



WAMBO COAL PTY LTD

NORTH WAMBO UNDERGROUND MINE LONGWALL 10A MODIFICATION ENVIRONMENTAL ASSESSMENT

APPENDIX E Flora Assessment



North Wambo Underground – Longwall 10A Modification

Flora Assessment

**Prepared for Wambo Coal Pty Limited
by FloraSearch**

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EXECUTIVE SUMMARY

Flora Survey Findings

Flora Communities and Species

- A flora survey of the Modification area was conducted on 13 June 2014. The data from this survey was combined with earlier data collected in 2011 over a wider Study area around the Modification.
- The Study area was found to support remnants of nine vegetation communities comprising:
 - ♦ River Oak riparian woodland;
 - ♦ Forest Red Gum – Grey Gum dry open forest;
 - ♦ Grey Box – Narrow-leaved Ironbark shrubby woodland;
 - ♦ *Melaleuca decora* low forest;
 - ♦ Bulloak Forests of the Central Hunter Valley;
 - ♦ Grey Ironbark – Spotted Gum – Grey Box open forest;
 - ♦ Slaty Box – Grey Gum shrubby woodland;
 - ♦ Native Olive – Scrub Wilga woodland; and
 - ♦ Derived Grasslands in coastal valleys.
- Totals of 190 (69.6 percent) native flora species and 83 (30.4 percent) introduced flora species were found by the surveys involving thirteen 20×20 m quadrat plots, 14 spot sampling sites and 7 random meanders.
- The plant families with the highest numbers of species were the Daisies, Asteraceae (46 species); Grasses, Poaceae (44 species); Pea Flowers, subfamily Faboideae (17 species); the Saltbushes and Bluebushes, Chenopodiaceae (10 taxa); the Wattles, subfamily Mimosoideae (10 species) and the Eucalypts and related genera in the family Myrtaceae (8 species). In all, some 64 plant families or sub-families were represented.
- The highest proportions of introduced species and weeds were in the cleared pasture areas and along the watercourses. Least weeds were found in the less disturbed natural communities on steeper slopes and stony soils. Semi-cleared, grazed natural communities and disturbed sites in bushland areas had intermediate weed levels.

Condition of the Vegetation

- The condition of the native vegetation within the Study area varied considerably. In general the most disturbed areas were the watercourses and the flat to gently undulating areas cleared for grazing on the valley floor. The least disturbed areas were the steep rocky slopes and foothills. The remaining areas with natural vegetation cover were all semi-cleared, former or current grazing land, with open areas and regeneration of various ages.
- The Modification area is dominated by cleared grazing paddocks comprising derived native grasslands. Highly disturbed remnant native vegetation occurs along Wambo Creek, Stony Creek and North Wambo Creek. Small patches of highly disturbed, regenerating native vegetation remnants occur in the north of the Modification area. The condition of the vegetation on the Modification area varies from poor to moderate.

Threatened Species

- No flora species listed in the schedules of the New South Wales *Threatened Species Conservation Act, 1995* (TSC Act) or Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) were found in the targeted searches conducted over the Study area.

Endangered Populations

- One endangered population (EP), listed in the schedules of the TSC Act was identified on the Modification area by the survey, viz.:
 - ♦ *Acacia pendula* population in the Hunter Catchment.

Endangered Ecological Communities

- Three endangered ecological communities (EEC), listed in the schedules of the TSC Act were identified on the Modification area by the survey, viz.:
 - ♦ *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC*;
 - ♦ *Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC*; and
 - ♦ *Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion EEC*.
- No EECs listed under the EPBC Act occur on the Modification area.

Conclusions of Assessment

Potential Impacts of the Modification on Flora

- No clearance of native vegetation would occur as part of this Project.
- Subsidence modelling and experience from previous longwall mining in similar terrain nearby indicate some small scale cracking of surface soils may occur, which may cause minor damage to plant roots.
- Cracking of soils in similar terrain to the west of the Modification area has produced no observable changes to vegetation condition or to the health of individual plants.

Assessment of Significance

The likelihood of the Modification significantly affecting threatened flora species, populations or ecological communities or their habitats was assessed in accordance with Part 3A of the NSW *Environmental Planning and Assessment Act, 1979* and the relevant *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

- An assessment was conducted of the potential impacts of the Modification on two threatened flora species that may potentially occur on the Modification area, but were not found by the Modification surveys, and found that a significant impact on the Wybong Leek Orchid or the Illawarra Greenhood is unlikely.
- An assessment of the potential impacts on one endangered flora population identified on the Modification area found that a significant impact on the *Acacia pendula* population in the Hunter Catchment EP is unlikely.

- An assessment of the potential impacts on three EECs concluded that the Modification is unlikely to have a significant impact on remnants of the *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC*, the *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* or the *Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion EEC*.
- It is considered that the potential for the Project to significantly impact on Matters of National Environmental Significance under the EPBC Act is very low and that a referral to the DotE is not warranted.
- Overall, it is concluded from the assessments that the proposed Modification would have no significant impact on threatened flora species, populations, ecological communities or critical habitat.

1 INTRODUCTION

FloraSearch was commissioned by Wambo Coal Pty Limited (WCPL) to conduct a flora assessment for the North Wambo Underground Longwall 10A Modification (the Modification), located approximately 15 kilometres (km) west of Singleton and 80 km north-west of Newcastle in the Hunter Valley, New South Wales (NSW) (Figure 1 of Appendix A).

The Modification includes the development of one additional longwall panel in the Wambo seam, adjacent to the existing North Wambo Underground Mine (Figures 2 and 3 of Appendix A). Access to the longwall panel would be via the existing North Wambo Underground Mine. The Modification would use existing surface infrastructure of the North Wambo Underground Mine.

Further detail in regard to the Modification is provided in Section 1 of the North Wambo Underground Longwall 10A Modification Environmental Assessment main text.

1.1 SURVEY AND ASSESSMENT OBJECTIVES

The objectives of the survey and assessment were to:

- sample the natural vegetation on 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, ecological communities or critical habitat, listed in the schedules of the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act);
- conduct targeted searches for potentially occurring threatened plant species, populations, communities and critical habitat, and map any occurrences;
- analyse the potential impacts of the proposed Modification on flora and their habitats;
- discuss avoidance and mitigation measures to minimise impacts on threatened flora; and
- assess the impact of the Modification on threatened flora by consideration of *Guidelines for Threatened Species Assessment* (Department of Environment and Conservation [DEC] and Department of Primary Industries [DPI], 2005).

1.2 STUDY AREA

The Study area extent is shown by the extent of vegetation mapping on Figure 3. The Study area encompasses Longwalls 7 to 10 of the approved North Wambo Underground Coal Mine and surrounds (Figure 2). Longwall 10A adjoins the south-eastern side of Longwall 10. The zone of potential surface impact (due to subsidence) of Longwall 10A is shown on Figure 2 and is calculated as the greater of the predicted 20 mm subsidence contour and the 26.5 degree angle of draw line.

The description of the Study area included in this report refers to the area of the flora survey effort shown on Figure 3. For the impact assessment, the discussion is focused on the extent of secondary extraction for Longwall 10A and the predicted extent of subsidence impacts, as provided by Mine Subsidence Engineering Consultants (MSEC) (2014). The extent of subsidence impacts is shown on Figure 2.

1.3 REGIONAL SETTING

The subject area for the flora survey in this report includes the Modification area and areas to the north, east and south, which constitute the Study area. The Study area is situated in the central Hunter Valley, to the south of the Hunter River (Figure 1). The Hunter River, and its main tributary, the Goulburn River, drain the third largest eastward flowing catchment in NSW. The Goulburn River extends some 210 km inland from the coast to just west of Cassilis, where the uppermost parts of the Hunter Valley coincide with the lowest point (ca. 500 metres [m]) of the Great Dividing Range in NSW. The lowness of the Great Dividing Range at this point has significant implications for both the climate of the Hunter Valley and the movement of plant communities into the valley from the west (Anderson, 1968).

The rugged and densely forested lands of the Narrabeen sandstone-dominated Yengo and Wollemi National Parks occur to the south and west of the Modification area. These ranges reach altitudes of some 600 to 700 m. The Liverpool and Mount Royal Ranges, which rise to much higher altitudes, in excess of 1,100 m, occur in the north. The valley floor is broad, relatively flat and low, being only 40 m altitude at Singleton. Adjacent to the major watercourses, such as the Hunter and Goulburn Rivers and Wollombi Brook, are extensive flat floodplains. These adjoin more extensive gently undulating lands that gradually rise away from the rivers into the foothills of the fringing ranges.

Geologically, the Hunter Valley is part of the Sydney Basin comprising mainly Permian and Triassic sediments. However, on the northern side of the valley Tertiary basalt flows have covered the sediments over considerable areas (e.g. the Merriwa Plateau). The Liverpool and Mount Royal Ranges also comprise mainly basalt rocks resulting from Tertiary volcanic activity. The Permian sediments contain the coal measures which form the basis of the Hunter Valley coal industry and also comprise shale, sandstone, conglomerate, coal, tuff and some older basalt. They are overlain on the southern and western margins of the Valley by the harder Triassic sandstones of the Narrabeen Group that form rugged ranges and plateaux in the Yengo, Wollemi and Goulburn River National Parks. The broad valley floor of the Hunter Valley has developed in the softer Permian sediments. By contrast, the Narrabeen sandstone areas resist erosion forming narrow valleys and gorges with much shallower soils.

1.4 DESCRIPTION OF THE MODIFICATION AREA AND SURROUNDS

1.4.1 Topography and Drainage

The Modification area lies to the west of Wollombi Brook, south of North Wambo Creek near its confluence with Wollombi Brook, and west of Wambo Creek near its confluence with Wollombi Brook. Wollombi Brook joins the Hunter River approximately 4 km north-east of Warkworth (Figure 1). The southern part of the Study area is traversed by Stony Creek including its confluence with Wambo Creek. The Study area occupies the broad valley floor comprising the lower floodplains of North Wambo Creek, Wambo Creek and Stony Creek and includes a low ridge and its footslopes between Stony Creek and North Wambo Creek. Altitudes in the Modification area and surrounds range from 60 m at Wollombi Brook to approximately 140 m on the foot of the escarpment east of Mt Wambo. Neither the escarpment nor the Wollemi National Park would be affected by the Modification.

1.4.2 Geology, Geomorphology and Soils

The Modification area is situated within the Late Permian age coal measures of the Singleton Supergroup which, in addition to coal, comprise mainly shale, sandstone, siltstone, mudstone and conglomerate. The Modification area is fringed on the south and west sides by an escarpment of Triassic Narrabeen series sandstone overlying the Permian sediments. Above the narrow alluvial flats on the creeks is gently undulating to hilly country, becoming steeper as it approaches the escarpment.

Kovac and Lawrie (1991) define three Soil Landscapes in the Modification area and surrounds; the Bulga, Benjang and Lees Pinch Soil Landscapes.

- **Bulga.** This Soil Landscape occurs on the lowest elevations of the Study area on gently undulating terrain. It is formed in colluvial material derived from the steep slopes of the Lees Pinch Soil Landscape. The underlying geological unit is the Singleton Supergroup Coal Measures with overlying colluvium from Narrabeen Sandstone. It comprises sandstone, conglomerate, red and green claystone, shale, mudstone and coal. On the Study area, it occupies the low flat valleys of North Wambo Creek, Wambo Creek and Stony Creek. The soils, formed from weathered parent rock and derived colluvium, include soloths on upper slopes, solodic soils on mid slopes and brown earths on lower slopes.
- **Benjang.** The Benjang Soil Landscape occupies the low ridge between Stony Creek and North Wambo Creek and the footslopes of the main escarpment. Hills of the Benjang Soil Landscape often have flat-topped surfaces, protected by basalt caps, with steep stony sideslopes. It is developed in the Singleton Supergroup Coal Measures comprising shale, sandstone, conglomerate, mudstone, coal, tuff and some basalt. The soils include yellow, red and brown solodic soils on imperfectly drained benched slopes, with brown podzolic soils on upper slopes, non-calcic brown soils on lower parts of flatter slopes and siliceous sands on midslopes on quartz sandstone.
- **Lees Pinch.** The Lees Pinch Soil Landscape encompasses the steep high sandstone ranges to the south and west of the Modification area comprising mountains with rounded summits edged by sandstone cliffs. The steep-sided valley of Stony Creek cuts into this soil landscape. Precipitous slopes with gradients to 90 percent (%) are littered with boulders, scree and minor rockfalls. The geological unit is Narrabeen Sandstone comprising lithic and quartz sandstone, conglomerate, green and red claystone, shale and siltstone. The soils include lithosols; shallow siliceous sands and shallow loams; some yellow and brown earths on footslopes; yellow and grey soloths in breaks of slope; and yellow podzolic soils and earthy sands on some upper slopes. This soil landscape would not be affected by the Modification.

1.4.3 Climate

The Modification area is situated some 80 km inland from the coastline. While annual rainfall on the coast may average greater than 1,200 millimetres (mm), it declines rapidly with distance inland, such that it averages only 640 mm at Jerrys Plains, to the north-west of the Modification area (Bureau of Meteorology [BOM], 2014). This rainfall is similar to that experienced on the upper parts of the north-west slopes of NSW. While significant rain may occur at any time of the year, on average it is summer dominant, with January being the highest rainfall month, similar to the north-west slopes. The total annual rainfall at Wambo between 2006-2007 and 2009-2010 has ranged between 564 and 787 mm. Evaporation is of the order of 1,600 mm per annum, or 2.5 times the annual rainfall, indicating a moderate degree of water stress in Australian terms. Relative humidities are comparatively high and do not vary greatly through the year reflecting the near coastal location of the Modification area. In January the 9.00 am and 3.00 pm relative humidities average 67 and 47%, respectively, while the comparable figures for July are 78 and 50% (BOM, 2014).

Summers are warm to hot with mean daily maximum temperatures of 31.7 degrees Celsius (°C) in January, the hottest month. July is the coldest month with a mean minimum temperature of 3.7°C. Frosts are common in winter; with July having an average lowest minimum temperature -4.5°C and an average of 5.2 days per annum with minimums below 0°C.

1.4.4 Land Use

The Modification area was part of the tribal lands of the Wonnarua people who inhabited most of the Hunter Valley. The European history of the valley began soon after the settlement of Sydney Cove in 1788. The Hunter River was discovered in 1797 by Lieutenant John Shortland while searching for escaped convicts. Shortland noted the presence of numerous coal outcrops, abundant red cedar trees and good grazing lands. By 1799 the first coal had been exported from the valley beginning an industry that has been important for its economy ever since. Cedar was being exported by 1801, like coal, using convict labour.

In 1819 John Howe blazed Howes Track from Sydney to Maitland, the first overland route to the Hunter Valley. A member of the party, John Singleton, received a land grant of 240 acres and established a trading business on the site of the town now bearing his name. By 1828 the Great North Road from Windsor on the Hawkesbury River to Jerrys Plains had been completed. The early 1820s saw widespread settlement of the area around Singleton following the awarding of land grants to free settlers, soldiers and freed convicts. The clearing of the Modification area for farming would date from this time (Office of Environment and Heritage [OEH], 2014a). A great variety of crops was grown in the Hunter in the 1800s, including wine grapes, which date from 1823 and continue to be a major industry. Currently, the main agricultural industries within the Modification area and surrounds include beef cattle and dairying. Alluvial soils along the Hunter River are used for irrigated pastures, lucerne hay production and some vegetable growing.

Coal mining around Singleton began in the 1870s and is now a major local industry. Mining at Wambo began in 1969 with underground operations. The commencement of open cut mining at Wambo in 1974 was the beginning of this kind of operation in the Hunter Valley. There are now over 20 open-cut pits in Singleton–Muswellbrook area, which collectively are transforming the local environment, and represent the largest environmental change since the clearing of much of the valley floor in the early 1800s.

1.5 BOTANICAL/BIOGEOGRAPHIC REGIONS

The Modification area lies in the north of the Sydney Basin Bioregion as defined originally by Thackway and Cresswell (1995) and in the south-west corner of the North Coast Botanical Division (Anderson, 1968; Harden, 2002). It is close to the southern boundary of the Brigalow Belt South Bioregion (Thackway and Cresswell, 1995) and just outside the eastern boundary of the Central Western Slopes Botanical Division (Anderson, 1968; Harden, 2002).

The intrusion of the Hunter Valley through the Great Dividing Range forms, in combination with the vast sandstone areas to the south, is a critical biogeographical barrier to the dispersal of higher altitude plants along the Range (Anderson, 1968). Hence the Hunter Valley marks the northern limit of the Central Tablelands and the southern limit of the Northern Tablelands Botanical Divisions (Anderson, 1968), respectively. The absence of high altitudes in the upper Hunter provides a direct link to the western slopes. This has allowed dispersal of Western Slopes Botanical Division plants into the Valley, so that many plants characteristic of the Western Slopes comprise an important component of the central and upper Hunter Valley flora. Indeed, the Central West Slopes Botanical Division (Anderson, 1968; Harden, 2002) extends into the Hunter Valley almost as far as Singleton where it abuts the southern end of the North Coast Botanical Division.

The Modification area lies just within the North Coast Botanical Division close to the junction of the North and Central Coast Botanical Divisions. Botanically therefore, the Modification area can be expected to comprise a mix of Central Western Slopes, Central Coast and North Coast plants.

The Interim Biogeographic Regionalisation of Thackway and Cresswell (1995) shows much of the upper Hunter Valley in the Brigalow Belt South Bioregion, which extends up the NSW North Western Slopes into south-east Queensland, suggesting the flora has greater affinities with that region than the NSW South Western Slopes Bioregion flora. The Hunter Valley is the only area where the Brigalow Belt South Bioregion crosses to the coastal side of the Great Dividing Range.

1.6 PREVIOUS VEGETATION STUDIES

Several broad scientific studies of flora communities and species within the Hunter Valley have been conducted (Story *et al.*, 1963; House, 2003; Peake, 2006; Somerville, 2009). The geographical scope of these studies varies; Story *et al.* (1963), documented the flora as part of an overall Study of the land systems for the whole valley, House (2003) was part of a detailed series of investigations and mapping of the flora of the Lower Hunter and Central Coast Regions, while Peake (2006) documented the flora of the central parts of the valley, including the Study area. Somerville (2009) combined data from previous studies with new data for the whole Hunter Valley, Central Coast and Lower North Coast regions. A large number of more localised studies have been conducted for environmental assessment purposes in the coal mining industry, including Orchid Research (2003) and FloraSearch (2011, 2012) which included parts of the Study area. FloraSearch (2012) surveyed and assessed the potential impact on flora of North Wambo Underground Longwalls 9 and 10, which adjoin Longwall 10A to the west.

The vegetation communities mapped by Peake (2006) as occurring within the Study area are summarised in Table 1 and related to the equivalent Plant Community Types (PCT) in the BioMetric Vegetation Types Database (OEH, 2012). The Peake (2006) classification was adopted by FloraSearch (2011, 2012) with some adjustments. However, this report utilises PCTs for classification of the Study area vegetation.

Table 1
Vegetation Communities Mapped by Peake (2006) within or near the Study Area

Vegetation Class (Keith, 2006)	Peake (2006)			Plant Community Type (OEH, 2012)			Comment
	Map Unit	Community name	Scientific name	Veg Type ID	Community name	Scientific name	
Dry Rainforests	MU4	Hunter Valley Vine Thicket	<i>Elaeodendron australe</i> – <i>Geijera parviflora</i> – <i>Notelaea microcarpa</i> var. <i>microcarpa</i> – <i>Alectryon oleifolius</i> subsp. <i>elongatus</i> – <i>Melia azedarach</i> – <i>Brachychiton populneus</i> subsp. <i>populneus</i>	HU578	Native Olive - Rusty Fig semi-evergreen vine thicket of the upper Hunter Valley, Sydney Basin	<i>N. microcarpa</i> var. <i>microcarpa</i> , <i>Ficus rubiginosa</i> , <i>E. australe</i>	FloraSearch (2011) showed that references to the potential occurrence of this community on WCPL-owned land by Orchid Research (2003), followed by Peake (2006), are incorrect. This community does not occur on or near the Modification area.
Eastern Riverine Forests	MU30	Hunter Valley River Oak Forest	<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>	HU598	River Oak riparian woodland of the North Coast and northern Sydney Basin	<i>C. cunninghamiana</i> , <i>Waterhousea floribunda</i> , <i>Angophora floribunda</i>	-
Coastal Valley Grassy Woodlands	MU24	Hunter Lowlands Red Gum Forest	<i>Eucalyptus tereticornis</i> – <i>Eucalyptus. punctata</i> – <i>Eucalyptus . crebra</i> – <i>A. floribunda</i> – <i>Corymbia maculate</i>	HU544	Forest Red Gum - Grey Gum dry open forest on hills of the lower Hunter Valley, Sydney Basin	<i>E. tereticornis</i> , <i>E. punctata</i> , <i>E. crebra</i>	-
	MU10	Central Hunter Box – Ironbark Woodland	<i>Eucalyptus crebra</i> – <i>Eucalyptus moluccana</i> – <i>Eucalyptus moluccana - albens</i> – <i>Allocasuarina luehmannii</i>	HU551	Grey Box - Narrow-leaved Ironbark shrubby woodland on hills of the Hunter Valley, North Coast and Sydney Basin	<i>E. moluccana</i> , <i>E. crebra</i> , <i>A. floribunda</i> , <i>A. luehmannii</i>	-
	MU32	Central Hunter Bullock Forest Regeneration	<i>A. luehmannii</i>	HU668	Bull Oak Forests of the Central Hunter Valley	<i>A. luehmannii</i> , <i>E. moluccana</i> , <i>E. crebra</i> , <i>A. floribunda</i>	-
Hunter-Macleay Dry Sclerophyll Forests	MU17	Central Hunter Paperbark Soak Woodland	<i>Melaleuca decora</i>	HU564	Melaleuca decora low forest of the central Hunter Valley, Sydney Basin	<i>M. decora</i> , <i>E. crebra</i>	-
	MU12	Southern Hunter Escarpment Spotted Gum Woodland	<i>C. maculata</i> – <i>E. crebra</i> – <i>E. moluccana</i> – <i>Callitris endlicheri</i>	HU556	Grey Ironbark - Spotted Gum - Grey Box open forest on hills of the Hunter Valley, Sydney Basin	<i>E. crebra</i> , <i>C. maculata</i> , <i>E. moluccana</i>	-
Western Slopes Dry Sclerophyll Forests	MU7	Narrabeen Foothills Slaty Box Woodland	<i>Eucalyptus dawsonii</i> – <i>E. moluccana</i> – <i>Acacia salicina</i>	HU618	Slaty Box - Grey Gum shrubby woodland on foothills of the upper Hunter Valley, Sydney Basin	<i>E. dawsonii</i> , <i>E. punctata</i> , <i>E. moluccana</i> , <i>E. crebra</i>	-

2 THREATENED SPECIES, POPULATIONS, ECOLOGICAL COMMUNITIES AND CRITICAL HABITAT

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

- BioNet website incorporating searches of the databases of the Atlas of NSW Wildlife and Royal Botanic Gardens and Domain Trust, Forests NSW and the Australian Museum (BioNet, 2014);
- Protected Matters Search Tool (Commonwealth Department of the Environment [DotE], 2014);
- Schedules of the TSC Act and the EPBC Act; and
- Preliminary and Final Determinations of the NSW Scientific Committee.

Database searches were conducted within a 20 × 20 km square centred on the Modification area. The databases were accessed on 23 June 2014.

2.1 THREATENED FLORA SPECIES

Table 2 shows threatened plant species listed in the schedules of the TSC Act and the EPBC Act that were returned by the database searches. Table 2 documents the known distribution and habitats of these species and assesses the likelihood of their occurrence within the habitats present on the Study area. These considerations identified five threatened species for targeted searches and assessment, of which four are considered to have a low probability and one a high probability, of occurring on the Study area (Table 3). These species were specifically targeted during the surveys conducted for this study.

Of the threatened species selected for targeted searches, one is a tree, two are shrubs and two are ephemeral herbs (Table 3). The presence of the tree and 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. However, detection of the herbs depends on flowering time and seasonal conditions. Both herbs flower in spring and plants may not grow at all, much less flower, in very dry conditions and may not be detectable.

2.2 THREATENED POPULATIONS

Twenty-six Endangered Populations (EP) are currently (June 2014) listed in Schedule 1 of the TSC Act. Three of the populations may potentially occur on the Modification area, viz.

- *Acacia pendula* population in the Hunter Catchment;
- *Eucalyptus camaldulensis* population in the Hunter Catchment; and
- *Cymbidium canaliculatum* population in the Hunter Catchment.

Table 4 discusses the likelihood of these three populations being represented on the Modification area or surrounds. These populations were specifically targeted during the surveys conducted for this study.

Table 2
Threatened Flora Species with Potential to Occur on the Study Area

Scientific Name	Common Name	Conservation Status ¹		Distribution	Habitat	Likelihood of Occurrence	Significance Assessment
		TSC Act	EPBC Act				
<i>Allocasuarina glareicola</i>	-	E	E	The known distribution is restricted to the Cumberland Plain west of Sydney, principally in the Richmond area, but with an outlier population found at Voyager Point, Liverpool (OEH, 2014b). This species was returned by the DotE (2014a) Protected Matters Search Tool. No records close to the Modification area were revealed by the NSW BioNet search.	Grows in Castlereagh woodland on lateritic soil. Spreads vegetatively, forming clonal colonies of up to 100 stems. Only produces substantial numbers of fruit if plants are unburnt for long periods (OEH, 2014b).	Nil	No
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	The Leafless Tongue Orchid was indicated as potentially occurring in the search area by the DotE (2014a) Protected Matters Search Tool. However, no records were returned for the search area by BioNet (2014).	The Leafless Tongue Orchid is confined to low open woodlands with a heathy understorey on infertile, dry sandy loam soils on the NSW Central Coast (Bell, 2001). Such habitats are absent from the Study area. Consequently, the Leafless Tongue Orchid is not considered further here.	Nil	No
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E	From the coast to the escarpment. Wollongong to Queensland border (OEH, 2014b).	Mainly in rainforest, but also occasionally in woodland (OEH, 2014b). The only nearby records are deep within Wollemi National Park to the south-west of the Modification area, where it is likely to occur in sandstone gully rainforest.	Nil	No
<i>Dillwynia tenuifolia</i>	-	V	-	The core distribution is the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee (OEH, 2014b). Other populations in western Sydney are at Voyager Point, Kemps Creek, Luddenham and South Maroota. Disjunct localities outside the Cumberland Plain include the Bulga Mountains at Yengo in the north, and Kurrajong Heights and Woodford in the Lower Blue Mountains. The BioNet (2014) search returned a record south of Bulga.	In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland. At Yengo, is reported to occur in disturbed escarpment woodland on Narrabeen sandstone (OEH, 2014b).	Low	Yes

Table 2 (Continued)
Threatened Flora Species with Potential to Occur on the Study Area

Scientific Name	Common Name	Conservation Status ¹		Distribution	Habitat	Likelihood of Occurrence	Significance Assessment
		TSC Act	EPBC Act				
<i>Eucalyptus glaucina</i>	Slaty Red Gum	V	V	From Broke to Taree and the Casino district (OEH, 2014b). There are several records within the BioNet (2014) search area.	On deep, fertile soils in river valleys (OEH, 2014b).	High	Yes
<i>Euphrasia arguta</i>	An Eye-bright	CE	CE	From Bathurst to the Nundle area including the North Coast, Central and Northern Tablelands, and Central West and North-West Slopes of NSW (Barker, 1992).	This species has recently been rediscovered in the Nundle area after being thought extinct (OEH, 2014b). Habitats include grassy areas beside rivers (Barker, 1992) and grassy forests (DotE, 2014b).	Nil	No
<i>Melaleuca groveana</i>	Grove's Paperbark	V	-	Scattered in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the northern tablelands (OEH, 2014b). There is a record deep within Wollemi National Park to the south west of the Modification area (BioNet, 2014).	Grows in heath and shrubland, often on exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. It also occurs in dry, shrubby open forest and woodlands (OEH, 2014b). Suitable rocky, shrubby habitats are lacking on the Study area.	Nil	No
<i>Olearia cordata</i>		V	V	A NSW endemic with a scattered distribution generally restricted to the south-western Hunter Plateau, eastern Colo Plateau, and the far north-west of the Hornsby Plateau near Wisemans Ferry east of Maroota (OEH, 2014b).	Dry sclerophyll forest and woodland on sandstone. Wiseman's Ferry to Wollombi. Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges (OEH, 2014b). Suitable habitat is lacking on the Study area.	Nil	No
<i>Pelargonium</i> sp. <i>striatellum</i> (G.W. Carr 10345)		-	E	The Omeo Stork's-bill is a newly recognised species, so far only known in NSW from the Southern Tablelands (OEH, 2014b).	Usually occurs just above the high water level of irregularly inundated or ephemeral high altitude lakes. During dry periods, the species may colonise exposed lake beds (DotE, 2014b). Such habitat is absent from the Study area.	Nil	No
<i>Pomaderris brunnea</i>	Rufous Pomaderris	E	V	Distributed in a limited area around the Colo, Nepean and Hawkesbury Rivers. It also occurs near Walcha on the New England tablelands and in far eastern Gippsland in Victoria (OEH, 2014b).	Occurs on active alluvium. Active alluvium is present in the watercourses of Wambo and Stony Creeks.	Low	Yes

Table 2 (Continued)
Threatened Flora Species with Potential to Occur on the Study Area

Scientific Name	Common Name	Conservation Status ¹		Distribution	Habitat	Likelihood of Occurrence	Significance Assessment
		TSC Act	EPBC Act				
<i>Prasophyllum</i> sp. Wybong (C. Phelps ORG 5269)	A Leek Orchid	-	CE	Known from seven populations in open eucalypt woodland and grassland in NSW. The species' area of occupancy is estimated to be 1.5 km ² with an estimated population size of 460 mature individuals (DotE, 2014b).	This species occurs mainly in Grassy Box Woodlands with fertile to moderately fertile soils on undulating terrain. The soils of the Study area are relatively infertile away from the former floodplains, and the latter are not a known habitat for the species. However, the proximity of populations at Wybong suggests this species may have potential to occur in open grassy sites on the Study area.	Low	Yes
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	E	E	Known from a small number of populations in the Hunter (Milbrodale), Illawarra (Albion Park and Yallah) and the Shoalhaven (near Nowra) regions. The Milbrodale occurrence lies just outside the 20 × 20 km BioNet (2014) search area.	Grows in woodland dominated by Forest Red Gum <i>Eucalyptus tereticornis</i> , Woollybutt <i>E. longifolia</i> , White Feather Honey-myrtle <i>Melaleuca decora</i> , or open forest of Spotted Gum <i>Corymbia maculata</i> , Forest Red Gum and Grey Ironbark <i>E. paniculata</i> . In the Hunter region, it grows in open woodland dominated by Narrow-leaved Ironbark <i>E. crebra</i> , Forest Red Gum and Black Cypress Pine <i>Callitris endlicheri</i> (OEH, 2014b). Several of these tree species occur on the Study area.	Low	Yes
<i>Streblus pendulinus</i>	Siah's Backbone	-	E	This species was returned by the DotE Protected Matters Search Tool (DotE, 2014a). The original listing considered it to be distributed on Norfolk Island and other Pacific Islands, and referred only to the Norfolk Island population (DotE, 2014b). Subsequently, this species has been synonymised with <i>S. brunonianus</i> which is common and widespread in eastern NSW.	The EPBC Act listing refers only to the Norfolk Island population of this species (DotE, 2014b). It is not considered further in this report.	Nil	No
<i>Thesium australe</i>	Austral Toadflax	V	V	Austral Toadflax has a disjunct distribution on the NSW tablelands; there are many records for the northern and southern tablelands, but none for the central tablelands or Hunter Valley (BioNet, 2014).	It is largely confined to grasslands, grassy woodlands or sub-alpine grassy heathlands (OEH, 2014b). Austral Toad-flax is usually hemiparasitic on Kangaroo Grass, but may associate less frequently with <i>Poa</i> spp. It is highly unlikely to occur on the Study area.	Nil	No

Table 2 (Continued)
Threatened Flora Species with Potential to Occur on the Study Area

Scientific Name	Common Name	Conservation Status ¹		Distribution	Habitat	Likelihood of Occurrence	Significance Assessment
		TSC Act	EPBC Act				
<i>Wollemia nobilis</i>	Wollemi Pine	E	E	Restricted to a few small occurrences in the west of Wollemi National Park. This species was not returned in the BioNet (2014) search, but was returned as potentially occurring by the DotE (2014a) Protected Matters Search Tool.	Found only in deep sandstone gorges (OEH, 2014b) that do not occur on the Study area.	Nil	No

¹ Threatened flora species conservation status under the TSC Act and/or EPBC Act (current at June 2014).

E = Endangered. CE = Critically Endangered V = Vulnerable.

Table 3
Threatened Flora Species for Targeted Searches and Impact Assessment

Family Name	Scientific Name	Conservation Status ¹		Likelihood of Occurrence	Description
		TSC Act	EPBC Act		
Fabaceae: Faboideae	<i>Dillwynia tenuifolia</i>	V	-	Low	Low spreading pea-flower shrub to a metre high. Leaves small and narrow (linear-terete, soft, 4-12 mm long, with the tip often bent downwards). Orange-yellow and red pea-flowers usually single, at or near the tips of the branches. Seed pods brownish, egg-shaped, 4-5 mm long with reticulate seeds (OEH, 2014b).
Myrtaceae	<i>Eucalyptus glauca</i>	V	V	High	Tree to 30 m, red gum bark, juvenile leaves ovate, glaucous; adult leaves lanceolate to 18x3 centimetres (cm), green or grey-green, concolorous; umbellasters 7-flowered, buds glaucous; fruit ovoid to globose, to 10x10 mm, disc raised, valves exserted. On deep, fertile soils (OEH, 2014b).
Rhamnaceae	<i>Pomaderris brunnea</i>	E	V	Low	Shrub to 3 m tall with hairy stems; stem-hairs comprise long brownish hairs above a thick white hairy under-coat. Leaves to 4 cm long and 1.5 cm wide with toothed margins. Upper leaf surface hairless; lower surface densely hairy like the stem. Leaf veins extend to the margins. Small yellowish flowers lacking petals cluster densely at branch ends (OEH, 2014b).
Orchidaceae	<i>Prasophyllum</i> sp. Wybong (C. Phelps ORG 5269)	-	CE	Low	Terrestrial orchid that grows to approximately 30 cm high. It has a single, tubular, fleshy, dull-green leaf and a single flower spike with numerous fragrant flowers (DotE, 2014b).
Orchidaceae	<i>Pterostylis gibbosa</i>	E	E	Low	Rosette of rounded leaves at the stem base, each to 35 mm long. Up to six leaves on the stem, which may be 45 cm high and bear up to seven flowers. Flowers bright glossy green with transparent patches in the hood. The broad black labellum protrudes from the front of the flower (OEH, 2014b).

¹ Threatened flora species conservation status under the TSC Act and/or EPBC Act (current at June 2014).

V = Vulnerable E = Endangered CE = Critically Endangered.

Table 4
Threatened Flora Populations Targeted During Modification Surveys

Family Name	Scientific Name	Conservation Status ¹		Likelihood of Occurrence	Comment
		TSC Act	EPBC Act		
Mimosoideae	<i>Acacia pendula</i>	E	-	High	<i>A. pendula</i> (Weeping Myall) is a small tree to 13 m high that is widespread in inland NSW. A disjunct population occurs in the central and upper Hunter Valley, although representing a different form of the species with an erect narrow habit by contrast with the spreading habit and weeping foliage of the inland form (Bell, 2006, 2007). The inland form also has grey-blue foliage versus the predominantly dark grey foliage of the Hunter form. Hunter Valley populations also rarely flower, have not been observed to produce seed and multiply vegetatively forming clonal colonies. Two known sites of Hunter Valley Weeping Myall occur quite close to the Modification area (BioNet, 2014). One is on WCPL owned land approximately 2 km north-west of the Modification area and the second is approximately 1 km south-east of the Modification area. Two other populations are known in the surrounds, at Jerrys Plains cemetery and beside the Charlton Road, to the north-west and south-east of the Modification area, respectively (BioNet, 2014). Potential habitat occurs in the Modification area.
Myrtaceae	<i>Eucalyptus camaldulensis</i>	E	-	Low	Occurs as a disjunct population on the major floodplains of the Hunter River and large tributaries, including Wollombi Brook and the Goulburn River (OEH, 2014b). A significant population occurs on alluvial flood terraces beside Wollombi Brook immediately to the east of the Modification area (BioNet, 2014). However, the Modification area lacks active floodplain habitats for this species.
Orchidaceae	<i>Cymbidium canaliculatum</i>	E	-	High	<i>C. canaliculatum</i> (Tiger Orchid) is a large epiphytic orchid that grows in the forks of tree branches, mainly eucalypts, but also <i>Angophora floribunda</i> (Rough-barked Apple) and <i>Acacia salicina</i> (Cooba). A small population (as few as 90 plants) in the Hunter Valley is at the south eastern extremity of the species' range (OEH, 2014b). Suitable hosts and habitat occur within the Modification area.

¹ Threatened flora species conservation status under the TSC Act and/or EPBC Act (current at June 2014).

E = Endangered.

2.3 THREATENED ECOLOGICAL COMMUNITIES

Seven Endangered Ecological Communities (EEC) listed in the schedules of the TSC Act are considered possible occurrences within the Modification area, viz.

- *Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions.*
- *Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions.*
- *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions.*
- *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions.*
- *Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion.* This community is also listed (albeit restricted to the Jerrys Plains cemetery) under the EPBC Act as the *Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley Critically Endangered Ecological Community (CEEC).*
- *Warkworth Sands Woodland in the Sydney Basin Bioregion.*
- *White Box – Yellow Box – Blakely’s Red Gum Woodland.* This community is also listed under the EPBC Act as the *White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Grassland CEEC.*

One Vulnerable Ecological Community (VEC) listed in the schedules of the TSC Act is considered a possible occurrence within the Modification area, viz.

- *Hunter Valley Foothills Slaty Gum Woodland in the Sydney Basin Bioregion.*

Table 5 summarises the known distributions and characteristics of each of the above EECs and VEC with an assessment of their likelihood of occurring on the Modification area.

2.4 CRITICAL HABITAT

No Critical Habitat for flora has been declared on or near the Modification area under the TSC Act (OEH, 2014c) or the EPBC Act (DotE, 2014c).

Table 5
Potential Threatened Ecological Communities in the Study Area

TEC	Conservation Status ¹		Dominant Species	Known Distribution	Potential Habitats	Likelihood of Occurrence
	TSC Act	EPBC Act				
Central Hunter Grey Box - Ironbark Woodland	E	-	<i>Eucalyptus crebra</i> – <i>Brachychiton populneus</i> – <i>E. moluccana</i>	Singleton to Muswellbrook area of the Central Hunter Valley (OEH, 2014b).	Gently undulating hills, slopes and valleys, occasionally on rocky knolls, Permian lithology (OEH, 2014b).	High
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	E	-	<i>E. crebra</i> – <i>Corymbia maculata</i> – <i>E. moluccana</i>	Mainly Maitland to Muswellbrook in the central Hunter Valley (OEH, 2014b).	Undulating terrain on low rises and slopes. Permian clays and colluvium and alluvium in valleys (OEH, 2014b).	High
Hunter Floodplain Red Gum Woodland	E	-	<i>E. camaldulensis</i> – <i>E. tereticornis</i> – <i>E. melliodora</i> – <i>Angophora floribunda</i>	Hunter Valley including Local Government Areas (LGAs) of Maitland, Mid-Western, Muswellbrook, Singleton, and Upper Hunter (OEH, 2014b).	Major floodplains and floodplain rises (OEH, 2014b). No major floodplains occur on the Modification area.	Low
Hunter Lowland Redgum Forest	E	-	<i>E. tereticornis</i> – <i>E. punctata</i> ± <i>E. moluccana</i> , <i>Angophora costata</i> , <i>C. maculata</i> or <i>E. crebra</i>	LGAs of Maitland, Cessnock, Port Stephens, Muswellbrook and Singleton (OEH, 2014b).	Gently sloping depressions and drainage flats of the Hunter Valley floor (OEH, 2014b).	High
Hunter Valley Weeping Myall Woodland/Weeping Myall – Coobah – Scrub Wilga Shrubland	E	CE	<i>Acacia pendula</i> – <i>E. crebra</i> – <i>Acacia salicina</i>	Singleton and Muswellbrook LGAs in the central Hunter Valley (OEH, 2014b).	Occurs on heavy Permian clay soils (OEH, 2014b). There are three known occurrences close to the Modification area; Jerrys Plains cemetery, west of the Modification area on WCPL owned land and Charlton Road.	High
Warkworth Sands Woodland	E	-	<i>A. floribunda</i> – <i>Banksia integrifolia</i>	Limited to the Warkworth area in the Singleton LGA of the central Hunter Valley (OEH, 2014b).	Restricted to aeolian sand deposits along Wollombi Brook, north and south of Warkworth (OEH, 2014b). Although known occurrences of this community are close (0.5 km) to the Modification area, suitable soil types are absent from it.	Low
White Box - Yellow Box - Blakely's Red Gum Woodland/White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Grassland	E	CE	<i>E. albens</i> - <i>E. melliodora</i> – <i>E. blakelyi</i>	Tablelands and western slopes of NSW and the upper Hunter Valley (OEH, 2014b). Not considered to have potential to occur on the Study area by the NSW BioNet database, but was returned by the EPBC Act Protected Matters search.	Deep fertile soils on undulating terrain (OEH, 2014b). Occurs on the footslopes of the Narrabeen Sandstone escarpments of the upper Hunter Valley. Occurrences of Yellow Box and Blakely's Red Gum close to the Study area are considered to belong to other communities.	Low
Hunter Valley Footslopes Slaty Gum Woodland	V	-	<i>E. dawsonii</i> – <i>E. moluccana</i> ± <i>A. salicina</i> , <i>Allocasuarina luehmannii</i>	South side of the Hunter Valley from Bulga to the Bylong/Goulburn River National Park area in the Singleton, Muswellbrook and Upper Hunter LGAs (OEH, 2014b).	Occurs mainly on colluvium derived from Triassic sandstones and conglomerates over Permian lithology (OEH, 2014b). Suitable environments occur in the Modification area.	High

¹ Threatened Ecological Communities conservation status under the TSC Act and/or EPBC Act (current at June 2014).

E = Endangered CE = Critically Endangered V = Vulnerable

3 METHODS

Flora surveys were designed and undertaken in conformance with DEC (2004) and OEH (2014d). The data considered in this report is derived from two vegetation surveys. The first was carried out over four days in the periods 8 to 10 June and 26 September 2011 over a broad Study area related to an earlier proposal (FloraSearch, 2012). A second one day survey was conducted over the Longwall 10A area on 13 June 2014 specifically for the current proposal. The data collected over the larger Study area provides an overall context to the current Modification area and the recent survey provides contemporary site specific data for the Modification area. The surveys encompassed all remnants 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 that may occur. Complete coverage of the area was facilitated by recent aerial photography showing remnant vegetation. Good 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.

3.1 VEGETATION SAMPLING

Three methods of documenting the vegetation were employed; quadrat sampling, spot sampling and random meanders. These methods are detailed in Sections 3.1.1, 3.1.2 and 3.1.3, respectively. Figure 3 shows the locations of quadrat and spot sample sites.

3.1.1 Quadrat Sampling

A total of thirteen 20 × 20 m (0.04 hectares) flora quadrat sites was sampled over the Study area (Figure 3). Within each plot 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 six category Braun-Blanquet scale in 2011 and an eight category scale in 2014. Details recorded for each site included its Global Positioning System (GPS) position, landform, physiography, soil characteristics, disturbance, vegetation structural formation and general comments. Plots were stratified across all vegetation communities in proportion to their representation on the Study area (Table 6).

Table 6
Sampling Effort Stratified by Plant Community Type

Community Number (this Study)	PCT	Community Name	Quadrat Numbers	Spot Sample Numbers	Random Meander Numbers
1	HU598	River Oak riparian woodland	-	2, 3, 4	7
2	HU544	Forest Red Gum – Grey Gum dry open forest	2, 11	1, 6, 7, 14	3
3	HU551	Grey Box – Narrow-leaved Ironbark shrubby woodland	1, 6, 7	8	1
4	HU564	<i>Melaleuca decora</i> low forest	4	-	4
5	HU668	Bullock Forests of the Central Hunter Valley.	3, 10	-	-
6	HU556	Grey Ironbark – Spotted Gum – Grey Box open forest	8	-	5
7	HU618	Slaty Box – Grey Gum shrubby woodland	5, 9	10	2
8	N/A ¹	Native Olive – Scrub Wilga shrubland	-	-	6
9	HU670	Derived Grasslands in coastal valleys	12, 13	5, 9, 11, 12, 13	-

¹ Not recognised in BioMetric (OEH, 2012).

3.1.2 Rapid Assessment Spot Sampling

In addition to the quadrat samples, and in order to comprehensively survey the flora over the entire Study area, 14 rapid assessment spot samples were conducted (Figure 3). Spot samples listed all vascular plants within a 15 m radius of the central point at which a GPS reading was taken. The dominant tree species were noted to allow classification of the site according to community. Brief notes were made on site characteristics, the condition of the vegetation and any disturbance. Spot samples were mainly taken in heavily cleared and other highly disturbed vegetation types (Table 6).

3.1.3 Random Meanders

Random meanders were used to search for threatened flora species and populations (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 NSW OEH and the Commonwealth DotE, as well as on the website of the Royal Botanic Gardens and Domain Trust Sydney (RBGDT). The species and populations targeted are given in Tables 3 and 4. Seven random meanders each of 30 minutes duration were conducted by a single surveyor. For each meander, lists of all flora species additional to those recorded at nearby quadrat sites, were compiled to provide further data on community composition and the flora diversity of the Study area.

3.2 VEGETATION MAPPING

The approximate distribution of each vegetation community was mapped onto high resolution colour aerial photos of the Study area during the field work. The field mapping was later refined by air photo interpretation (in consideration of the survey data) in the office.

3.3 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. 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, 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 RBGDT.

3.4 VEGETATION CONDITION ASSESSMENT

Native vegetation condition varies widely across the Study area according to the history of land use. This report does not aim to provide a detailed quantitative assessment of vegetation condition similar to those generated by methodologies such as BioMetric (Gibbons *et al.*, 2005) or BioBanking (Department of Environment and Climate Change, 2008). Rather, the aim is to broadly describe vegetation condition enabling a general understanding of the variation across the Study area. The condition assessment considers the status of key parameters commonly used in vegetation condition monitoring. These are:

- **Disturbance.** Anthropogenic disturbance factors such as land clearing, vegetation thinning, fire roads and tracks, grazing, logging, quarrying, hazard reduction burning and recreation are considered. Natural disturbance factors considered include wildfires, storms and drought.

- *Native vegetation cover.* Broad comparisons are made between the current cover percentages of each vegetation layer and those expected in undisturbed examples of each community.
- *Juveniles.* The presence of juvenile plants of perennial species indicating that successful reproduction is occurring.
- *Exotic flora.* The presence of exotic flora species and their likely impacts on the viability of natural communities.
- *Fragmentation.* The degree to which the original natural vegetation has been broken into small patches isolated from other such patches and/or large undisturbed areas.
- *Overall degradation.* An overall level of degradation (nil, low, moderate, high, completely alienated) is assessed from the degree of disturbance and weed invasion.
- *Resilience.* An assessment is made of the likely ability of the area to naturally regenerate its native vegetation cover, either partially or fully, if degrading influences are removed.

4 RESULTS AND DISCUSSION

4.1 VEGETATION COMMUNITIES

The survey revealed the presence on the wider Study area of nine vegetation communities (Table 7). The distribution of each community is shown on Figure 3. Not all vegetation communities in the Study area occur on the Modification area. In particular, Communities 6 (Southern Hunter Escarpment Spotted Gum woodland), 7 (Slaty Box – Grey Gum shrubby woodland) and 8 (Native Olive – Scrub Wilga woodland) in Table 7 are outside the Modification area (Figure 3).

Table 7
Vegetation Communities Recognised within the Study Area

Community Number (this report)	PCT	Common Names	Scientific Names
1	HU598	River Oak riparian woodland	<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>
2	HU544	Forest Red Gum – Grey Gum dry open forest	<i>Eucalyptus tereticornis</i> , <i>E. punctata</i> , <i>E. crebra</i>
3	HU551	Grey Box – Narrow-leaved Ironbark shrubby woodland	<i>E. moluccana</i> , <i>E. crebra</i> , <i>Angophora floribunda</i> , <i>Allocasuarina luehmannii</i>
4	HU564	<i>Melaleuca decora</i> low forest	<i>Melaleuca decora</i> , <i>E. crebra</i>
5	HU668	Bulloak Forests of the Central Hunter Valley.	<i>A. luehmannii</i> , <i>E. moluccana</i> , <i>E. crebra</i> , <i>A. floribunda</i>
6	HU556	Grey Ironbark – Spotted Gum – Grey Box open forest	<i>E. crebra</i> , <i>Corymbia maculata</i> , <i>E. moluccana</i>
7	HU618	Slaty Box – Grey Gum shrubby woodland	<i>E. dawsonii</i> , <i>E. punctata</i> , <i>E. moluccana</i> , <i>E. crebra</i>
8	NA ¹	Native Olive – Scrub Wilga shrubland	<i>Notelaea microcarpa</i> var. <i>microcarpa</i> , <i>Geijera salicifolia</i> var. <i>salicifolia</i>
9	HU670	Derived Grasslands in coastal valleys	<i>Aristida vagans</i> , <i>Microlaena stipoides</i> var. <i>stipoides</i> , <i>Themeda australis</i> , <i>Cymbopogon refractus</i>

¹ Not recognised in BioMetric (OEH, 2012)

The following sections provide descriptions of each plant community specific to the Study area using sample data collected in this study.

Community 1. River Oak riparian woodland

River Oak woodland is confined to the riparian zone and adjacent alluvial soils on the lower reaches of North Wambo Creek and Wambo Creek, where it forms a discontinuous strip along the creek owing to past clearing (Figure 3). Three rapid assessment samples and a random meander were conducted in this community due to its small representation on the Study area (Plate 1) and highly fragmented nature.



Plate 1. Community 1, River Sheoak within the incised parts of North Wambo Creek with fringing Forest Red Gum on the adjacent alluvial floodplain.

Community 1 is highly variable across its distribution in the Hunter Valley (Peake, 2006). While River Sheoak, *Casuarina cunninghamiana* subsp. *cunninghamiana*, is always the dominant mid storey species it may associate with a variety of other trees. On lower North Wambo Creek, the dominant upper canopy associate is Forest Red Gum, *Eucalyptus tereticornis*, with Rough-barked Apple, *Angophora floribunda* as a less common associate. Along Wambo Creek, Rough-barked Apple is the main associated tree species.

Most of the upper and mid storeys have been cleared historically from all but the sloping creek banks for grazing. Common remnant mid-storey species on lower North Wambo Creek include Cooba, *Acacia salicina*; Scrub Wilga, *Geijera salicifolia*, and Bulloak, *Allocasuarina luehmannii*. The low native shrub Small-leaf Bluebush, *Maireana microphylla*, is also present.

The most common native ground cover species included Pennywort, *Hydrocotyle tripartita*; Stinging Nettle, *Urtica incisa*; Slender Bamboo Grass, *Austrostipa verticillata*; Red Grass, *Bothriochloa decipiens*; Couch, *Cynodon dactylon* and Slender Rat's Tail Grass, *Sporobolus creber*.

The understorey of Community 1 tends to be dominated by introduced species. These included trees; Pepper Tree, *Schinus areira*; shrubs including Common Olive, *Olea europaea* and African Boxthorn, *Lycium ferocissimum*. Common introduced herbs and grasses are Galenia, *Galenia pubescens*; Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus*; Spear Thistle, *Cirsium vulgare*; Fireweed, *Senecio madagascariensis*; Common Sowthistle, *Sonchus oleraceus*; Common Chickweed, *Stellaria media*; Red-flowered Mallow, *Modiola caroliniana*; Scarlet Pimpernel, *Anagallis arvensis*; Lamb's Tongue, *Plantago lanceolata*; a Purpletop, *Verbena caracasana*; Sharp Rush, *Juncus acutus* and Rhodes Grass, *Chloris gayana*.

Community 2. Forest Red Gum – Grey Gum dry open forest

Remnants of Community 2 occur along the course of Stony Creek in the south of the Study area and in the north-east corner near the confluence of North Wambo Creek and Wollombi Brook (Figure 3). This community was sampled by two quadrats, four rapid assessment samples and two random meanders. The community is characterised by an overstorey dominated by Forest Red Gum, *Eucalyptus tereticornis* (Plate 2). The most common associate of Forest Red Gum along Stony Creek is Rough-barked Apple, *Angophora floribunda*, while Coast Grey Box, *Eucalyptus moluccana* is a less common associate.

The most frequent tall shrubs include Cooba, *Acacia salicina*, White Cedar, *Melia azedarach*; Native Olive, *Notelaea microcarpa* var. *microcarpa* and Scrub Wilga, *Geijera salicifolia* var. *salicifolia*. Small leaf Bluebush, *Maireana microphylla*, is a common native low shrub, while *Bertya oleifolia* and Native Rosella, *Hibiscus heterophyllus* subsp. *heterophyllus* are occasional.

Common native ground cover species include Common Everlasting, *Chrysocephalum apiculatum*; Carrot Weed, *Cotula australis*; Red Berry Saltbush, *Einadia hastata*; Slender Tick-trefoil, *Desmodium varians*; a Glycine, *Glycine tabacina*; Slender Flat-sedge, *Cyperus gracilis*; Speargrass, *Austrostipa scabra*; Slender Bamboo Grass, *Austrostipa verticillata*; Brown's Lovegrass, *Eragrostis brownii* and Weeping Grass, *Microlaena stipoides*.

Introduced species are common and include Galenia, *Galenia pubescens*; Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus*; Spear Thistle, *Cirsium vulgare*; Tall Fleabane, *Conyza sumatrensis*; Smooth Catsear, *Hypochaeris glabra*; Fireweed, *Senecio madagascariensis*; Stinking Roger, *Tagetes minuta*; Common Chickweed, *Stellaria media*; Paddy's Lucerne, *Sida rhombifolia*; Scarlet Pimpernel, *Anagallis arvensis*; Lamb's Tongue, *Plantago lanceolata*; Black-berry Nightshade, *Solanum nigrum*; Stinging Nettle, *Urtica incisa*; Purpletop, *Verbena caracasana* and Pale Pigeon Grass, *Setaria pumila*.



Plate 2. Community 2, Forest Red Gum – Grey Gum dry open forest (Quadrat 2).

Community 3. Grey Box – Narrow-leaved Ironbark shrubby woodland

Grey Box – Narrow-leaved Ironbark shrubby woodland is the most widespread community on the Study area (Plate 3, Figure 3). It is dominated by Narrow-leaved Ironbark, *Eucalyptus crebra* and Coast Grey Box, *Eucalyptus moluccana*. Low trees include mainly Bulloak, *Allocasuarina luehmannii*; White Feather Honeymyrtle, *Melaleuca decora* and Cooba, *Acacia salicina*.

The most prominent tall shrub species is Native Olive, *Notelaea microcarpa* var. *microcarpa*. Low shrubs are relatively diverse and include Cunningham's Everlasting, *Cassinia cunninghamii*; Small-leaf Bluebush, *Maireana microphylla*; Broom Bitter-pea, *Daviesia genistifolia*; Fan Wattle, *Acacia amblygona* and Western Boobialla, *Myoporum montanum* among others.

The ground cover in this community tends to be sparse but relatively diverse. The dominant native ground cover species are Poison Rock Fern, *Cheilanthes sieberi*; Purple Burr-daisy, *Calotis cuneifolia*; Yellow Burr-daisy, *Calotis lappulacea*; Common Everlasting, *Chrysocephalum apiculatum*; Cobbler's Tack, *Glossocardia bidens*; Vernonia, *Vernonia cinerea*; Fuzzweed, *Vittadinia cuneata* var. *hirsuta*; Climbing Saltbush, *Einadia nutans* subsp. *linifolia*; Kidney Weed, *Dichondra repens*; Slender Tick-trefoil, *Desmodium varians*; a Glycine, *Glycine tabacina*; Round-leaf Goodenia, *Goodenia rotundifolia*; Amulla, *Eremophila debilis*; Trailing Speedwell, *Veronica plebeia*; Slender Flat-sedge, *Cyperus gracilis*; Wattle Mat-rush, *Lomandra filiformis* subsp. *filiformis*; Many-flowered Mat-rush, *Lomandra multiflora*; Purple Wire-grass, *Aristida personata*; Three-awn Speargrass, *Aristida vagans*; a Wallaby Grass, *Rytidosperma fulvum*; Speargrass, *Austrostipa scabra*; Red Grass, *Bothriochloa decipiens*; Plump Windmill Grass, *Chloris ventricosa*; Hairy Panic, *Panicum effusum* and Slender Rat's Tail Grass, *Sporobolus creber*.

Introduced species are much less frequent in Community 3 than in Communities 1 and 2 owing to drier conditions and less fertile soils. The main species include Fireweed, *Senecio madagascariensis*; the Peppercress, *Lepidium africanum*; Creeping Pear, *Opuntia humifusa*; Common Prickly Pear, *Opuntia stricta* and African Lovegrass, *Eragrostis curvula*.



Plate 3. Community 3, Grey Box – Narrow-leaved Ironbark shrubby woodland (Quadrat 6).

Community 4. *Melaleuca decora* low forest

Within the Modification area Community 4 is confined to a small area adjacent to the south and east sides of the centrally placed water storage facility (known as Wambo South Water Dam) and a small area to the west of the Modification (Figure 3). The community was sampled by one quadrat and one random meander only. This community is dominated by White Feather Honeymyrtle, *Melaleuca decora*, which forms continuous stands in areas of impeded drainage, or where there are springs and soaks that remain moist for long periods (Plate 4). There may be emergent trees of Narrow-leaved Ironbark, *Eucalyptus crebra* and/or Forest Red Gum, *Eucalyptus tereticornis*. The community is characterised by a range of species that tolerate moist conditions, especially various rushes and sedges, but is also strongly influenced by the surrounding vegetation and may have many understorey species in common with adjacent communities (Peake 2006).

Other low trees or tall shrubs occurring in Community 3 were Sickie Wattle, *Acacia falcata*; Western Boobialla, *Myoporum montanum* and Scrub Wilga, *Geijera salicifolia* var. *salicifolia*. The main low shrubs included Small-leaf Bluebush, *Maireana microphylla*; Straggly Lantern-bush, *Abutilon oxycarpum* and Spiked Sida, *Sida subspicata*.

The dominant ground cover species were Bristly Cloak Fern, *Cheilanthes distans*; Carrot Weed, *Cotula australis*; Star Cudweed, *Euchiton involucratus*; Kidney Weed, *Dichondra repens*; a Glycine, *Glycine tabacina*; Slender Flat-sedge, *Cyperus gracilis*; Purple Wire-grass, *Aristida personata*; Red Grass, *Bothriochloa decipiens*; Plump Windmill Grass, *Chloris ventricosa*; Paddock Lovegrass, *Eragrostis leptostachya*; Weeping Lovegrass, *Eragrostis parviflora* and Slender Rat's Tail grass, *Sporobolus creber*.

Introduced species were more frequent than in the drier communities and included Galenia, *Galenia pubescens*; Flaxleaf Fleabane, *Conyza bonariensis*; Smooth Catsear, *Hypochaeris glabra*; Fireweed, *Senecio madagascariensis*; a Peppergrass, *Lepidium bonariense*; Red-flowered Mallow, *Modiola caroliniana*; Paddy's Lucerne, *Sida rhombifolia* and Lamb's Tongue, *Plantago lanceolata*.



Plate 4. Community 4, *Melaleuca decora* low forest (Quadrat 4).

Community 5. Bulloak Forests of the Central Hunter Valley

Community 5 is a secondary community resulting from the regeneration and/or recolonisation of cleared areas formerly occupied by Community 3. This community comprises dense monospecific stands of Bulloak, *Allocasuarina luehmannii* (Plate 5) which tend to project heavy shade on the ground, thereby excluding most other species. On the Study area, Community 5 lacks other emergent tall or low tree species, or tall shrubs. This vegetation type is limited to several small patches in the north of the Study area (Figure 3). Two quadrats were undertaken in this community (Table 6).

Low shrubs tend to be a minor component of the community except where openings occur in the dense canopy. The main low shrub recorded was Broom Bitter-pea, *Daviesia genistifolia*. The ground cover is sparse due to heavy shading by the Bulloak and the relatively poor soils on which this community occurs. Ground cover species include many characteristic of Community 3; Poison Rock Fern, *Cheilanthes sieberi*; the Yellow Burr-daisy, *Calotis lappulacea*; Common Everlasting, *Chrysocephalum apiculatum*; Red Berry Saltbush, *Einadia hastata*; Climbing Saltbush, *Einadia nutans* subsp. *nutans*; Australian Stonecrop, *Crassula sieberiana*; Caustic Weed, *Chamaesyce drummondii*; Threeawn Speargrass, *Aristida vagans*; Plump Windmill Grass, *Chloris ventricosa*; Barbwire Grass, *Cymbopogon refractus*; Curly Windmill Grass, *Enteropogon acicularis*; Clustered Lovegrass, *Eragrostis elongata*; Hairy Panic, *Panicum effusum* and Fine Panic, *Paspalidium criniforme*.



Plate 5. Community 5, Bulloak Forest (Quadrat 3).

Due to its poor soils this community has few introduced species including; Fireweed, *Senecio madagascariensis*, Creeping Pear, *Opuntia humifusa*, Catsear, *Hypochaeris radicata* and Pale Pigeon Grass, *Setaria pumila*.

Community 6. Grey Ironbark – Spotted Gum – Grey Box open forest

Community 6 is confined to small occurrences outside the Modification area, mainly on the footslopes of the escarpment (Figure 3). One quadrat and one random meander were conducted in Community 6 (Table 6). This community is characterised and dominated by Spotted Gum, *Corymbia maculata*, often with smaller amounts of other canopy species, particularly Grey (Narrow-leaved) Ironbark, *Eucalyptus crebra* (Plate 6).

Low trees or tall shrubs are often also present including Native Cherry, *Exocarpos cupressiformis*; Scrub Wilga, *Geijera salicifolia* var. *salicifolia*; Blackthorn, *Bursaria spinosa*; Winged Broom-pea, *Jacksonia scoparia*; Shiny-leaved Canthium, *Psydrax odorata*; *Choretrum* species A and Wedge-leaf Hop-bush, *Dodonaea viscosa* subsp. *cuneata*. Low shrubs included Cunningham's Everlasting, *Cassinia cunninghamii*; Sticky Daisy-bush, *Olearia elliptica*; Hoary Guinea Flower, *Hibbertia obtusifolia*; Large Tick-trefoil, *Desmodium brachypodum*; Fan Wattle, *Acacia amblygona*; Bead Bush, *Spartothamnella juncea* and Amulla, *Eremophila debilis*.

The ground cover tends to be sparse in Community 6 and includes Bristly Cloak Fern, *Cheilanthes distans*; Poison Rock Fern, *Cheilanthes sieberi*; Kidney Weed, *Dichondra repens*; the Slender Tick-trefoils, *Desmodium gunnii* and *D. varians*; Round-leaf Goodenia, *Goodenia rotundifolia*; Small Vanilla Lily, *Arthropodium minus*; the Wattle Mat-rushes, *Lomandra filiformis* subsp. *coriacea* and *L. filiformis* subsp. *filiformis*; Barbwire Grass, *Cymbopogon refractus* and Long-leaved Wallaby Grass, *Rytidosperma longifolium*.

Introduced species are generally uncommon; Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus*; Fireweed, *Senecio madascariensis* and Common Prickly Pear, *Opuntia stricta* were recorded.



Plate 6. Community 6, Grey Ironbark – Spotted Gum – Grey Box open forest (Quadrat 8).

Community 7. Slaty Box – Grey Gum shrubby woodland

Community 7 is dominated by Slaty Box, *Eucalyptus dawsonii*, a tall straight tree that may form extensive monospecific stands, although usually having Narrow-leaved Ironbark, *Eucalyptus crebra*, as a less common associate (Plate 7). Community 7 occurs extensively in the southern half of the Study area on the footslopes of the Narrabeen Sandstone escarpment (Figure 3), although not found on the Modification area. It was sampled by two quadrats, one spot sample and one random meander (Table 6).



Plate 7. Community 7, Slaty Box – Grey Gum shrubby woodland (Quadrat 5).

Low trees and tall shrubs most commonly included Kurrajong, *Brachychiton populneus* and Native Olive, *Notelaea microcarpa* var. *microcarpa*. Community 7 often has dense stands of medium height shrubs (1 to 3 m approximately) comprising various combinations of Blackthorn, *Bursaria spinosa*; White Sour Bush, *Choretrum* species A and Hop-bushes, *Dodonaea viscosa* subsp. *cuneata*, *Dodonaea viscosa* subsp. *spatulata* and *D. sinuolata* subsp. *sinuolata*.

Low shrubs are also common and diverse, including Sticky Daisy-bush, *Olearia elliptica*; Cunningham's Everlasting, *Cassinia cunninghamii*; Rice Flower, *Ozothamnus diosmifolius*; Narrow-leaved Orangebark, *Maytenus silvestris*; Large Tick-trefoil, *Desmodium brachypodium*; Fan Wattle, *Acacia amblygona*; Spiked Sida, *Sida subspicata*; Amulla, *Eremophila debilis* and Violet Nightshade, *Solanum brownii*.

The ground cover in this community is generally quite open with bare ground and leaf litter predominant. The main herbaceous species include Bristly Cloak Fern, *Cheilanthes distans*; Poison Rock Fern, *Cheilanthes sieberi*; Blue Trumpet, *Brunoniella australis*; Pink Tongues, *Rostellularia adscendens* var. *adscendens*; Yellow Burr-daisy, *Calotis lappulacea*; Cobbler's Tack, *Glossocardia bidens*; Climbing Saltbush, *Einadia nutans* subsp. *linifolia*; Kidney Weed, *Dichondra repens*; Variable Glycine, *Glycine tabacina*; Round-leaf Goodenia, *Goodenia rotundifolia* and Corrugated Sida, *Sida corrugata*.

A variety of sedges, mat-rushes, lilies and grasses are also sparsely distributed, including Slender Flat-sedge, *Cyperus gracilis*; Wattle Mat-rush, *Lomandra filiformis* subsp. *filiformis*; Purple Wiregrass, *Aristida personata*; Speargrass, *Austrostipa scabra* subsp. *falcata*; Plump Windmill Grass, *Chloris ventricosa*; Barbwire Grass, *Cymbopogon refractus*; Paddock Lovegrass, *Eragrostis leptostachya*; Weeping Grass, *Microlaena stipoides*; Hairy Panic, *Panicum effusum* and Slender Rat's Tail grass, *Sporobolus creber*.

Introduced species are uncommon in Community 7. The most prominent are Narrow-leaved Cotton Bush, *Gomphocarpus fruticosus*; Fireweed, *Senecio madagascariensis*; Common Sowthistle, *Sonchus oleraceus* and Common Prickly Pear, *Opuntia stricta*.

Community 8. Native Olive – Scrub Wilga woodland

A small patch of Community 8 occurs in the extreme south-west of the Study area outside the Modification area (Figure 3). Native Olive – Scrub Wilga Woodland was not identified as a separate vegetation type by Peake (2006) or in the BioMetric database (OEH, 2012). However, Story *et al.* (1963), Orchid Research (2003) and FloraSearch (2011) consider it to be a distinct vegetation association along the footslopes of the southern escarpment of the Hunter Valley. FloraSearch (2011) noted that Native Olive – Scrub Wilga Woodland appears to be associated with the Benjang Soil Landscape of Kovac and Lawrie (1991). FloraSearch also noted that extant occurrences of this vegetation association may be a derived community following clearing of the distinctive 'hill form' of 'Central Hunter Box – Ironbark Woodland' that occurs on the Benjang Soil Landscape. The small occurrence of this community on the margins of the Study area was not sampled during this study. Its occurrence was mapped by Orchid Research (2003) and refined by air photo interpretation for Figure 3. A full description of the community on WCPL-owned land is given in FloraSearch (2011). Community 8 would not be impacted by the Modification.

Community 9. Derived Grasslands in coastal valleys

Much of the lower lying and flatter parts of the Study area and the Modification area comprise cleared grazing paddocks (Plate 8; Figure 3). North of Stony Creek in the Modification area, the paddocks are predominantly native grasslands with varying proportions of introduced pasture and weed species. South of Stony Creek outside the Modification area, the paddocks comprise mainly improved pastures dominated by exotic pasture and weed species. Two quadrat samples and three spot samples were conducted in the pastures north of Stony Creek. Two spot samples were conducted to the south of Stony Creek (Table 6).

Some 19 species of grasses were recorded in the paddocks, 16 of which are native and three introduced (Appendix B). The dominant native species are Red Grass, *Bothriochloa decipiens*; Slender Rat's Tail Grass, *Sporobolus creber*; Slender Bamboo Grass, *Austrostipa verticillata*; Hairy Panic, *Panicum effusum*; Purple Wire Grass, *Aristida personata*; Barbwire Grass, *Cymbopogon refractus*; Weeping Grass, *Microlaena stipoides* and Couch, *Cynodon dactylon*. The main introduced grasses are Paspalum, *Paspalum dilatatum* and Pale Pigeon Grass, *Setaria pumila*.

A few scattered native herbs and others have persisted in the paddocks, despite a long history of grazing, including mainly Common Everlasting, *Chrysocephalum apiculatum*; Blue Trumpet, *Brunoniella australis*; Amulla, *Eremophila debilis*; Cobbler's Tack, *Glossocardia bidens*; Poison rock Fern, *Cheilanthes sieberi*; Whiteroot, *Pratia purpurascens*; Kidney Weed, *Dichondra repens* and Small-leaf Bluebush, *Maireana microphylla*.

The paddocks are greatly dominated by introduced herbs including Slender Celery, *Cyclospermum leptophyllum*; Spear Thistle, *Cirsium vulgare*; Flaxleaf Fleabane, *Conyza bonariensis*; Stinking Roger, *Facelis retusa*; Cudweed, *Gamochaeta americana*; Smooth Catsear, *Hypochaeris radicata*; Fireweed, *Senecio madagascariensis*; Mouse-ear Chickweed, *Cerastium glomeratum*; Proliferous Pink, *Petrorhagia nanteuillii*; seven clover species, *Trifolium* spp.; Paddy's Lucerne, *Sida rhombifolia*; Scarlet Pimpernel, *Anagallis arvensis*; Lamb's Tongue, *Plantago lanceolata* and Onion Grass, *Romulea rosea*.



Plate 8. Community 9, Derived Grassland.

4.2 FLORA SPECIES

A total of 273 plant species was identified by the quadrat plots, spot samples, random meanders and in general movement around the Study area (Table 8). Of these, 190 (69.6%) are native to the natural communities of the Study area and 83 (30.4%) are introduced. The numbers of species found in each community generally varied according to the sampling intensity (Table 8), except for Community 9, secondary native grassland, which had relatively few species, and a very small marginal area of Community 8 (Figure 3), which was not sampled by this Study. The largest number of species was found in Communities 2 and 7, with 127 and 107 species, respectively.

The plant families with the highest numbers of species (Appendix B) were the Daisies, Asteraceae (46 species); Grasses, Poaceae (44 species); Pea Flowers, subfamily Faboideae (17 species); the Saltbushes and Bluebushes, Chenopodiaceae (10 taxa); the Wattles, subfamily Mimosoideae (10 species) and the Eucalypts and related genera in the family Myrtaceae (8 species). In all, some 64 plant families or sub-families were represented.

**Table 8
Numbers and Percentages of Native and Introduced Vascular Plant Species
Identified in the Vegetation Communities within the Study Area**

Community	Number of Samples	Total Plant Species	Number of Native Species	% of Native Species	Number of Introduced Species	% Introduced Species
1	4	79	40	50.6	39	49.4
2	7	127	87	68.5	40	31.5
3	6	99	88	88.9	11	11.1
4	2	63	46	73.0	17	27.0
5	2	60	50	83.3	10	16.7
6	2	50	45	90.0	5	10.0
7	4	107	96	89.7	11	10.3
8	0	-	-	-	-	-
9	7	72	33	45.8	39	54.2
Total	34	273	190	69.6	83	30.4

4.3 INTRODUCED SPECIES AND WEEDS

The number of introduced species is relatively high (83; 30.4%), largely because much of the Study area is cleared or semi-cleared farmland used for grazing livestock (Table 8). The highest proportion of introduced species (49.4%) was found in the grazing paddocks (Community 9). High proportions of introduced species (31.5%) also comprised Community 1, Hunter Valley River Oak Forest, which occurs in moist fertile soils along North Wambo, Wambo and Stony Creeks. Relatively high proportions of exotic species also occurred in Communities 2 and 4, 31.5% and 27.0%, respectively, owing to the relatively higher soil fertility and moisture status of these communities. As would be expected, the lowest percentages of introduced species were recorded in the less disturbed habitats on poorer, drier soils; viz., Community 3 (11.1%), Community 5 (16.7%) and Communities 6 and 7 (10.0% and 10.3%, respectively). Apart from Prickly Pear, *Opuntia stricta* var. *stricta*, which was scattered throughout the bushland areas, and to a lesser extent Fireweed, *Senecio madagascariensis*, most other weeds were confined to tracks and other disturbances.

Six introduced species recorded in this survey are regarded as noxious weeds in the Upper Hunter County Council area, Green Cestrum, *Cestrum parqui* (class 3)¹, African Boxthorn, *Lycium ferocissimum* (class 3), the Prickly Pears, *Opuntia* spp. (class 4)², Silver-leaf Nightshade, *Solanum elaeagnifolium* (class 4), Fireweed (class 4) and Mexican Poppy, *Argemone ochroleuca* subsp. *ochroleuca* (class 5)³. However, none was abundant anywhere within the Study area, although Fireweed and Prickly Pear are widespread (Appendix B). Fireweed, African Boxthorn, *Opuntia* spp. and Silver-leaf Nightshade are also Weeds of National Significance (Australian Weeds Committee, 2014).

4.4 THREATENED FLORA SPECIES

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

4.5 ENDANGERED POPULATIONS

No evidence was found by the flora surveys on the Study area of the *Eucalyptus camaldulensis* population in the Hunter Catchment; or the *Cymbidium canaliculatum* population in the Hunter Catchment EPs. However, three patches of Hunter Valley Weeping Myall, *Acacia pendula* (Figure 3) were found. Two of the patches (one comprising two trees and associated grazed suckers, and one comprising five small trees and associated grazed suckers) lie above Longwall 10A in the north of the Modification area. These patches constitute part of the 'Acacia pendula population in the Hunter Catchment EP'.

4.6 THREATENED ECOLOGICAL COMMUNITIES

Three threatened ecological communities listed in the schedules of the TSC Act were identified by the survey on the wider Study area, viz.:

- 1 Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC;
- 2 Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC; and

¹ The plant must be fully and continuously suppressed and destroyed.

² The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.

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

3 *Hunter Valley Footslopes Slaty Box Woodland in the Sydney Basin Bioregion VEC.*

The Hunter Lowland Redgum Forest EEC is equivalent to Map Unit 24 of Peake (2006), Community 2 of this Study and PCT HU544 (Forest Red Gum – Grey Gum dry open forest) (OEH, 2012). This community occurs on the Modification area (Figure 3).

The Central Hunter Grey Box – Ironbark Woodland EEC is equivalent to Map Unit 10 of Peake (2006), Community 3 of this Study and PCT HU551 (Grey Box – Narrow-leaved Ironbark shrubby woodland) (OEH, 2012). This community occurs on the Modification area (Figure 3).

The Hunter Valley Footslopes Slaty Box Woodland VEC is equivalent to Map Unit 7 of Peake (2006), Community 7 of this Study and PCT HU618 (Slaty Box- Grey Gum shrubby woodland) (OEH, 2012). This community does not occur on the Modification area (Figure 3).

No threatened ecological communities listed under the EPBC Act occur on the Modification area.

Is Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion EEC (TSC Act) or Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC (EPBC Act) present on the Study Area?

The presence of three patches of Hunter Valley Weeping Myall (*Acacia pendula*) on the Study area raises the question of whether either of the NSW or Commonwealth listed endangered or critically endangered communities based on Hunter Valley Weeping Myall is present. This section compares the occurrences on the Study area with the descriptions and identification guidelines of the threatened communities to determine whether either is present on the Study area. The three patches of Hunter Valley Weeping Myall are referred to below as the northern, central and southern patches (mapped as *Acacia pendula* in Figure 3).

Description of Study Area Occurrences

Hunter Valley Weeping Myall occurs on the Study area in a paddock that has likely been grazed by livestock for almost 200 years and was probably cleared for much of that time. The patches occur near areas of native woodland regeneration comprising Communities 3 (Grey Box – Narrow-leaved Ironbark shrubby woodland) and 5 (Bullock Forest).

The Hunter Valley Weeping Myall trees tend to occur in tight clumps (Plates 9 and 10) reflecting the root-suckering mode of vegetative reproduction in this form of the species (Bell, 2006). The three patches have no closely associated tree or shrub species and the ground cover comprises native grasses and forbs typical of the derived grassland paddock in which they occur.

The northern patch, which is just outside the Modification area, is the largest, comprising four main groups of large trees and several more isolated trees (Plate 9). Trees in this patch are up to 10 m high, but several fallen stems indicate trees up to 16 m high with trunk diameters up to 25 cm were formerly present. The centre patch encompasses two well separated trees 5 to 6 m high and numerous small heavily grazed root suckers surrounding them. The southern patch comprises a clump of five small trees (Plate 10) with four small severely grazed outliers nearby.



**Plate 9. Hunter Valley Weeping Myall. Part of the northern patch.
Another group is behind on the right.**



Plate 10. Hunter Valley Weeping Myall. Southern patch.

There has been much discussion regarding the relationships between the three Hunter Valley Weeping Myall Woodland protected entities (Umwelt, 2006; Bell, 2007; OEH, 2013), viz.:

- *Acacia pendula* in the Hunter Catchment EP (TSC Act);
- Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC (TSC Act); and
- Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley CEEC (EPBC Act).

There is no doubt that the three patches on the Study area comprise part of the EP (NSW Scientific Committee, 2005a). Similarly, there is no doubt that the occurrences on the Study area are not covered by the EPBC Act CEEC listing, which specifically encompasses only the occurrence at Jerrys Plains cemetery (Threatened Species Scientific Committee, 2005).

The following discussion considers whether the Study area occurrences meet the NSW Scientific Committee's definition of the EEC in the Final Determination (NSW Scientific Committee, 2005b). Ecological communities are defined by the presence of a characteristic set of species. These species are usually not all present at every site, rather they are a set of species that commonly occur with each other on good quality sites representative of a particular community. It should be noted that not all occurrences of Hunter Valley Weeping Myall indicate the EEC is present, or was formerly present, on a given site, since *Acacia pendula* may also occur as an understorey species in other communities, including Grey Box – Narrow-leaved Ironbark shrubby woodland and Slaty Box – Grey Box shrubby woodland (Peake, 2006). Accordingly, the ecological setting in which *Acacia pendula* occurs is critical for deciding whether or not the EEC is present.

The Final Determination for the EEC lists 17 flora species characteristic of the community (NSW Scientific Committee, 2005b), of which one is a tree, Narrow-leaved Ironbark, 11 are shrubs or scramblers and five are grasses or herbs. Only the tree, one shrub (*Maireana microphylla*) and two herbs (*Chrysocephalum apiculatum* and *Einadia nutans*) were observed in association with the Study area occurrences. These species are also common in Grey Box – Narrow-leaved Ironbark woodland, which occurs close to the occurrences and most likely formerly covered much, if not all, of the paddock where Hunter Valley Weeping Myall occurs. Therefore, it is difficult to determine whether the Hunter Valley Weeping Myall occurrences on the Study area represent surviving relics of former Hunter Valley Weeping Myall Woodland EEC or are simply surviving understorey components of former Grey Box – Narrow-leaved Ironbark woodland. However, the absence of nearly all characteristic species of the EEC suggests the latter is most likely. Despite the low likelihood that the Hunter Valley Weeping Myall remnants on the Study area represent the EEC, this report assumes conservatively (for the purpose of assessment) that the EEC is present.

5 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; wildfires, the most recent being in 1994, and mining.

The most alienated parts of the Study area are the flat valley floor and gentle lower slopes in the valleys of North Wambo Creek and Stony Creek, which have been almost completely cleared of their original native tree and shrub cover. This cleared land has been used mainly for grazing in recent decades, but may have been cropped historically. The cleared grazing paddocks north of Stony Creek, including the Modification area (Figure 3), are currently secondary native grassland with a predominance of native grass species. Scattered regeneration of Bulloak and Weeping Myall is starting to occur in the northernmost paddock in the Modification area. The remaining paddocks show no evidence of native tree or shrub regeneration.

South of Stony Creek, the cleared pastures are dominated by a wide variety of introduced pasture species and weeds. 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 bushland, although a proportion of the original species are likely to have been lost completely. The biodiversity value and resilience of most of the cleared pastures is considered to be low.

The vegetation within the incised watercourses of North Wambo Creek, Wambo Creek and Stony Creek comprises a mix of native and introduced species. The tree cover has been considerably thinned into disjunct patches and scattered individuals, especially along Stony Creek. Dense regeneration of River Oak has occurred on parts of North Wambo Creek within the Modification area. Some introduced tree species have also become established, although they are not dominant. The ground cover vegetation has high proportions of introduced species owing to the moist conditions and fertile alluvial soils. Overall, the riparian vegetation on the Study area is considered to be in poor condition.

Adjacent to the lowlands of North Wambo Creek and Stony Creek is steeper partially cleared land on the footslopes and ridges of the Narrabeen Sandstone escarpment. These areas have been semi-cleared and logged historically and have been used mainly for grazing. The tree cover is predominantly regeneration approximately 30 or more years old with occasional scattered old growth trees. These wooded areas tend to occupy poorer soils, and are dominated by native species in all canopy layers. There is a high diversity of the original flora and low numbers and biomass of introduced species. These sites are considered to have retained most of their ecological resilience with a high capacity for regeneration. They are assessed to be in moderate to good condition.

In summary, the Modification area is dominated by cleared grazing paddocks comprising derived native grasslands. Highly disturbed remnant native vegetation occurs along Wambo Creek, Stony Creek and North Wambo Creek. Small patches of highly disturbed, regenerating native vegetation remnants occur in the north of the Modification area. The condition of the vegetation on the Modification area varies from poor to moderate.

6 POTENTIAL IMPACTS ON FLORA

6.1 POTENTIAL IMPACTS OF MODIFICATION SURFACE ACTIVITIES ON FLORA

Vehicular movements (outside the open cut) would be limited to those required for monitoring and general site maintenance activities. There is no surface infrastructure required for the Modification.

6.2 VEGETATION CLEARANCE

Clearing of native vegetation is listed as a Key Threatening Process (KTP) under both the TSC Act (OEH, 2014e) and the EPBC Act (DotE, 2014d). The underground mining methods to be employed on the Modification area avoid the need for vegetation clearance on the surface. The lack of vegetation clearance also avoids any impact on habitat connectivity and the lack of soil disturbance avoids potential problems with dust generation and reduces the potential for weed invasion.

6.3 POTENTIAL IMPACTS OF SUBSIDENCE ON FLORA

Alteration of habitat following subsidence due to longwall mining is listed as a KTP under the TSC Act (OEH, 2014e). Mine subsidence effects on the surface of the immediate Modification area are expected to vary slightly according to the depth of cover above the coal seam (MSEC, 2014). Surface cracking of soils may potentially occur over most parts of the Modification area which is relatively flat such that depth of cover does not change greatly across the site (MSEC, 2014).

Inspection of previously undermined areas to the west of the Modification area showed that surface cracking of the soil was relatively frequent on low flat areas supporting Grey Box – Narrow-leaved Ironbark shrubby woodland (Plates 11 to 14). The condition of the vegetation on the undermined area was not noticeably different from that on adjacent similar unmined areas. Tree health in the Grey Box – Narrow-leaved Ironbark shrubby woodland was good with no signs of dieback. The naturally sparse shrub and ground layers were likewise in good health (Plates 15 to 17). Similarly, areas of *Melaleuca decora* low forest also showed no signs of decline (Plate 18). The latter community might be expected to be susceptible to water loss through soil cracking, since it occurs on sites that remain wet for long periods in the winter months.

In addition, no scientific evidence of adverse surface effects on vegetation due to soil cracking induced by subsidence has been reported in the scientific literature from underground mining anywhere in Australia. Consequently, it is unlikely that EECs would be adversely affected by mine subsidence.

6.4 CUMULATIVE IMPACTS ON FLORA

By contrast with open cut mining methods which potentially have large impacts on native vegetation because of the need to remove the overburden above the ore body, underground mining is relatively benign. The avoidance of vegetation clearance for this Project means that it will not add to the cumulative vegetation losses resulting from extensive open cut coal mining in the south-western parts of the Hunter Valley.



Plate 11. Typical soil cracking.



Plate 12. Typical soil cracking.



Plate 13. Typical soil cracking.



Plate 14. Typical soil cracking.



Plate 15. Undermined Grey Box – Narrow-leaved Ironbark woodland.



Plate 16. Undermined Grey Box – Narrow-leaved Ironbark woodland.



Plate 17. Undermined Grey Box – Narrow-leaved Ironbark woodland.



Plate 18. Undermined *Melaleuca decora* low forest.

7 ASSESSMENT OF IMPACTS ON FLORA

The likelihood of the Modification significantly affecting threatened flora species, populations or ecological communities or their habitats listed under the TSC Act has been assessed in accordance with Part 3A of the NSW *Environmental Planning and Assessment Act, 1979* and the relevant *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).

The following questions are considered in order to determine the likelihood of a significant impact (DEC and DPI, 2005):

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
4. How is the proposal likely to affect current disturbance regimes?
5. How is the proposal likely to affect habitat connectivity?
6. How is the proposal likely to affect critical habitat?

7.1 THREATENED FLORA SPECIES

The flora survey targeted five threatened flora species for field searches (Table 3). Although listed as potentially occurring on the Study area in Table 3, Slaty Red Gum (*Eucalyptus glaucina*) is a large conspicuous species that would have been detected by the surveys if it was present. Similarly, the shrubs *Dillwynia tenuifolia* and *Pomaderris brunnea* would have been detected if they were present, given the small size of the Study area and the completeness of the search coverage. As these three conspicuous species were not recorded on the Study area they are not considered further.

The assessment in this section is confined to the Modification area and to the two remaining less conspicuous species, Wybong Leek Orchid, *Prasophyllum* sp. Wybong and the Illawarra Greenhood, *Pterostylis gibbosa*, both native terrestrial orchids, which are treated together below.

7.1.1 Assessment of Impact

1. How is the proposal likely to affect the lifecycle of a threatened species or population?

If the Illawarra Greenhood was present on the Modification area, it would most likely occur within the woodland remnants in the north. The Wybong Leek Orchid is a grassland/grassy woodland species and would most likely occur in areas of better quality native grassland, if it were to occur. The Project would not result in vegetation clearance in the remnant woodlands. A small area of derived grassland may be cleared in the unlikely event that it becomes necessary to establish a monitoring site. The likelihood of such clearing adversely impacting on the Wybong Leek Orchid is considered to be very low, given the lack of records of the species in the Modification area and surrounds, despite previous extensive surveys.

Soil cracking as a result of subsidence may adversely impact individuals of both species if they were to occur. For example, it is possible that the underground tubers of individual plants may be exposed by soil cracking and subsequently desiccate, resulting in plant death. However, this is an unlikely scenario, since cracks are widely spaced and unlikely to impact on more than a very small part of the population. Nor is the any plausible scenario in which subsidence could exert a significant adverse effect on pollinator populations.

It is concluded that the Project is unlikely to initiate or exacerbate any threatening processes that would significantly reduce the long term viability of populations of either the Wybong Leek Orchid or the Illawarra Greenhood, if they were to occur.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The underground mining methods to be employed by the Project avoid the need for surface disturbance in the Modification area. Should any minor surface disturbance be required, for monitoring sites for example, it would be undertaken in already cleared grazing paddocks. There would be no clearing of native vegetation (Section 6.2). However, the derived grasslands may represent potential habitat for the Wybong Leek Orchid. A very small area of derived grassland may be disturbed should it be necessary to establish a monitoring site above Longwall 10A. While this may result in the loss of a small amount of potential habitat for the Wybong Leek Orchid, it is unlikely to represent actual habitat given the lack of records of the species in the Study area and surrounds, despite intensive flora surveys.

In addition, subsidence impacts are unlikely to adversely affect surface habitats as demonstrated by the continued health of native vegetation on nearby undermined areas at similar depths of cover. Subsidence movements may affect the integrity of farm dams, requiring minor earth works to repair them. Farm dams are confined to cleared areas of grazing paddocks and earth works associated with dam repair would not affect remnant native vegetation, being within previously approved disturbance areas related to dam construction.

It is concluded that significant adverse impacts on threatened flora habitats are highly unlikely.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

If the Wybong Leek Orchid and the Illawarra Greenhood were to occur on the Modification area, both would be at their distributional limits. In the case of the Wybong Leek Orchid, it would be at its eastern distributional limit; currently it is not known east of Wybong which is approximately 50 km north-west of the Modification area. Similarly, the Illawarra Greenhood would be at the northern limit of its range; the nearest known population is at Milbrodale, approximately 12 km south of the Modification area. However, neither species has been found on the Modification area or surrounds despite numerous surveys.

4. How is the proposal likely to affect current disturbance regimes?

The proposal would not change any current surface land uses. The Modification area and surrounds are used for livestock grazing which would continue. The proposal is not expected to influence the frequency or severity of wildfires. Continued grazing of the area significantly mitigates fire risk and the presence of WCPL employees increases the likelihood of early detection and suppression of fires.

5. How is the proposal likely to affect habitat connectivity?

The proposal would not result in any clearance of native vegetation and therefore would not reduce habitat connectivity for the Wybong Leek Orchid or the Illawarra Greenhood.

6. How is the proposal likely to affect critical habitat?

No Critical Habitat for either the Wybong Leek Orchid or the Illawarra Greenhood has been declared under the TSC Act (OEH, 2014c) or the EPBC Act (DotE, 2014c) on the Study area or surrounds.

Conclusion

It is concluded that the Project is unlikely to significantly impact on the Wybong Leek Orchid or the Illawarra Greenhood, if they were to occur on the Modification area.

7.2 ENDANGERED POPULATIONS

The flora surveys revealed the presence of one EP on the Modification area, the *Acacia pendula in the Hunter Catchment EP*. The part of the EP on the Study area is described in Section 4.5.

7.2.1 Assessment of Impact

1. How is the proposal likely to affect the lifecycle of a threatened species or population?

The Project would not result in vegetation clearance anywhere in the Modification area. Neither of the two patches of *Acacia pendula* in the Modification area is threatened by vegetation clearance.

The *Acacia pendula in the Hunter Catchment EP* occurs in two locations on WCPL owned land; on the Modification area and approximately 2 km to the north-west of the Modification area. The north-western occurrence has been undermined by North Wambo Longwall 4 with no obvious detrimental effects on *Acacia pendula* (RPS in Wambo Coal, 2012). Longwall 10A is in the same coal seam at a similar depth below the surface. Accordingly, although there is potential for minor root damage caused by soil cracking, subsidence impacts are not expected to cause the deaths of any *Acacia pendula* plants.

It is concluded that the Project is unlikely to initiate or exacerbate any threatening processes that would reduce the long term viability of the part of the *Acacia pendula in the Hunter Catchment EP* that occurs on the Modification area.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The underground mining methods to be employed by the Project avoid the need for surface disturbance in the Modification area. Should any minor surface disturbance be required, for monitoring sites for example, it would be undertaken in already cleared grazing paddocks. There would be no clearing of native vegetation (Section 6.2), including *Acacia pendula*. In addition, subsidence impacts are unlikely to adversely affect surface trees and shrubs as demonstrated by the continued health of native trees and shrubs on nearby undermined areas at similar depths of cover.

Subsidence movements may affect the integrity of farm dams, requiring minor earth works to repair them. Farm dams are confined to cleared areas of grazing paddocks and earth works associated with dam repair would not affect remnant native vegetation.

There are not expected to be any significant adverse impacts on *Acacia pendula*.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The *Acacia pendula* occurrences on the Modification area are not at the known eastern limit of the species (BioNet, 2014), which is near Branxton, approximately 30 km east of the Modification area. Similarly, the southern limit of the species in the Hunter Valley is north-west of Broke (BioNet, 2014), approximately 12 km south-east of the Modification area.

4. How is the proposal likely to affect current disturbance regimes?

The proposal would not change any current surface land uses. The Modification area and surrounds are used for livestock grazing which would continue. The proposal is not expected to influence the frequency or severity of wildfires. Continued grazing of the area significantly mitigates fire risk and the presence of WCPL employees increases the likelihood of early detection and suppression of fires.

5. How is the proposal likely to affect habitat connectivity?

The proposal would not result in any clearance of native vegetation and therefore would not reduce habitat connectivity for *Acacia pendula*.

6. How is the proposal likely to affect critical habitat?

No Critical Habitat for *Acacia pendula* has been declared under the TSC Act (OEH, 2014c) or the EPBC Act (DotE, 2014c) on the Study area or surrounds.

Conclusion

It is concluded that the Project is unlikely to significantly impact on the *Acacia pendula* in the Hunter Catchment EP.

7.3 ENDANGERED ECOLOGICAL COMMUNITIES

Three EECs are considered to occur on the Modification area:

1. *Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions.*
2. *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions.*
3. *Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion (conservatively included – refer Section 4.6).*

The potential impact of the Modification on these communities is assessed below. Owing to the relatively flat topography of the Modification area, a similar risk of soil cracking occurs across the whole site and to all plant communities.

7.3.1 Assessment of Impact

1. *How is the proposal likely to affect the lifecycle of a threatened species and/or population?*

Not applicable.

2. *How is the proposal likely to affect the habitat of a threatened species, population or ecological community?*

The underground mining methods to be employed by the Project avoid the need for surface disturbance in the Modification area. Should any minor surface disturbance be required, for monitoring sites for example, it would be undertaken in already cleared grazing paddocks. There would be no clearing of native vegetation (Section 6.2), including the *Hunter Lowland Redgum Forest*, *Central Hunter Grey Box – Ironbark Woodland* and *Hunter Valley Weeping Myall Woodland* EECs. In addition, subsidence impacts are unlikely to adversely affect surface trees and shrubs as demonstrated by the continued health of native trees and shrubs on nearby undermined areas at similar depths of cover.

Subsidence movements may affect the integrity of farm dams, requiring minor earth works to repair them. Farm dams are confined to cleared areas of grazing paddocks and earth works associated with dam repair would not affect remnant native vegetation.

There are not expected to be any significant adverse impacts on *Hunter Lowland Redgum Forest*, *Central Hunter Grey Box – Ironbark Woodland* or *Hunter Valley Weeping Myall Woodland*.

3. *Does the proposal affect any threatened species or populations that are at the limit of its known distribution?*

The *Hunter Lowland Redgum Forest*, *Central Hunter Grey Box – Ironbark Woodland* or *Hunter Valley Weeping Myall Woodland* occurrences on the Modification area are not at the known limits of their distributions (BioNet, 2014; Peake, 2006).

4. *How is the proposal likely to affect current disturbance regimes?*

The proposal would not change any current surface land uses. The Modification area and surrounds are used for livestock grazing which would continue. The proposal is not expected to influence the frequency or severity of wildfires. Continued grazing of the area significantly mitigates fire risk and the presence of WCPL employees increases the likelihood of early detection and suppression of fires.

5. *How is the proposal likely to affect habitat connectivity?*

The proposal would not result in any clearance of native vegetation and therefore would not reduce habitat connectivity for *Hunter Lowland Redgum Forest*, *Central Hunter Grey Box – Ironbark Woodland* or *Hunter Valley Weeping Myall Woodland*.

6. *How is the proposal likely to affect critical habitat?*

No Critical Habitat for *Hunter Lowland Redgum Forest*, *Central Hunter Grey Box – Ironbark Woodland* or *Hunter Valley Weeping Myall Woodland* has been declared under the TSC Act (OEH, 2014c) or the EPBC Act (DotE, 2014c) on the Study area or surrounds.

7.4 EPBC ACT CONSIDERATIONS

A search for potential Matters of National Environmental Significance (MNES) was conducted within a 20×20 km square centred on the Modification area using the EPBC Act Protected Matters Search Tool. All entities identified by the database search have been evaluated in this report. None of the threatened ecological communities or threatened species returned by the search was found on the Modification area, or on the wider Study area by the surveys. It is considered that the potential for the Project to significantly impact on MNES (in accordance with DotE [2013] [*Matters of National Environmental Significance Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*]) is very low and therefore that a Referral to the DotE is not warranted.

7.5 STATE ENVIRONMENTAL PLANNING POLICY 44

NSW State Environmental Planning Policy (SEPP) 44 aims to protect habitat utilised by the Koala, *Phascolarctos cinereus*. Forest Red Gum, *Eucalyptus tereticornis*, is a favoured Koala food tree listed in Schedule 2 of SEPP 44. Remnant mature Forest Red Gum trees occur sparingly in the south of the Modification area along Stony Creek and in the north adjacent to Wollombi Brook. SEPP 44 requires consideration of the Study area as potential Koala habitat.

Since there are vegetated patches of land on the Study area that exceed one hectare in size and may have 15% or more coverage by Forest Red Gums, those patches are considered to be potential Koala habitat. However, the area does not have an extant Koala population, and none is known to occur close by (BioNet, 2014; Niche Environment and Heritage, 2014). Accordingly, the Study area does not include 'core' Koala habitat and a SEPP 44 plan of management is not required.

7.6 OVERALL CONCLUSION OF THE ASSESSMENT

It is concluded from the above assessments that the proposed Modification would have no significant impact on threatened flora species, populations, ecological communities or critical habitat.

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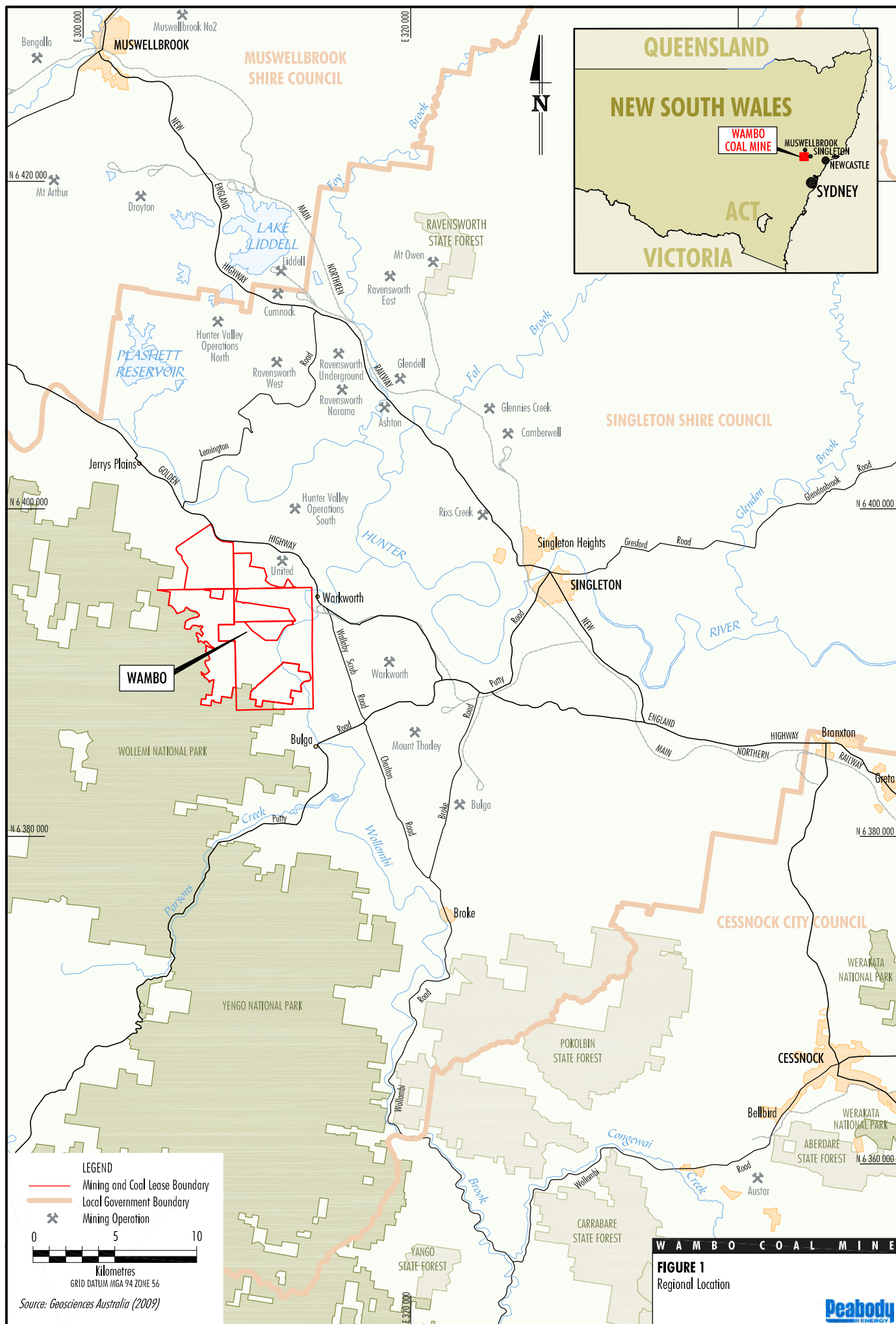
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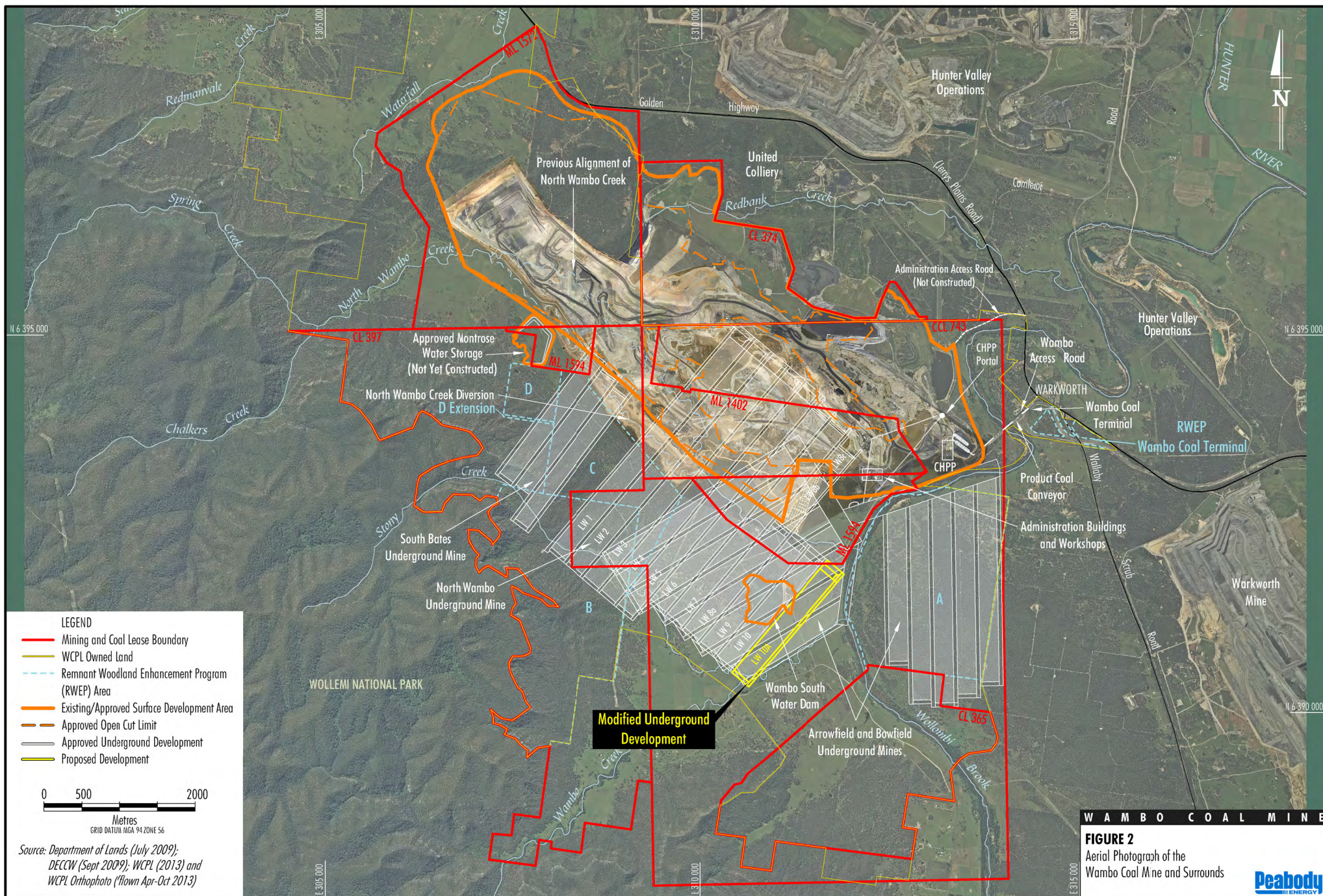
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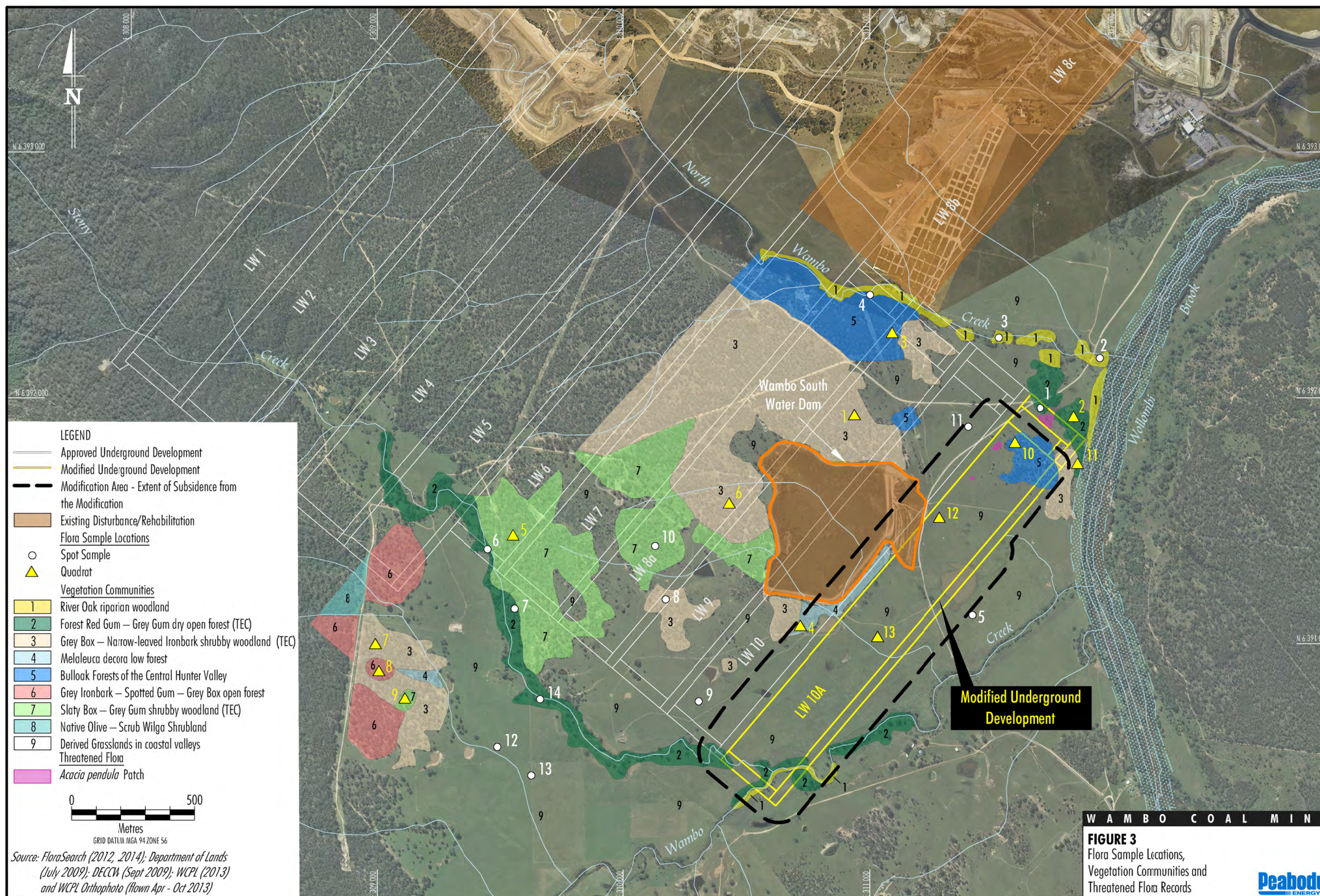
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APPENDIX A

FIGURES







APPENDIX B

FLORA SPECIES LIST FOR THE STUDY AREA

APPENDIX B. FLORA SPECIES LIST FOR EACH VEGETATION COMMUNITY

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
CLASS FILICOPSIDA									
Pteridaceae									
Cheilanthes austrotenuifolia	Rock Fern							•	
Cheilanthes distans	Bristly Cloak Fern	•	•	•	•		•	•	
Cheilanthes sieberi	Poison Rock Fern	•	•	•	•	•	•	•	•
CLASS CONIFEROPSIDA									
Cupressaceae									
Callitris endlicheri	Black Cypress Pine						•		
CLASS MAGNOLIOPSIDA									
SUBCLASS MAGNOLIIDAE									
Acanthaceae									
Brunoniella australis	Blue Trumpet		•	•		•	•	•	
Rostellularia adscendens var. adscendens	Pink Tongues							•	
Aizoaceae									
*Galenia pubescens	Galenia	•	•		•				
Amaranthaceae									
Alternanthera sp. A					•				
*Gomphrena celosioides	Gomphrena Weed					•			•
Anacardiaceae									
*Schinus areira	Pepper Tree	•	•						
Apiaceae									
*Cyclospermum leptophyllum	Slender Celery								•
Daucus glochidiatus form F	Native Carrot		•						
Hydrocotyle tripartita	Pennywort	•							
Apocynaceae									
*Gomphocarpus fruticosus	Narrow-leaved Cotton Bush	•	•			•	•	•	
Asteraceae									
*Aster subulatus	Wild Aster		•						
*Bidens subalternans	Greater Beggar's Ticks		•		•				
Brachyscome multifida	Cut-leaved Daisy			•					
Brachyscome sp.						•			
Calocephalus citreus	Lemon Beauty-heads			•		•			
Calotis cuneifolia	Purple Burr-daisy			•					
Calotis lappulacea	Yellow Burr-daisy		•	•	•	•		•	•
Cassinia arcuata	Sifton Bush					•			
Cassinia cunninghamii	Cunninghams Everlasting			•			•	•	
Cassinia laevis	Cough Bush		•						•
Cassinia quinquefaria							•		
Chrysocephalum apiculatum	Common Everlasting		•	•	•	•		•	•
*Cirsium vulgare	Spear Thistle	•	•		•				•
*Conyza bonariensis	Flaxleaf Fleabane	•	•	•	•				•
*Conyza canadensis		•							
*Conyza sumatrensis	Tall Fleabane		•						•
Cotula australis	Carrot Weed		•		•		•	•	•
Cymbonotus sp.								•	
Euchiton involucratus	Star Cudweed		•	•	•				

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
<i>Euchiton sphaericus</i>	Cudweed							•	
* <i>Facelis retusa</i>	Stinking Roger	•	•					•	•
* <i>Garnochaeta americana</i>	Cudweed		•						•
<i>Glossocardia bidens</i>	Cobbler's Tack		•	•		•		•	
* <i>Hypochaeris glabra</i>	Smooth Catsear		•		•				•
* <i>Hypochaeris microcephala</i> var. <i>albiflora</i>	White Flatweed								•
* <i>Hypochaeris radicata</i>	Catsear		•		•	•			•
<i>Leptorhynchos squamatus</i>			•	•				•	
<i>Olearia elliptica</i>	Sticky Daisy-bush			•		•	•	•	
<i>Ozothamnus diosmifolius</i>	Rice Flower			•				•	
<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed	•							
* <i>Schkuhria pinnata</i> var. <i>abrotanoides</i>	Dwarf Marigold		•						•
<i>Senecio linearifolius</i> var. <i>macrodonatus</i>			•						
* <i>Senecio madagascariensis</i>	Fireweed	•	•	•	•	•	•	•	•
<i>Senecio microbasis</i>								•	
<i>Sigesbeckia orientalis</i> subsp. <i>orientalis</i>	Indian Weed		•						
* <i>Silybum marianum</i>	Variegated Thistle	•							
* <i>Sonchus asper</i>	Prickly Sowthistle		•						
* <i>Sonchus oleraceus</i>	Common Sowthistle	•	•		•			•	•
* <i>Tagetes minuta</i>	Stinking Roger	•	•						
* <i>Taraxacum officinale</i>	Dandelion								•
* <i>Verbesina encelioides</i>	Crownbeard	•							
<i>Vernonia cinerea</i>	A Vernonia	•		•	•			•	
<i>Vittadinia cuneata</i> var. <i>cuneata</i> forma <i>cuneata</i>				•					
<i>Vittadinia cuneata</i> var. <i>hirsuta</i>	Fuzzweed			•				•	
<i>Vittadinia pustulata</i>						•			
* <i>Xanthium italicum</i>	Hunter Burr	•							
Brassicaceae									
* <i>Capsella bursa-pastoris</i>	Shepherd's Purse		•						
* <i>Lepidium africanum</i>	A Peppergrass	•		•					
* <i>Lepidium bonariense</i>					•				
* <i>Rorippa nasturtium-aquaticum</i>	Watercress	•							
Cactaceae									
* <i>Opuntia aurantiaca</i>	Tiger Pear		•	•		•			
* <i>Opuntia humifusa</i>	Creeping Pear		•	•		•		•	
* <i>Opuntia stricta</i>	Prickly Pear			•	•		•	•	
Campanulaceae									
<i>Wahlenbergia communis</i>	Tufted Bluebell						•		
<i>Wahlenbergia gracilis</i>	Australian Bluebell			•	•		•	•	
Caryophyllaceae									
* <i>Cerastium glomeratum</i>	Mouse-ear Chickweed		•						•
* <i>Paronychia brasiliensis</i>	Brasilian Whitlow		•		•				
* <i>Petrorhagia nanteuillii</i>									•
* <i>Polycarpon tetraphyllum</i>	Four-leaved Allseed		•						
* <i>Silene gallica</i>									•
* <i>Spergularia rubra</i>	Sandspurry				•				
<i>Stellaria flaccida</i>		•							
* <i>Stellaria media</i>	Common Chickweed	•	•						

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
Casuarinaceae									
<i>Allocasuarina luehmannii</i>	Bulloak	•	•	•		•	•	•	•
<i>Casuarina cunninghamiana</i>	River Sheoak	•							
Celastraceae									
<i>Maytenus silvestris</i>	Narrow-leaved Orangebark							•	
Chenopodiaceae									
<i>Atriplex semibaccata</i>	Creeping Saltbush	•							
<i>Atriplex</i> sp.			•						
<i>*Chenopodium ambrosioides</i>	Mexican Tea	•							
<i>Einadia hastata</i>	Red Berry Saltbush		•	•	•	•		•	
<i>Einadia nutans</i> subsp. <i>linifolia</i>	Climbing Saltbush	•	•	•	•	•		•	
<i>Einadia nutans</i> subsp. <i>nutans</i>	Climbing Saltbush					•		•	
<i>Einadia polygonoides</i>	Knotweed Goosefoot			•	•			•	
<i>Einadia trigonos</i>	Fishweed							•	
<i>Enchylaena tomentosa</i>	Ruby Saltbush				•	•			
<i>Maireana microphylla</i>	Small-leaf Bluebush	•	•	•	•				•
Clusiaceae									
<i>Hypericum gramineum</i>	Small St. John's Wort					•			•
Convolvulaceae									
<i>Dichondra repens</i>	Kidney Weed		•	•	•		•	•	
Crassulaceae									
<i>Crassula sieberiana</i>	Australian Stonecrop			•		•		•	
Dilleniaceae									
<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower						•		
Euphorbiaceae									
<i>Bertya oleifolia</i>	A Bertya		•	•					
<i>Chamaesyce drummondii</i>	Caustic Weed		•	•		•		•	
Fabaceae - Caesalpinioideae									
<i>Senna coronilloides</i>	A Cassia	•	•					•	
Fabaceae - Faboideae									
<i>Daviesia genistifolia</i>	Broom Bitter Pea			•		•		•	
<i>Daviesia ulicifolia</i>	Gorse Bitter Pea			•			•	•	
<i>Desmodium brachypodium</i>	Large Tick-trefoil			•			•	•	
<i>Desmodium gunnii</i>	Slender Tick-trefoil			•			•	•	
<i>Desmodium varians</i>	Slender Tick-trefoil		•	•		•	•	•	
<i>Glycine clandestina</i>	Love Creeper		•			•			
<i>Glycine tabacina</i>	A Glycine		•	•	•	•		•	
<i>Hardenbergia violacea</i>	Purple Coral-pea						•		
<i>Jacksonia scoparia</i>	Winged Broom-pea						•		
<i>*Medicago polymorpha</i>	Burr Medic								•
<i>*Trifolium arvense</i>	Haresfoot Clover								•
<i>*Trifolium campstre</i>	Hop Clover								•
<i>*Trifolium dubium</i>	Yellow Suckling Clover								•
<i>*Trifolium glomeratum</i>	Clustered Clover		•						•
<i>*Trifolium repens</i>	White Clover		•						•
<i>*Trifolium subterraneum</i>	Subterranean Clover								•
<i>*Trifolium tomentosum</i>	Woolly Clover								•

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
Fabaceae - Mimosoideae									
Acacia amblygona	Fan Wattle			•			•	•	
Acacia binervia	Coast Myall			•				•	
Acacia bulgaensis	Bulga Wattle						•		
Acacia decora	Western Silver Wattle			•				•	
Acacia falcata	Sickle Wattle			•	•				
Acacia filicifolia	Fern-leaved Wattle		•						
Acacia implexa	Hickory Wattle		•					•	
Acacia pendula	Weeping Myall	•							
Acacia salicina	Cooba	•	•	•				•	
Neptunia gracilis forma gracilis	Sensitive Plant		•						
Gentianaceae									
*Centaurium erythraea	Common Centaury								•
Geraniaceae									
Erodium crinitum	Blue Storksbill								•
*Erodium moschatum	Musky Crowfoot								•
Goodeniaceae									
Goodenia rotundifolia	Round Leaf Goodenia			•			•	•	
Lamiaceae									
Mentha satureioides	Creeping Mint					•			
*Prunella vulgaris	Self-heal						•	•	
*Salvia verbenaca	Vervain	•							
Spartothamnella juncea	Bead Bush	•		•			•	•	
Linaceae									
Linum marginale	Native Flax		•			•			
Lobeliaceae									
Pratia purpurascens	Whiteroot		•						
Loranthaceae									
Amyema cambagei		•							
Amyema miquelii	Stalked Mistletoe		•						
Amyema pendulum subsp. pendulum	Drooping Mistletoe		•	•	•		•		
Malvaceae									
Abutilon oxycarpum	Straggly Lantern-bush		•		•		•	•	
Hibiscus heterophyllus subsp. heterophyllus	Native Rosella		•						
*Modiola caroliniana	Red-flowered Mallow	•			•				
*Pavonia hastata	Pink Pavonia		•						
Sida corrugata	Corrugated Sida		•	•		•		•	
*Sida rhombifolia	Paddy's Lucerne	•	•	•	•			•	•
Sida subspicata	Spiked Sida			•	•			•	
Meliaceae									
Melia azedarach	White Cedar		•						
Menispermaceae									
Stephania japonica	Snake Vine	•							
Myrsinaceae									
*Anagallis arvensis	Scarlet Pimpernel	•	•	•	•	•	•	•	•
Myrtaceae									
Angophora floribunda	Rough-barked Apple	•	•						
Corymbia maculata	Spotted Gum						•		

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark		•	•	•	•	•	•	
<i>Eucalyptus dawsonii</i>	Slaty Gum		•	•				•	
<i>Eucalyptus melliodora</i>	Yellow Box		•						
<i>Eucalyptus moluccana</i>	Grey Box		•	•	•		•	•	
<i>Eucalyptus tereticornis</i>	Forest Red Gum	•	•		•				
<i>Melaleuca decora</i>	White Feather Honeymyrtle			•	•		•		
Oleaceae									
<i>Jasminum voluble</i>	Stiff Jasmine			•					
<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	Native Olive	•	•	•				•	
* <i>Olea europaea</i>	Common Olive	•							
Oxalidaceae									
<i>Oxalis radiciosa</i>			•						•
<i>Oxalis</i> sp.	An Oxalis		•		•			•	•
Papaveraceae									
* <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>	Mexican Poppy	•							
Phyllanthaceae									
<i>Breynia oblongifolia</i>	Coffee Bush		•					•	
<i>Phyllanthus</i> sp.	A Phyllanthus			•					
Pittosporaceae									
<i>Bursaria spinosa</i>	Blackthorn	•		•			•	•	
Plantaginaceae									
* <i>Plantago lanceolata</i>	Lamb's Tongue	•	•	•	•	•		•	•
* <i>Plantago myosuros</i>									•
<i>Veronica plebeia</i>	Trailing Speedwell		•	•		•			•
Polygonaceae									
<i>Persicaria lapathifolia</i>	Pale Knotweed		•						
<i>Persicaria prostrata</i>	Creeping Knotweed	•	•						
<i>Rumex brownii</i>	Swamp Dock		•						
* <i>Rumex crispus</i>	Curled Dock	•							
Ranunculaceae									
<i>Clematis microphylla</i>	Small-leaved Clematis		•						
Rosaceae									
<i>Rubus moluccanus</i> var. <i>trilobus</i>	Molucca Bramble	•							
<i>Rubus parvifolius</i>	Native Raspberry	•							
Rubiaceae									
<i>Asperula conferta</i>	Common Woodruff			•		•		•	
<i>Opercularia diphylla</i>				•			•		
<i>Psydrax odorata</i>	Shiny-leaved Canthium			•			•	•	
* <i>Richardia stellaris</i>				•					
Rutaceae									
<i>Geijera salicifolia</i>		•	•		•		•	•	
Santalaceae									
<i>Choretrum</i> species A				•			•	•	
<i>Exocarpos cupressiformis</i>	Native Cherry						•		
<i>Exocarpos strictus</i>	Dwarf Cherry		•						
Sapindaceae									
<i>Dodonaea sinuolata</i> subsp. <i>sinuolata</i>								•	

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
<i>Dodonaea viscosa</i> subsp. <i>cuneata</i>	Wedge-leaf Hop-bush			•			•	•	
<i>Dodonaea viscosa</i> subsp. <i>spatulata</i>								•	
Scrophulariaceae									
<i>Eremophila debilis</i>	Amulla	•	•	•	•	•	•	•	
<i>Myoporum montanum</i>	Western Boobialla		•	•	•			•	
Solanaceae									
* <i>Cestrum parqui</i>	Green Cestrum	•	•						
* <i>Datura stramonium</i>	Common Thornapple	•							
* <i>Lycium ferocissimum</i>	African Boxthorn	•	•		•				
* <i>Nicotiana glauca</i>	Tree Tobacco	•							
<i>Solanum aviculare</i>	Kangaroo Apple		•						
<i>Solanum cinereum</i>	Narrawa Burr								•
<i>Solanum brownii</i>	Violet Nightshade			•				•	•
* <i>Solanum elaeagnifolium</i>	Silver-leaved Nightshade								•
* <i>Solanum mauritianum</i>	Wild Tobacco Bush	•							
* <i>Solanum nigrum</i>	Black-berry Nightshade	•	•					•	
Stackhousiaceae									
<i>Stackhousia muricata</i>	Western Stackhousia						•	•	
Sterculiaceae									
<i>Brachychiton populneus</i>	Kurrajong	•	•	•	•			•	
<i>Rulingia dasphylla</i>	Kerrawang		•						
Ulmaceae									
<i>Trema tomentosa</i> var. <i>aspera</i>	Poison Peach		•						
Urticaceae									
<i>Urtica incisa</i>	Stinging Nettle	•	•						
Verbenaceae									
* <i>Verbena caracasana</i>		•	•						•
* <i>Verbena bonariensis</i>	Purpletop		•						•
* <i>Verbena ridgii</i>	Veined Verbena		•						•
Vitaceae									
<i>Cayratia clematidea</i>	Native Grape		•						
SUBCLASS LILIIDAE									
Anthericaceae									
<i>Arthropodium milleflorum</i>	Pale Vanilla-lily			•				•	
<i>Arthropodium minus</i>	Small Vanilla Lily						•	•	
<i>Dichopogon fimbriatus</i>	Nodding Chocolate Lily				•				
<i>Laxmannia gracilis</i>	Slender Wire Lily			•					
Cyperaceae									
<i>Carex appressa</i>	Tall Sedge		•						
<i>Cyperus gracilis</i>	Slender Flat-sedge		•	•	•			•	
<i>Cyperus haspan</i>									•
<i>Cyperus polystachyos</i>		•							
<i>Fimbristylis dichotoma</i>	Common Fringe-sedge					•		•	•
<i>Gahnia aspera</i>	Common Saw-sedge		•					•	
<i>Scleria mackaviensis</i>								•	
Iridaceae									
* <i>Romulea rosea</i>	Onion Grass								•
Juncaceae									

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
<i>*Juncus acutus</i>	Sharp Rush	•							
<i>Juncus sp.</i>	A Rush	•	•						
Lomandraceae									
<i>Lomandra confertifolia</i>	Mat-rush			•			•		
<i>Lomandra filiformis</i> subsp. <i>coriacea</i>				•			•	•	
<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	Wattle Mat-rush		•	•	•		•	•	•
<i>Lomandra multiflora</i>	Many-flowered Mat-rush			•		•		•	
Phormiaceae									
<i>Dianella caerulea</i> var. <i>cinerascens</i>	Blue Flax Lily			•				•	
<i>Dianella longifolia</i> var. <i>longifolia</i>	Blueberry Lily		•						
<i>Dianella longifolia</i> var. <i>stenophylla</i>							•	•	
<i>Dianella revoluta</i>	Spreading Flax-lily			•					
<i>Dianella sp.</i>				•				•	
Poaceae									
<i>Ancistrachne uncinulata</i>	Hooky Grass							•	
<i>Aristida personata</i>	Purple Wire-grass	•	•	•	•	•		•	•
<i>Aristida vagans</i>	Threeawn Speargrass		•	•		•		•	•
<i>Austrostipa scabra</i>	Speargrass		•	•	•			•	
<i>Austrostipa verticillata</i>	Slender Bamboo Grass	•	•		•				•
<i>Bothriochloa decipiens</i>	Red Grass	•	•	•	•	•		•	•
<i>*Briza minor</i>	Quaking Grass		•						
<i>*Bromus cartharticus</i>	Prairie Grass								•
<i>*Chloris gayana</i>	Rhodes Grass	•							
<i>Chloris truncata</i>	Windmill Grass				•				
<i>Chloris ventricosa</i>	Plump Windmill Grass	•		•	•	•		•	
<i>Cymbopogon refractus</i>	Barbwire Grass	•	•	•		•	•	•	
<i>Cynodon dactylon</i>	Couch	•	•		•				•
<i>Dichelachne micrantha</i>	Shorthair Plumegrass								•
<i>Digitaria brownii</i>	Cotton Panic Grass		•						•
<i>Digitaria diffusa</i>	Open Summer Grass		•	•	•	•		•	
<i>Digitaria divaricatissima</i>	Umbrella Grass		•			•			•
<i>*Ehrharta erecta</i>	Panic Veldtgrass	•							
<i>Enteropogon acicularis</i>	Curly Windmill Grass			•	•	•			•
<i>Eragrostis brownii</i>	Brown's Lovegrass		•					•	
<i>*Eragrostis curvula</i>	African Lovegrass			•					
<i>Eragrostis elongata</i>	Clustered Lovegrass		•		•	•			•
<i>Eragrostis leptostachya</i>	Paddock Lovegrass		•	•	•	•		•	•
<i>Eragrostis parviflora</i>	Weeping Lovegrass		•	•	•			•	
<i>Eriochloa pseudoacrotricha</i>	Early Spring Grass				•	•		•	
<i>Eulalia aurea</i>	Silky Browntop		•			•			
<i>Lachnagrostis filiformis</i>									•
<i>*Megathyrsus maximus</i>	Guinea Grass	•							
<i>Microlaena stipoides</i>	Weeping Grass	•	•	•		•		•	•
<i>Oplismenus imbecillis</i>	Basket Grass	•							
<i>Panicum effusum</i>	Hairy Panic		•	•		•		•	•
<i>Panicum simile</i>	Two Coloured Panic			•		•		•	•
<i>Paspalidium criniforme</i>	Fine Panic			•		•		•	
<i>Paspalidium distans</i>						•			

Scientific Name	Common Name	Community							
		1	2	3	4	5	6	7	9
<i>Paspalidium gracile</i>	Slender Panic		•						
* <i>Paspalum dilatatum</i>	Paspalum		•			•			•
* <i>Pennisetum clandestinum</i>	Kikuyu Grass	•	•						
<i>Phragmites australis</i>	Common Reed	•							
<i>Rytidosperma fulvum</i>	Wallaby Grass			•		•		•	
<i>Rytidosperma longifolium</i>	Long-leaved Wallaby Grass			•			•		
<i>Rytidosperma racemosum</i> var. <i>obtusatum</i>	Wallaby Grass							•	
* <i>Setaria pumila</i>	Pale Pigeon Grass	•	•			•			•
<i>Sporobolus creber</i>	Slender Rat's Tail Grass	•	•	•	•	•		•	•
<i>Urochloa piligera</i>	Hairy Armgrass	•							
TOTAL NATIVE SPECIES	190	40	87	88	46	50	45	96	33
TOTAL INTRODUCED SPECIES	83	39	40	11	17	10	5	11	39
GRAND TOTAL SPECIES	273	79	127	99	63	60	50	107	72