATION CLEARANCE

Vegetation clearance would be undertaken progressively over the life of the Project with areas progressively rehabilitated. Clearance activities for the Project would be outlined in the Biodiversity Management Plan and would include:

- The clearing of vegetation in campaigns during late summer and autumn (where practicable) in order to avoid the spring breeding season for nesting birds and over-wintering bats in hollows.
- The clear delineation and marking of disturbance areas to avoid excessive clearing. The area cleared in each campaign would be no greater than that required to accommodate the mine's needs for the following 12 months.
- The chainsaw felling and/or bulldozing of larger vegetation to just above the ground to minimise soil disturbance. Groundcover would be retained and subsequently collected when the topsoil is stripped.

Prior to the commencement of any clearance activities, an inspection would be carried out on the area to be cleared by a suitably qualified and experienced fauna expert to inspect trees containing hollows (including stags) for the presence of any threatened fauna that may be utilizing those hollows. The Biodiversity Management Plan would include a protocol for the removal and translocation of threatened fauna species located during the pre-clearance inspections.

The Biodiversity Management Plan would also include measures for the salvage and reuse of cleared vegetation, such as:

- The incorporation of ground-layer vegetation and low shrubs into the topsoil when it is stripped.
- The salvage of cleared trunks, logs, branches, small stumps and roots to be transferred directly to an area that has been prepared to the post mining landform, or alternatively stockpiled for later use in the rehabilitation.

- The salvage of hollow tree trunks and branches to be placed on rehabilitated areas to provide fauna habitat.
- The salvage of large stumps to be buried within the overburden emplacements.
- The collection of seed from felled trees for seedling propagation on rehabilitated areas.

In addition to the practices described above, the following management measures would be implemented as part of the Project.

- Pre-clearance surveys of ancillary infrastructure areas (e.g. water management structures, monitoring equipment areas) for threatened flora species.
- Relocation (if practicable) of ancillary infrastructure areas (e.g. water management structures, monitoring equipment) to avoid any threatened species.

8.2 REHABILITATION AND REVEGETATION

The disturbance areas associated with the Project would be progressively rehabilitated and revegetated to either native bushland and/or agricultural land. The Biodiversity Management Plan would outline the rehabilitation objectives and provide a description of the rehabilitation and revegetation methods. The Biodiversity Management Plan would also include measures to protect the rehabilitated areas, such as:

- Maintenance of perimeter fencing around the active mine site and rehabilitated areas to exclude stock.
- Installation of biodegradable plastic or cardboard tree guards around the planted seedlings to protect against wind and cold and rabbit/hare grazing, if required. The necessity for tree guards would be determined during each tree planting campaign and based on likely impacts of grazing.
- Temporary fencing around tree lots on the re-created agricultural land. Fencing will be removed at the completion of mining or once the trees attain a height of 4 to 5 m and are not liable to damage from stock.
- Permanent fencing of native bushland re-establishment areas to prevent stock access.
- Exotic vertebrate pest (e.g. rabbit) control.
- Fire protection.

In addition to the practices described above, the following management measures would be implemented as part of the rehabilitation strategy for the Project:

- Restriction of vehicles within revegetated areas.
- Irrigation to promote revegetation where practically possible.

8.3 WEEDS

The Biodiversity Management Plan for the Tarrawonga Coal Mine would provide details of the weed control measures that would be used to minimise the introduction and spread of weeds. These include:

- Regular campaigns targeting noxious and environmental weeds to ensure their control, and where possible their eradication.
- Twice yearly inspections of all revegetated areas for noxious and other weed species by a suitably qualified person.

Additional weed control measures that would be implemented as part of the Project include:

- The inspection of vehicles and mechanical equipment bought to site to avoid the importation of weed seeds and organic matter.
- Follow up inspections to assess the effectiveness of weed management measures and to determine the need for any supplementary action.
- Focus weed management/suppression on stockpiles, roadsides and disturbance areas.

Declared noxious weeds that were recorded within the study area are listed in Section 6.3. Six species, Blue Heliotrope (*Heliotropium amplexicaule*), Galvanised Burr (*Sclerolaena birchii*), Golden Dodder (*Cuscuta campestris*), Johnson Grass (*Sorghum halepense*), Mexican Poppy (*Argemone Mexicana*) and Spiny Burrgrass (*Cenchrus Spinifex*) have not been previously recorded at the Tarrawonga Coal Mine site. The Biodiversity Management Plan would include consideration of these noxious weeds.

8.4 HYDROLOGY

The SWMP provides a description of water management measures at the Tarrawonga Coal Mine. These include:

- Description of surface water management structures.
- Site water balance.
- Erosion and sediment control plan.
- Surface water monitoring programme.
- Groundwater monitoring programme.

The SWMP would be reviewed and revised to incorporate the proposed Project.

8.5 FIRE

A BMP has been developed for the Tarrawonga Coal Mine in consultation with the Rural Fire Service Narrabri and Narrabri Shire Council. Bushfire management measures that are outlined in the BMP include:

- Clearing restrictions – clearing would not be undertaken during periods of extreme fire danger as defined by the Bureau of Meteorology.

- Controlled grazing – controlled high intensity short term grazing would be employed to assist in the reduction of vegetative fuel loads on areas on which active mining operations are not occurring and appropriate fencing is available.
- Vehicle movements – all personnel and contractors would be required to use diesel vehicles and/or remain on defined roads or tracks.
- Fire breaks – The establishment and maintenance of a fire break around the perimeter of the mining leases.
- No smoking areas – prohibition of smoking in fire prone areas.
- Fire fighting equipment – provision of fire fighting equipment on-site including a fully equipped fire tender to provide immediate response to a bushfire.
- Training – all mine personnel will receive basic fire control training.

The bushfire management measures described above would be implemented as part of the Project.

8.6 DUST

Dust controls and air quality monitoring at the Tarrawonga Coal Mine are described within the AQGGMP, as follows:

- Soil stripping is avoided during periods of high wind and/or low soil moisture as to prevent dust lift-off.
- Water spraying is used to increase the soil moisture if soil stripping occurs during periods of high wind or low soil moisture.
- Vegetation clearance ahead of construction is minimized.
- Cleared areas are sprayed regularly with water during any construction activities, where appropriate.
- Scheduling of blasting events to avoid low-level atmospheric temperature inversions.
- Progressive rehabilitation of disturbance areas including topsoil and subsoil stockpiles.
- Water spraying of internal unsealed haul roads.

Observations during the field surveys were that there was substantial dust on vegetation immediately adjacent to the active working areas (particularly in the area between the Tarrawonga and Boggabri operations). It is recommended that in addition to the implementation of the above listed controls, TCPL consider extra dust suppression measures as part of the Project (such as increased watering of active areas and/or use of surfactants).

9 THREATENED FLORA ASSESSMENT – TSC ACT

As specified by the Director Generals Requirements for the Tarrawonga Coal Project, this flora impact assessment has been prepared in accordance with s. 5a of the *Environmental Planning & Assessment Act (1979)*. This requires the application of the Seven Part Test, which is applied here according to *The Threatened Species Assessment Guideline – The Assessment of Significance* (DECCW 2007). The guideline identifies factors that must be considered when assessing potential impacts on threatened species, populations, or ecological communities, or their habitats, for development applications. To assist in identifying whether the potential impacts of the Project are likely to have a significant effect on threatened flora, evaluations were conducted under the following seven assessment criteria (DECCW 2007):

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

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

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

- ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or***
- ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

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

- ***(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and***
- ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.***

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

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

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

Evaluations were conducted for threatened flora species that have been considered to potentially occur in the study area and immediate surrounds by this and other studies (Table 3).

9.1 THREATENED ECOLOGICAL COMMUNITIES

One TEC listed under the TSC Act was identified on the study area by the surveys, *viz*. the *White Box, Yellow Box, Blakely's Red Gum Woodland*. This community is commonly known as Box-Gum Woodlands. The characteristics and distribution of Box-Gum Woodlands on the study area are discussed in detail in Table 10 and Section 6.6 and is mapped as Community 3 (including variants 3a, 3b and 3c) on Figure 4.

Box-Gum Woodlands were formerly a dominant and very widespread community on the NSW tablelands and western slopes. As such there are many thousands of hectares of fragmented and disturbed remnants on farmland, roadsides, travelling stock routes and other lands. Threats to this community include clearing, degradation and fragmentation of remnants, continuous heavy grazing, invasion of habitat by exotic plant species and feral animals, firewood harvesting and other removal of woody debris on the ground (DEC 2005q).

The Seven Part Test criteria are applied below:

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

Not applicable.

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

Not applicable.

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

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

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

Clearing of native vegetation is listed as a key threatening process under the TSC Act. Clearance of vegetation for this Project would reduce habitat availability for Box-Gum Woodlands. Some 13 ha of Box-Gum Woodland is located within the proposed new mine facilities area and the proposed services corridor. Possible alternative locations for the new mine facilities area that would avoid impacts on Box-Gum Woodlands, exist on the cleared farmland of the Quarternary alluvial plain. However, this location would be more susceptible to flooding, and would also impact local surface water flows and high quality flood plain agricultural land.

The Box-Gum Woodlands in the proposed new mine facilities area and services corridor have been severely disturbed historically, are highly fragmented and have high perimeter to area ratios. They would have poor long term prospects for survival under continued agricultural land use. However, despite depleted biodiversity values, the remnants retain the ability to regenerate their overstorey and some understorey components, and have potential for recovery if current disturbance factors were removed.

Many remnants in similar condition occur widely in the immediate region and it is considered unlikely that the project would result in the loss or serious depletion of the EEC in the local area. Significant areas of the EEC in very good condition occur in parts of Leard State Forest that would not be affected by any of the existing or proposed coal mining developments within the forest. In addition, the proposed 'Willeroi' offset area contains significant areas of this community (Attachment C) that would benefit greatly from being removed from agricultural land use.

The offset strategy for this community is presented in Attachment C.

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

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

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

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

The main impact of the proposed new mine facilities area and services corridor would be the removal of approximately 13 ha of young Box-Gum Woodland regeneration and derived grassland. There will be no disturbance to the mature Box-Gum Woodland corridor to the west of the new mine facilities area, which would maintain its connective capacity in the landscape. However, the majority of the adjoining patch of regeneration would be unaffected by the development and would continue its recovery following the withdrawal of grazing from this area.

As indicated above, the patches of Box-Gum Woodland to be cleared by the Project have been considerably disturbed and degraded by past land use practices including clearing of trees and shrubs, cropping and heavy grazing by domestic animals. These areas have been reduced to small fragments isolated from other patches of Box-Gum Woodland in the region. The long term viability of these remnants is considered to be doubtful, even if previous management were to continue.

The Project would result in additional fragmentation of Box-Gum Woodland remnants in the local area. However, given the high degree of existing fragmentation of this community, the additional fragmentation resulting from the project is not considered to be significant.

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

Critical habitat, as defined by the TSC Act, has not been declared for any areas of Box-Gum Woodland. There is no critical habitat listed on the NSW Critical Habitat register (OEH 2011) in the Project area or surrounds.

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

There is no current recovery plan for this EEC listed on either the NSW OEH or the Commonwealth DSEWPaC websites (accessed August 2011). A draft *Grassy White Box Woodland Recovery Plan* was released for public comment in April 2004 for implementation over five years (Dobbie 2004). This draft plan listed eight broad recovery actions which relate mainly to the continuation of the *Grassy Box Woodlands Conservation Management Network*, identifying and protecting key sites, increasing awareness in government circles and the general community, improving management of high priority sites, developing improved management techniques, education on social and economic values, and creating an inventory of remnants through surveying and documentation. No sites on the Project area have been identified as having a high priority for protection under the recovery plan.

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

Listed key threatening processes relevant to the Box-Gum Woodland EEC include:

- Clearing of native vegetation.
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*).
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae.
- Removal of dead wood and dead trees.

The impact of clearing has been discussed under point (d) above.

The main human-induced fire risks for bushland on and near the Project area are the ignition of dry vegetation by petrol vehicle exhaust pipes and cigarette butts. Whitehaven personnel and contractors would be required to use diesel vehicles to minimise fire risks, and/or to remain on formed tracks, and to dispose of cigarette butts correctly. These and other protocols for bushfire management would be implemented to manage the behaviour of people in the Project area (Section 8.5), making it unlikely there would be an increase in fire frequency resulting from Project related human activities. In addition, the presence of Whitehaven personnel on the Project area would provide early warning of any fires lit by lightning with rapid suppression activities being implemented.

While the recently introduced Myrtle Rust Fungus poses a risk to all natural communities dominated by species of Myrtaceae, its spread, which is primarily by wind-borne spores, is unlikely to be influenced by Project activities. However, there may be potential for dust generated by the Project to affect its pathogenicity, should it invade surrounding bushland in Leard State Forest. There is evidence that air borne particulates from roads and quarries may affect the virulence of plant diseases, although much but not all of the data is from limestone dust which affects pH (Manning 1975, Farmer 2002). The potential influence of project-generated dust on Myrtle Rust is not known.

Firewood harvesting and removal of woody debris would be prohibited by Whitehaven in native vegetation remnants on the study area.

Conclusion

It is concluded that the Project would result in the loss of a number of small, highly disturbed fragments of the Box-Gum Woodland EEC and would not significantly reduce its representation in the immediate region.

9.2 THREATENED POPULATIONS

No Threatened Populations have been listed under the TSC Act for the study area or surrounds (Section 4.3).

9.3 THREATENED FLORA SPECIES

Of the 15 threatened flora species that were identified from database and literature searches as having potential to occur in the wider region (Table 3), three are considered to have a medium to high likelihood of occurring on the study area through the potential existence of suitable habitat (*Diuris tricolor, Thesium australe*) or the close proximity of recorded occurrences (*Pomaderris queenslandica*) (Table 20). These three species have not been recorded previously, or by this study, in the Project area and are assessed together below.

Table 20
TSC Act Threatened Flora Species Considered in this Assessment

Scientific Name	Common Name	Conservation Status[1]
Diuris tricolor	Tricolour Diuris	V
Pomaderris queenslandica	Scant Pomaderris	E
Thesium australe	Austral Toadflax	V

[1] V=Vulnerable; E=Endangered

Tricolor Diuris (Diuris tricolor)

The Tricolour Diuris is a small perennial terrestrial orchid with one to three erect, green, linear leaves to 30 cm long and a single flower stem arising from the base of the plant with one to six yellow flowers having maroon, purple and white markings. The plant is dormant in summer, shoots its leaves after the first soaking autumn-winter rains and flowers from September to November. The Tricolour Diuris occurs in Box/Pine woodlands, usually in habitats with White Cypress Pine (*Callitris glaucophylla*) as one of the dominant species (Burrows 1999; Bishop 2000; DEC 2005d). However, there are no database records for *D. tricolor* within an area of 200 × 200 km around the study area. Threats include habitat clearing and modification, feral herbivores such as rabbits and goats, and competition from weeds (DEC 2005d).

Scant Pomaderris (Pomaderris queenslandica)

The Scant Pomaderris is a 2 to 3 m high shrub with whitish stems and cream flowers. The leaves are shiny dark green above, densely covered in pale hairs below, ovate to narrow elliptic and 7 cm long and 2.5 cm wide (DEC 2005i). It occurs in shrubby eucalypt forests or along creeks. Attachment A gives database records of *P. queenslandica* showing its known regional distribution, which does not include the Project area. There is one record from Leard State Forest in the Royal Botanic Gardens, Sydney. Threats to *P. queenslandica* include loss and fragmentation of habitat through clearing, road construction and intensive timber harvesting; competition from weeds; isolation of populations and possible interference in pollination by European honeybees (*ibid*.).

Austral Toadflax (Thesium australe)

The Austral Toadflax is a small straggling herb to 40 cm high with narrow pale green leaves (to 40 × 1.5 mm); tiny white axillary flowers and small nut-like fruits (DEC 2005j). The fruits are large, up to 10 mm long and 10 mm in diameter. Austral Toadflax is a root parasite on grasses, especially Kangaroo Grass (*Themeda australis*). It favours grassland and grassy woodlands often on damp sites (*ibid.*). Attachment A gives database records of *T. australe* showing its known regional distribution, which does not include the Project area or Leard State Forest. Threats to *T. australe* include clearing of habitat, grazing, weed invasion and roadworks (*ibid.*).

Impacts of the proposed Project on these threatened flora species are assessed below in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI 2005).

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

If *D. tricolor*, *P. queenslandica* or *T. australe* were to occur on the study area there is a high probability that individuals would be lost through direct mortality during clearing of their habitat. However, there are no database records of the species in the study area (Attachment A) and none were detected during extensive sampling, including targeted searches, for this study and past studies. Accordingly, the likelihood of actual adverse effects occurring to individuals or populations of these species is considered to be low.

The Project is likely to result in increased deposition of dust in bushland adjacent to the development area, which may have adverse effects on plant physiology in dry periods, which are experienced frequently in the study area.

The Project has the potential for some increase in fire risk. Too-frequent bushfires can cause disruption to the lifecycle of some plant species. A range of management protocols have been developed by Whitehaven to manage the behavior of people in the study area in order to reduce the potential for unplanned bushfire (Section 8.5).

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

Not applicable

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

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

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

Not applicable

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

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

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

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

Clearance of vegetation for this Project has the potential to reduce habitat availability for *D. tricolor*, *P. queenslandica* or *T. australe*, if suitable habitat occurs on the study area. However, there are no database records of the species on the Project area and none were detected during extensive sampling, including targeted searches, for this study and past studies. Consequently there is a low likelihood of any actual habitat loss occurring.

Clearing of native vegetation is listed as a key threatening process under both the TSC Act and EPBC Act. A total of 397 ha of native vegetation would be cleared by the Project (Table 19). Most of the native vegetation loss is associated with the open cut (and associated upslope water management structures) and the Northern Emplacement, and is consequently unavoidable. The new mine facilities area for the Project would be located in the south west of the study area in former cropping and grazing paddocks to minimise impacts on native vegetation. Small amounts of clearing of very young regeneration and roadside vegetation along Goonbri Road would be required in this area. Similarly, a small amount of vegetation would be cleared for the services corridor, most of which would traverse areas of disturbance from the currently approved mining operation. Suitable habitat does not exist in the highly disturbed new mine facilities and services corridor areas for *D. tricolor*, *P. queenslandica* or *T. australe.*

If there is a need to place any additional infrastructure in bushland, for example environmental monitoring equipment, all such sites would be surveyed for threatened flora species, populations and communities prior to disturbance. Where practicable, works would be relocated to avoid threatened species as described in Section 7.1.

It is concluded that the Project is unlikely to significantly reduce the quality or availability of habitat for *D. tricolor*, *P. queenslandica* or *T. australe*.

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

Critical habitat, as defined by the TSC Act, has not been declared for any of the threatened flora species. There is no critical habitat listed on the NSW Critical Habitat register (DECCW 2011) in the Project area or surrounds.

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

A range of recovery actions is listed for *D. tricolor, P. queenslandica* and *T. australe* under their species profiles on the OEH website as follows:

Recovery actions for *D. tricolor* are (DEC 2005e):

- Avoid changing land use where Pine Donkey Orchid is known to survive.
- Instigate monitoring studies within known populations.

- Investigate regeneration including seed-set, germination and seedling survival.
- Conduct experimental studies on the effects of fire and grazing disturbance.
- Conduct searches for further populations.
- Organise proactive surveying in potential habitats.
- Erect rabbit, goat and stock-proof fences.

Recovery actions for *P. queenslandica* are (DEC 2005i):

- Support local Landcare groups.
- Manage fire to maintain populations of Scant Pomaderris.
- Protect known populations from disturbance from logging or roadworks.
- Control introduced weeds.
- Protect areas of moist forest and woodland habitat from clearing and fragmentation.
- Notify the DEC of any new occurrences of the species.
- Determine need to collect seed for NSW Seedbank. Investigate seed viability, germination dormancy and longevity (in natural environments and in storage).

Recovery actions for *T. australe* are (DEC 2005j):

- Protect known populations from changes to land use.
- Do not undertake road works, pasture modification or other changes in land use that may affect populations.
- Do not increase grazing pressures on sites where populations persist - reduce grazing pressures where possible.
- Undertake weed control in and adjacent to populations, taking care to spray or dig out only target weeds.
- Mark sites and potential habitat onto maps (of the farm, shire, region, etc) used for planning (e.g. road works, residential and infrastructure developments, remnant protection, rehabilitation).
- Search for new populations in potential habitat.
- Control feral animals.

The proposed Project is not incompatible with the objectives of any of these actions, most of which relate to known populations. Since no populations of any of these species have been identified on the study area despite intensive flora survey work, the recovery actions are not relevant to the study area.

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

Threats to *D. tricolor* include habitat clearing and modification, feral herbivores such as rabbits and goats, and competition from weeds (DEC 2005e).

Threats to *P. queenslandica* include loss and fragmentation of habitat through clearing, road construction and intensive timber harvesting; competition from weeds; isolation of populations and possible interference in pollination by European honeybees (DEC 2005i).

Threats to *T. australe* include clearing of habitat, grazing, weed invasion and roadworks (DEC 2005j).

From the above threats to these species, the relevant listed Key Threatening Processes (KTP) (OEH 2011b) are:

- Clearing of native vegetation.
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).
- Competition and habitat degradation by feral goats (*Capra hircus*).
- Competition from feral honeybees (*Apis mellifera*).
- Invasion of native plant communities by exotic perennial grasses.

The potential impacts of vegetation clearance have been discussed under (d) above.

The remaining KTPs all refer to the deleterious impacts of increases in exotic animal pest and weed species, and feral bees. These pests, weeds and bees are already prevalent in the landscape surrounding the Tarrawonga Coal Mine. They have been controlled historically by landholders on farmland, the Shire Council on roadsides and State government agencies on crown land (e.g. Leard State Forest). TCPL would develop a detailed Biodiversity Management Plan for the Project that specifies appropriate weed and vertebrate pest control measures on land owned by the company. The plan would recognise the potential for some weeds and pests to increase as result of the creation of new habitat opportunities by the Project, e.g. through soil disturbance and rehabilitation, and outlines strategies to suppress any outbreaks of noxious weeds or vertebrate pests. The Project is considered unlikely to have any impact, either positive or negative, on feral bees, which are widely distributed throughout the region, including naturally forested areas such as Leard State Forest.

Conclusion. It is concluded that the Project is highly unlikely to have deleterious effects on any local populations of *D. tricolor, P. queenslandica* or *T. australe.*

10 THREATENED FLORA ASSESSMENT - EPBC ACT

These assessments have been prepared in consideration of the *Matters of National Environmental Significance, Significant Impact Guidelines 1.1* (DEWHA 2009).

Evaluations were conducted for threatened flora recorded in the study area and/or in the immediate surrounds by this and other studies. The evaluations for TECs are provided in Section 9.1 while the evaluations for threatened flora species are provided in Section 9.3

10.1 THREATENED ECOLOGICAL COMMUNITIES

One threatened ecological community listed under the EPBC Act occurs on the study area; the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grasslands* CEEC. The characteristics and distribution of Box-Gum Woodlands on the study area are discussed in detail in Table 10 and Section 6.6 and is mapped as Community 3 (including variants 3a, 3b and 3c) on Figure 4.

Box-Gum Woodlands were formerly a dominant and very widespread community on the NSW tablelands and western slopes. As such there are many thousands of hectares of fragmented and disturbed remnants on farmland, roadsides, travelling stock routes and other lands. See Section 6.6 for a detailed discussion of the structure, composition and distribution of the CEEC on the study area. The impact of the Project on this community, referred to here as the Box-Gum Woodland CEEC, is assessed below under the following significant impact criteria (DEWHA 2009):

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

a) reduce the extent of an ecological community

b) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

c) adversely affect habitat critical to the survival of an ecological community

d) 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

e) 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

f) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- ***i) assisting invasive species, that are harmful to the listed ecological community, to become established, or***
- ***ii) causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or***

g) interfere with the recovery of an ecological community.

The following sections apply the above criteria to the Box-Gum Woodland CEEC.

1. Would the Project reduce the extent of an ecological community?

Vegetation clearance for the Project would result in the removal of approximately 13 hectares of the Box-Gum Woodland CEEC. The Box-Gum Woodlands in the proposed new mine facilities area and services corridor have been severely disturbed historically, are highly fragmented and have high perimeter to area ratios. They would have poor long term prospects for survival under continued agricultural land use. However, despite depleted biodiversity values, the remnants retain the ability to regenerate their overstorey and some understorey components, and have potential for recovery if current disturbance factors were removed. Many remnants in similar condition occur widely in the immediate region and it is considered unlikely that the Project would result in the loss or serious depletion of the CEEC in the local area. Significant areas of the CEEC in very good condition occur in parts of Leard State Forest that would not be affected by any of the existing or proposed coal mining developments within the forest. In addition, the proposed 'Willeroi' offset area contains significant areas of this community (Attachment C) that would benefit greatly from being removed from agricultural land use.

The offset strategy for this community is presented in Attachment C.

2. Would the Project fragment or increase fragmentation of an ecological community?

The patches of Box-Gum Woodland CEEC proposed to be cleared by the Project have been considerably disturbed and degraded by past land use practices, including clearing of trees and shrubs, cropping and heavy grazing by domestic animals. These areas have been reduced to small fragments isolated from other patches of Box-Gum Woodland in the region. The long term viability of these remnants is considered to be doubtful, even if previous management were to continue.

The main impact of the proposed new mine facilities area and services corridor would be the removal of approximately 13 ha of young Box-Gum Woodland regeneration and derived grassland. There will be no disturbance to the mature Box-Gum Woodland corridor to the west of the new mine facilities area, which would maintain its limited connective capacity in the landscape. However, the majority of the adjoining patch of regeneration to the east would be unaffected by the development and would continue its recovery following the withdrawal of grazing from this area.

While the Project would result in additional fragmentation of the Box-Gum Woodland remnants in the local area, the high degree of existing fragmentation of this community means that the additional fragmentation resulting from the Project is not likely to be significant.

3. Would the Project adversely affect habitat critical to the survival of an ecological community?

Critical habitat, as defined by the EPBC Act, has not been declared for any areas of Box-Gum Woodland. There is no critical habitat listed on the Commonwealth Register of Critical Habitat (DSEWPaC 2011) in the Project area or surrounds.

4. Would the Project modify or destroy abiotic (non-living) factors necessary for an ecological community's survival?

The Box-Gum Woodland CEEC occurs on low ridges and the footslopes of hills on the study area and is unlikely to be ground-water dependent. Rather, it is vadophytic, depending primarily on water held in the soil profile that is replenished by infiltration of rainfall. Nor is it considered likely that the Project would substantially alter surface or subsurface flows in the vicinity of nearby Box-Gum Woodland CEEC remnants.

The Project is also unlikely to have significant off-site effects, apart from dust deposition, that might affect the CEEC. In the case of dust, the nearest patch of Box-Gum Woodland CEEC in Leard State Forest is over 1.5 km from the nearest parts of the proposed open cut pit, such that minimal dust deposition would be expected to occur. However, patches of the CEEC close to the new mine facilities area are in closer proximity to the pit and may experience dust deposition in dry conditions.

Dust effects would be mitigated by a rigorous suppression regime through regular watering of roads and implementation of other techniques within the study area (Section 8.6). However, drift of dust into surrounding bushland following blasting is difficult to mitigate and may result in some residual deleterious effects to vegetation adjacent to the study area boundary. It is concluded that sporadic short term physiological damage to native plants may occur in areas near the working open cut.

5. Would the Project cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species?

Increased fire frequency and dust deposition are two potential Project impacts that might result in a change in species composition of Box-Gum Woodland CEEC remnants on or near the Project area. Project activities, including exploration, construction and environmental management and monitoring, may increase the risk of fire ignition (e.g. via increased vehicle traffic through dry vegetation). Whitehaven would implement strategies to minimise fire risk including the use of diesel vehicles, prohibition of smoking in fire prone areas and rapid response to any outbreak of fire (Section 7.6). The overall risk of increased bush fire frequency due to the Project is likely to be very low.

Farmer (2002) cites many examples of changes in the composition of plant communities due to particulate pollution (i.e. dust). Although most of the examples relate to calcareous dust derived from limestone quarries or calcareous road materials, which can alter soil pH, it is clear that dust can affect soil chemistry, disease incidence and plant growth, ultimately affecting community composition. Dust control measures are detailed in Section 8.6. See further discussion of the dust issue under point 4 above. However, any changes to composition of the Box-Gum Woodland CEEC due to dust deposition are considered unlikely to be large and would be localised to areas close to the mine site. No effects on remnants of the community in the wider region are considered likely to occur.

6. Would the Project cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

i) assisting invasive species, that are harmful to the listed ecological community, to become established, or

ii) **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?**

Most pests and weeds with potential to affect the Box-Gum Woodland are already prevalent in the landscape surrounding the Tarrawonga Coal Mine. An exception is Coolatai Grass (*Hyparrhenia hirta*) which has significant potential to invade Box-Gum Woodlands and displace native understorey species. Coolatai Grass is not yet prevalent in the Tarrawonga Coal Mine area or Leard State Forest.

Weeds and pests have been controlled historically by landholders on farmland, the Shire Council on roadsides and State government agencies on crown land (e.g. Leard State Forest). TCPL would develop a detailed Biodiversity Management Plan for the Project that would specify appropriate weed and vertebrate pest control measures on land owned by the company. The plan would recognise the potential for some weeds, including Coolatai Grass, and pests to increase as result of the creation of new habitat opportunities by the Project, e.g. through soil disturbance and rehabilitation, and outlines strategies to suppress any outbreaks of noxious weeds or vertebrate pests.

The Project is considered unlikely to release dangerous pollutants to the surrounds owing to strict management of toxic materials, lubricants, fuel etc. As indicated in points 4 and 5 above there is potential for escape of dust from the mine site to the surrounds. Dust may affect the growth of plant species, the prevalence of plant pests and diseases, and the composition of ecological communities (Farmer 2002). The likely magnitude of these effects and the mitigation strategies proposed to be deployed are discussed under points 4 and 5 above.

7. Would the Project interfere with the recovery of an ecological community?

Areas of Box-Gum Woodland CEEC mapped on Figure 4 as Community 3a and 3b comprise regeneration and represent areas on which the community is recovering. This recovery has occurred since the land was purchased for mining purposes and would not have occurred had the previous land use of farming continued. Part of this regeneration would be cleared by the proposed mine infrastructure area and the services corridor. The proposed offset strategy (Attachment C) would enable larger areas of similar Box-Gum Woodland CEEC habitat to similarly recover from past grazing and be preserved in perpetuity.

10.2 THREATENED SPECIES

Two threatened flora species listed as Vulnerable under the EPBC Act are considered in this assessment (Table 21). Other Commonwealth listed threatened species returned in database searches of the region around the Project area are considered to have low or nil probabilities of occurring on the study area owing to a lack of suitable habitat (Section 4.2, Table 3) and are not assessed here.

Table 21
EPBC Act Threatened Flora Species Considered in this Assessment

Scientific Name	Common Name	Conservation status
Pultenaea setulosa	An Egg and Bacon Pea	V
Thesium australe	Austral Toadflax	V

[1] V=Vulnerable

An Egg and Bacon Pea (Pultenaea setulosa)

P. setulosa is an erect shrub to 2.5 m high, with appressed hairs on the stems; six to 12 alternate, linear, 6-12 × 0.5 mm leaves with involute margins and a 1 mm spine at the tip; 2-5 mm long stipules; dense leafy inflorescences with orange or yellow flowers and globular 5 mm long seed pods (DEWHA 2008). Habitats in NSW are wet sclerophyll forests on volcanic substrates in the Nandewar Range (Weston 1991 [as *Pultenaea* species I]). Recently, it has been reported to occur in the western and central parts of Leard State Forest (Parsons Brinkerhoff 2010), where it occurs in steep sheltered gullies on the south facing slopes of the Willowtree Range. Similar habitats are lacking in the study area. Attachment A gives database records of *P. setulosa* showing its known regional distribution, which does not include the Project area. Threats to *P. setulosa* include mining activities and associated infrastructure, and development (DEWHA 2008).

Austral Toadflax (Thesium australe)

The Austral Toadflax is a small straggling herb to 40 cm high with narrow pale green leaves (to 40 × 1.5 mm); tiny white axillary flowers and small nut-like fruits (DEC 2005j). The fruits are large, up to 10 mm long and 10 mm in diameter. Austral Toadflax is a root parasite on grasses, especially Kangaroo Grass (*Themeda australis*). It favours grassland and grassy woodlands often on damp sites (*ibid.*). Attachment A gives database records of *T. australe* showing its known regional distribution, which does not include the Project area or Leard State Forest. Threats to *T. australe* include clearing of habitat, grazing, weed invasion and roadworks (*ibid.*).

The impact of the Project on *P. setulosa* and *T. australe* is assessed below under the following significant impact criteria (DEWHA 2009):

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- ***lead to a long-term decrease in the size of an important population of a species***
- ***reduce the area of occupancy of an important population***
- ***fragment an existing population into two or more populations***
- ***adversely affect habitat critical to the survival of a species***
- ***disrupt the breeding cycle of an important population***
- ***modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline***
- ***result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat***
- ***introduce disease that may cause the species to decline, or***
- ***interfere with the recovery of the species.***

The following sections apply the EPBC Act criteria to *P. queenslandica* and *T. australe*.

1. **Would the Project lead to a long-term decrease in the size of an important population of a species?**
2. **Would the Project reduce the area of occupancy of an important population?**
3. **Would the Project fragment an existing important population into two or more populations?**

Criteria 1 to 3 are addressed together as the answers to each are similar.

If *P. setulosa* or *T. australe* were to occur on the study area there is a high probability that individuals would be lost through direct mortality during clearing of their habitat. However, there are no database records of the species in the study area (Attachment A) and none were detected during extensive sampling, including targeted searches, for this study and past studies. Accordingly, the likelihood of actual adverse effects occurring to individuals or populations of these species is considered to be low. Consequently, it is highly unlikely that the Project would reduce the size of a population, reduce its area of occupancy or fragment it.

4. **Would the Project adversely affect habitat critical to the survival of a species?**

Critical habitat, as defined by the EPBC Act, has not been declared for any populations of *P. setulosa* or *T. australe*. There is no critical habitat listed on the Commonwealth Register of Critical Habitat (DSEWPaC 2011) in the Project area or surrounds.

5. **Would the Project disrupt the breeding cycle of a population?**

If populations of *P. setulosa* or *T. australe* were to occur near the study area, there would be some potential for disruption of breeding by dust deposition if it were to occur during flowering. Dust could obscure flower colour making them less attractive to pollinators, could absorb nectar making it unavailable to pollinators and could block stigma function, thereby reducing flower visitation and pollination, and ultimately lowering seed production.

No populations of *T. australe* are known to occur close enough to the Project area to be affected by dust deposition. By contrast, populations of *P. setulosa* occur within Leard State Forest. However, all known populations of *P. setulosa* are over 3 km from the Project area and are unlikely to receive sufficient dust deposition to be adversely affected.

6. **Would the Project modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?**

Habitat for *P. setulosa* and *T. australe* is absent from the study area. Local populations of *P. setulosa* in Leard State Forest are dependent on the moist conditions of steep south facing gullies in the Willowtree Range to the north and west of the study area. Suitable sheltered habitat for *P. setulosa* is lacking within the study area. Dust deposition may potentially affect the habitat of nearby plant populations by altering soil chemistry (Farmer 2002). However, the nearest known populations of *P. setulosa* are over 3 km from the Project area and their habitat is unlikely to be significantly affected, since the longest recorded effects of dust are up to 1 km from the source (Farmer 2002).

T. australe is dependent on native grasslands, mainly those dominated by Kangaroo Grass, *Themeda australis*, on relatively fertile soils. The soils of the study area are mostly of low fertility and Themeda dominated grasslands are absent.

It is concluded that the Project is unlikely to adversely affect habitat availability or quality for *P. setulosa* or *T. australe*.

7. Would the Project result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Most pests and weeds with potential to affect *P. setulosa* and *T. australe* or their habitats are already prevalent in the landscape surrounding the Tarrawonga Coal Mine. An exception is Coolatai Grass (*Hyparrhenia hirta*) which has significant potential to invade natural ecosystems on the north-west slopes and displace native understorey species. Coolatai Grass is not yet prevalent in the Tarrawonga Coal Mine area or Leard State Forest.

Weeds and pests have been controlled historically by landholders on farmland, the Shire Council on roadsides and State government agencies on crown land (e.g. Leard State Forest). TCPL would develop a detailed Biodiversity Management Plan that would specify appropriate weed and vertebrate pest control measures on land owned by the company. The plan would recognise the potential for some weeds, including Coolatai Grass, and pests to increase as result of the creation of new habitat opportunities by the Project (e.g. through soil disturbance and rehabilitation, and outlines strategies to suppress any outbreaks of noxious weeds or vertebrate pests).

8. Would the Project introduce disease that may cause the species to decline?

The main plant disease of conservation concern in Australia is *Phytophthora cinnamomi*. *Dieback caused by the root-rot fungus Phytophthora cinnamomi*, is listed as a key threatening process under the EPBC Act. The genus *Pultenaea*, of which *P. setulosa* is a member, contains species known to be susceptible to *P. cinnamomi*. However, damage to native ecosystems by *P. cinnamomi* is confined largely to the southern parts of Australia with winter-dominant rainfall (Environment Australia 2001). It is generally a minor problem in NSW and is not known to affect the north-west slopes region.

9. Would the Project interfere substantially with the recovery of the species?

No recovering populations of *P. setulosa* or *T. australe* occur in the Project area or surrounds. Populations of *P. setulosa* in Leard State Forest are largely undisturbed, apart from some forestry access tracks and can be regarded as in a climax condition.

Conclusion

It is concluded that the Project is unlikely to adversely impact on any populations of *P. setulosa* or *T. australe.*

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